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WELDING ABSTRACTS

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(6) Welding in the World, vol.52, no.5-6. May-June. 2008. pp.95-109. 31 fig., 3 tab., 17 ref. ISSN: 0043-2288

(7) [in English] (IIW-1858-07 (ex doc.XIII-2163r1-07)) [See also Weldasearch 232428]

(8) An experimental study was carried out to investigate the applicability of structural plates made from newly developed low carbon steels (0.04-0.07%C, 0.22-0.44%Si, 0.99-1.55%Mn) for use in welded structures such as bridges and ships; improvements in fatigue life for example welded components were assessed. Fatigue testing was carried out on plain plates and example welded joint configurations found in ships and bridges (beam to column connections, steel plate girders, joints between deck plates and U-ribs). The test pieces included submerged arc welded and CO2 welded joints. Fracture mechanisms were investigated also. The use of these plates in the construction of the Nyuno Bridge (Japan) is noted.

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(8) **Abstract**, tending to be indicative rather than the informative; usually 50-100 words in length.

(9) **Company** or **companies** referred to in the article.

01 ARC WELDING

See also abstracts: 09-277353, 30-277333, 40-277322, 40-277358, 40-277404, 42-277368, 44-277360, 44-277367, 45-277363

01-277323

The effect of SiC addition on microstructure and mechanical properties of gas tungsten arc [TIG]-welded Ti-6Al-4V alloy.

LANGEN D; MAIER H J; HASSEL T

Journal of Materials Engineering and Performance, vol.27, no.1. Jan.2018. pp.253-260. 13 fig., 2 tab., 18 ref. ISSN: 1059-9495

[in English]

[https://link.springer.com/article/10.1007%2Fs11665-017-3091-y]

The influence of silicon carbide (SiC) addition on the microstructure, mechanical properties and grain size of TIG welded Ti6Al4V alloy was studied. A groove (0.4 mm depth, 5 mm width) was milled along the longitudinal axis of Ti6Al4V (Ti, 6.33%Al, 3.94%V) specimens (120 x 68 x 3 mm), filled with SiC and subjected to bead-on-plate welding (current 80 A, shielding gas argon 4 l/min, standoff distance 3 mm, travel speed 100 mm/min) with filler wire (Ti, 6.05%Al, 4.10%V). Fusion joint welding (current 80 A, shielding gas argon 4 l/min, standoff distance 1 mm, travel speed 120 mm/min, wire feed 0.4 m/min) was performed on Ti6Al4V alloy sheet metal (2 mm thickness; Ti, 6.15%Al, 3.80%V) with a V-shaped butt joint preparation without root face and bevel angle of 45 degrees, coated with SiC powder. The tensile strength, strain, microstructure and hardness of the joints were analysed and compared with those with no SiC additions.

01-277325

Microstructures and mechanical properties of plasma arc welded joints of ultra-high strength steel and aluminium alloy using Al-Si and Al-Cu fillers.

GENG W H; WU D; SUN D Q; LI H M; CHE Y Y

ISIJ International, vol.58, no.6. June 2018. pp.1108-1116. 11 fig., 3 tab., 31 ref. ISSNs: 0915-1559, 1347-5460

[in English]

[https://tinyurl.com/ybx2g48a]

The weld appearance, microstructure and mechanical properties of plasma arc welded joints of ultra high strength steel and aluminium alloy were investigated. Ultra high strength steel (1180DP - max. 0.23%C, 3%Mn) and aluminium alloy (5A06 - Al, 6.25%Mg, 0.72%Mn, 0.21%Fe) sheets of 3 mm thickness were welded using different preparations (steel bevel angle 45 degrees; aluminium alloy angle 0, 30 and 45 degrees). Filler materials used were: Al-Si (ER 4043 - Al, 5%Si, max. 0.25%Cr, max. 0.2%Zn) and Al-Cu (ER 2319 - Al, 5.8-6.8%Cu, 0.2-0.4%Mn, 0.2-0.4%Mg). Welding parameters used were: current 80-110 A; speed 32 cm/min; wire feed rate 300 cm/min; Ar shielding gas flow rate 23 l/min; plasma gas flow rate 2.3 l/min. The microstructure characteristics of the weld zone, bond zone and interface zone of the welded joints were examined by SEM, X-ray diffraction, energy dispersive spectroscopy and transmission electron microscopy. Diffraction patterns and the interdiffusion of Fe and Al in the interface zone were measured and compared. The effect on the weld appearance of the joint preparations was analysed. The welding parameters and filler wire composition and their effect on the thickness of the interface layer, and the microhardness, tensile strength and fracture surface morphology of the welded joints were investigated.

01-277331

Peculiarities of development of structural heterogeneity in the fusion zone of pearlite steel with austenitic nitrogen-containing weld metal.

ELAGIN V P; LIPODAEV V N; GORDAN G N

Paton Welding Journal, no.8. Aug.2016. pp.23-28. 7 fig., 14 ref. ISSN: 0957-798X

[in English and Russian] *(Translated from Avtomaticheskaya Svarka) [See also Weldasearch 156521]*

[https://patonpublishinghouse.com/eng/journals/tpwj/2016/08/05/]

Structural heterogeneity at the weld metal and pearlitic steel parent material interface was studied for welds produced using austenitic steel filler materials and operating at high temperature. To study the influence of the nickel content of the filler material and the nitrogen content of the weld metal on carbon diffusion from the parent material leading to embrittlement, bead on plate welds were produced on low carbon steel plate (20-22 mm thickness) by MIG/MAG welding using austenitic steel 08Kh20N9G7T, 08Kh20N25M8G8 and 08Kh25N40M7 filler wires of 1.2 mm diameter, with argon, carbon dioxide, nitrogen, and CO2, 5-80%N2 shielding gases, to vary the nitrogen content of the weld metal. The welding parameters were: current 240-260 A; voltage 24-26 V; speed 16 or 25 m/h; energy inputs of 0.41 and 0.79 kJ/cm. Service conditions were simulated by heating the specimens to 550 deg.C for 1000-3000 h. Composition (including carbon distribution), microhardness, and microstructure (including the formation of carbides, nitrides and a ferrite interlayer in the HAZ) were characterised. Lack of penetration low carbon steel plate butt welds were produced using 08Kh20N9G7T filler wire and CO2, 2%N2 shielding gas; and using 08Kh25N40M7 filler wire with Ar shielding gas. The specimens were subjected to heat treatment (550 deg.C, 3000 h) and embrittlement assessed by bend testing.

01-277335

Stainless Q&A [Questions and Answers] [TIG welding of 17-4PH stainless steel].

KOTECKI D J

Welding Journal, vol.97, no.9. Sep. 2018. pp.20-21. 2 fig., 1 ref. ISSN: 0043-2296

[in English]

[https://bit.ly/33Fu8qp]

Solutions for penetration problems when TIG welding two pieces of 17-4PH stainless steel (16%Cr, 4%Ni, 4%Cu) in a lap joint configuration using a lathe welding machine are presented. A fusion run, the first of two TIG welding runs performed, resulted in wide and shallow penetration. The Marangoni Effect, where a fluid flow in a liquid is driven by a surface tension gradient, is explained. The effect of sulphur content on the direction of the surface tension and the use of argon-oxygen decarburisation (AOD) to deal with very low sulphur content (0.010%) are discussed. Overcoming the penetration problem of 17-4PH with very low sulphur content (0.0003%) by painting a penetration enhancing flux on the joint surfaces before welding is briefly described.

01-277340

Influence of multiple Gleeble - simulated weld thermal cycles on maraging 17-4 and 13-8+Mo.

HAMLIN R J; DUPONT I N

Welding Journal, vol.97, no.9. Sep. 2018. Supplement: Welding Research. pp.253s-262s. 13 fig., 2 tab., 29 ref. ISSN: 0043-2296

[in English]

[https://bit.ly/2Zf9zSn]

The effects of multirun welding represented by primary and secondary

welding thermal cycles, on maraging 17-4 and 13-8+Mo stainless steels was investigated. PH-17-4 (0.03%C, 0.41%Mn, 16.08%Cr, 4.09%Ni, 0.21%Mo, 0.20%Nb) and PH-13-8+Mo (0.06%C, 0.19%Mn, 12.71%Cr, 7.90%Ni, 2.27%Mo) plates were solution treated at 1052 deg.C and 926 deg.C respectively. The 17-4 samples were air cooled to room temperature and aged for 1.5 h at 579 deg.C. The 13-8+Mo samples were argon gas cooled, water quenched to 15 deg.C and aged at 593 deg.C for 4 h. Autogenous TIG welding was performed on sheets (1.27 cm thickness) of each material using current 200 A, voltage 10 V, travel speed 1 mm/s, argon shielding gas and various combinations of simulated welding thermal cycles (650-1300 deg.C, 650-1150 deg.C, 650-875 deg.C; 1000 and 2000 J/mm heat input), representative of multirun welding, using a thermo-mechanical simulator. The hardness of the samples was determined and microstructure analysed. The results are discussed with regard to the hardening behaviour and matrix microstructures of the parent material and weld metal.

01-277357

Characteristics of hot cracking in dissimilar joint of A690 overlay and stainless steel clad.

KO G B; SEO K M; KIM H J; HONG H

Welding in the World, vol.61, no.5. Sep. 2017. pp.945-953. 12 fig., 4 tab., 19 ref. ISSN: 0043-2288

[in English]

[https://rd.springer.com/article/10.1007%2Fs40194-017-0477-2]

The hot cracking behaviour and characteristics of a joint between A690 Nb-containing solid-solution Ni-base alloy overlay and stainless steel were investigated. Submerged arc welding (SAW) was used to deposit 309L (first layer) and 308L (second layer) stainless steel strip electrodes (thickness 0.5 mm) onto SA 508 Gr3 (0.24%C, 1.41%Mn, 0.22%Cr, 0.91%Ni) steel plate (40 mm thickness). Bead on plate welds of A690 nickel alloy (Ni, 30%Cr, 9.44%Fe, 3.34%Mn, 1.86%Nb) were deposited onto the 308L layer (0.028%C, 1.82%Mn, 20.7%Cr, 10%Ni, 0.006%Nb, 0.007%Ti) using MMA welding process (current 130-140 A; voltage 30 V; welding speed 150 mm/min) as a single run or as three runs. The microstructure and phase composition of the A690 weld bead and the 308L deposited layer were determined. The proportion of Laves phase distribution, the Fe content in the A690 weld near the welded joint, and liquation cracking susceptibility were observed and the results are discussed.

01-277359

Single pass full penetration joining for heavy plate steel using high current GMA [MIG/MAG] process.

BABA H; ERA T; UEYAMA T; TANAKA M

Welding in the World, vol.61, no.5. Sep. 2017. pp.963-969. 11 fig., 2 tab., 15 ref. ISSN: 0043-2288

[in English] *[See also Weldasearch 273910]*

[https://rd.springer.com/article/10.1007%2Fs40194-017-0464-7]

A MAG welding system based on current waveform control with 100% CO2 shielding gas was developed to facilitate single-run full-penetration welding of a structural steel heavy plate (thickness 25 mm) and metal transfer modes and high-current buried arc stabilisation characteristics were investigated. The materials studied were a JIS SS400 carbon steel parent metal and a JIS YGW12 carbon steel filler wire. Buried arc phenomena were observed by a high-brightness X-ray system and a high-speed video camera. Drop, pendulum and rotating metal transfer modes were examined at wire feed rates of 30, 50 and 60 m/min, respectively. Issues discussed include arc generation under the surface of the molten pool, spatter generation reduction and arc stabilisation by low-frequency modulated voltage control.

01-277361

A study on sidewall penetration of cable-type welding wire electrogas welding.

CHEN Y; FANG C F; YANG Z D; WANG J Y; WU M F

Welding in the World, vol.61, no.5. Sep. 2017. pp.979-986. 12 fig., 4 tab., 22 ref. ISSN: 0043-2288

[in English] *[See also Weldasearch 275637]*

[https://rd.springer.com/article/10.1007%2Fs40194-017-0479-0]

The sidewall penetration mechanism of cable type welding wire electrogas welding (CWW-EGW) was studied. This process uses cable type welding wire (CWW) as the consumable electrode, with up to seven wires able to be melted simultaneously using a single power source, wire feeder and welding torch. Joints were fabricated in steel substrates (max. 0.18%C, 0.9-1.6%Mn, 0.05-0.1%V; 30 mm thickness) using CWW-EGW (3 mm diameter) or single-wire EGW (1.6 mm diameter) under CO2 shielding gas at 28 L/min. Welding parameters used were: current 380-475 A; voltage 37.0-42.6 V; welding torch swing 5-15 mm; welding torch dwell time 0-2.5 s. Welding arc, droplet transfer and sidewall penetration were monitored by a high speed digital camera. Microstructure, elongation, tensile strength and hardness of the welded joints were determined. The influence of droplet transfer on sidewall penetration during CWW-EGW was evaluated.

01-277366

Effect of rare earth metal on plasma properties in GMAW [MIG/MAG] using CO2 shielding gas.

METHONG T; YAMAGUCHI T; SHIGETA M; TANAKA M; IKEDA R; MATSUSHITA M; POOPAT B

Welding in the World, vol.61, no.5. Sep. 2017. pp.1039-1047. 15 fig., 1 tab., 23 ref. ISSN: 0043-2288

[in English] *[See also Weldasearch 240813]*

[https://rd.springer.com/article/10.1007%2Fs40194-017-0491-4]

The influence of polarity and rare earth metal (REM) content on the plasma properties during MAG welding was investigated using optimal emission spectroscopy. Welding of SS400 carbon steel substrate was carried out using MG-50 wire electrode (0.04%C, 1.58%Mn, 0.22%Ti; 1.2 mm diameter) or KC-500 wire electrode (0.05%C, 1.6%Mn, 0.2%Ti, added REM; 1.2 mm diameter) under CO2 shielding gas at 20 L/min, in either direct current electrode positive (DCEP) or direct current electrode negative (DCEN) polarity. Welding parameters used were: current 300 A; voltage 33.5 V; welding travel speed 60 cm/min. Arc plasma temperature, electron density, and metal vapour concentrations were determined. The spectroscopic data were evaluated and compared with images from a high speed camera. The maximal temperature and distribution in the plasma region were determined. The relationship between the REM addition and high current density, electromagnetic pinch force and droplet diameter briefly discussed.

01-277461

Elucidation of the weld pool convection and keyhole formation mechanism in the keyhole plasma arc welding.

WU D S; NGUYEN A V; TASHIRO S; HUA X M; TANAKA M

International Journal of Heat and Mass Transfer, vol.131. Mar. 2019. pp.920-931. 21 fig., 1 tab., 44 ref. ISSN: 0017-9310

[in English] *[See also Weldasearch 245904 and 273811]*

Weld pool convection and keyhole formation mechanism in keyhole plasma arc welding (KPAW) of stainless steel (SS) was investigated, using numerical simulation. An electrode-arc model was developed to examine the plasma arc physics in KPAW, and to obtain significant parameters related to the current density, arc pressure and plasma

shear stress. A 3D weld pool model was developed based on a self-adaptive heat source model, arc pressure model and plasma shear stress model, to examine the weld pool convection and keyhole formation. Numerical simulation was applied to the KPAW of SUS304 SS sheet (thickness 4 mm), to examine weld pool convection (before and after penetrated keyhole formation) and the keyhole formation mechanism. Welding experiments were conducted on SUS304 SS sheets (thickness 4 mm) using KPAW (direct current 120 A; output arc voltage 27 V; welding speed 3 mm/s; argon main plasma gas flow rate 1.7 l/min; argon shielding gas flow rate at 7.5 l/min). Convective patterns inside the weld pool were estimated by use of an X-ray transmission system to observe the movement of W particles. Convective patterns on the weld pool surface were measured by use of a high speed video camera to observe the movement of ZrO2 particles. Temperature distributions at the weld pool surfaces were measured with a thermal camera. Numerical simulation and experimental results are compared.

02 RESISTANCE WELDING

02-277324

Quality estimation in small scale resistance spot welding of titanium alloy based on dynamic electrical signals.

WAN X D; WANG Y X; ZHAO D W

ISIJ International, vol.58, no.4. Apr.2018. pp.721-726. 7 fig., 1 tab., 21 ref. ISSNs: 0915-1559, 1347-5460

[in English] *[See also Weldasearch 259881]*

[https://www.jstage.jst.go.jp/article/isijinternational/58/4/58_ISIJINT-2017-282/_article]

The development of a quality monitoring system in small scale resistance spot welding (SSRSW) of titanium alloy was investigated. Sheets of Ti alloy TC2 (Ti, 3.5-5.0%Al, 0.8-2.0%Mn, 0.30%Fe, 0.15%O, 0.10%C, 0.05%N) of 0.4 mm thickness were spot welded in a series of tests. Electrode force was varied from 75 to 200 N, welding current from 1.0 to 2.4 kA, and welding time from 4 to 12 milliseconds. Tensile shear strength of the welded joints was determined and the nugget size was measured. The effect of varied parameters on dynamic resistance; nugget size; weld quality; and detection of weld expulsion were determined. A back propagation neural network (BPNN) analysis was carried out, using proprietary software for model training and validation. The nugget size predictions were compared with experimental values. A brief assessment of the accuracy of using BPNN with dynamic resistance signals for quality monitoring and classification purposes is given.

03 ENERGY BEAM PROCESSES

See also abstracts: 08-277347, 09-277460, 30-277342, 30-277343, 30-277344, 30-277345, 40-277358

03-277320

Experimental study of the microstructure and micromechanical properties of laser cladded Ni-based amorphous composite coatings.

LI R F; ZHENG Q C; ZHU Y Y; LI Z G; FENG K; LIU C

Journal of Materials Engineering and Performance, vol.27, no.1. Jan.2018. pp.80-88. 14 fig., 1 tab., 27 ref. ISSN: 1059-9495

[in English]

[https://link.springer.com/article/10.1007%2Fs11665-017-3066-z]

The microstructure of NiFeBSiNbC amorphous composite coating fabricated using laser surfacing was investigated. (Ni0.6Fe0.4)65B18Si10Nb4C3 (atomic %) coating was deposited on AISI 1045 steel (150 x 15 x 10 mm) using a fibre laser with a coaxial powder delivery nozzle. The laser beam focused on a 5 x 5 mm spot on the parent material, the powder was dried for 2 hours at 200 deg.C before surfacing and argon shielding gas was used at 10 l/min. The process parameters were laser power 2100-4200 W, scanning speed 16-80 mm/s, feeding rate 13.3-20.9 g/min, heat input 52.5-131.3 J/mm, coating thickness 0.19-0.45 mm, heat affected zone (HAZ) 0.41-0.59 mm. The microstructure was analysed as a function of laser heat input, and the hardness and indentations determined. Theoretical results, predicted using the Orowan-Ashby equation, were compared with the experimental results.

03-277321

Effects of the electron beam welding process on the microstructure, tensile, fatigue and fracture properties of nickel alloy Nimonic 80A.

ZHANG H; HUANG C X; GUAN Z W; LI J K; LIU Y J;
CHEN R H; WANG Q Y

Journal of Materials Engineering and Performance, vol.27, no.1. Jan.2018. pp.89-98. 14 fig., 2 tab., 36 ref. ISSN: 1059-9495

[in English]

[https://link.springer.com/article/10.1007%2Fs11665-017-3068-x]

The effect of electron beam welding (EBW) on the microstructure, rotary bending fatigue properties and mechanical behaviour of Nimonic 80-A was studied. Two plates (200 x 45 x 14 mm) of forged nickel alloy Nimonic 80-A (Ni, 0.04-0.10%C, 18.0-21.0%Cr, 1.00-1.80%Al, 1.8-2.7%Ti,) underwent EBW butt welding with welding parameters accelerating voltage 85 kV, beam current 40 mA, cathode heating current 20 A, vacuum in working chamber 0.08 mBar and welding velocity 1400 mm/min. The stress distribution was calculated using finite element method (FEM). The hardness, rotary bending fatigue and fatigue crack growth were determined. The results are discussed with regard to the microstructure, tensile properties, microhardness, rotary bending high-cycle fatigue properties, cyclic stress versus variation of fatigue life and fatigue crack growth properties of the alloy, and its weldment.

03-277330

Formation of weld metal structure in electron beam welding of single crystals of high-temperature nickel alloys.

YUSHCHENKO K A; ZADERY B A; GAKH I S;
KARASEVSKAYA O P

Paton Welding Journal, no.8. Aug.2016. pp.15-22. 10 fig., 4 tab., 23 ref. ISSN: 0957-798X

[in English and Russian] *(Translated from Avtomaticheskaya Svarka) [See also Weldasearch 236418]*

[https://patonpublishinghouse.com/eng/journals/tpwj/2016/08/04/]

The influence of the orientation and welding parameters on molten pool crystal orientation in EB welded nickel alloy single crystal welds was investigated. Bead on plate welds were produced on sheet specimens of single crystal high temperature nickel alloys JS26 (Ni, 9.0%Co, 5-15%W, 5.0%Cr, 4.5-8.0%Al, 1.6%Nb, 1.0%V, 0.5-5.0%Mo, 0.2-4.0%Ti) and JS32 (Ni, 9.3%Co, 2-10%W, 5.0%Cr, 4.5-8.0%Al, 4.0%Re, 4.0%Ta, 1.5-5.0%Nb, 0.5-5.0%Mo) by EB welding at speeds of up to 90 m/h, with other welding parameters chosen to ensure full penetration. Heating and cooling rates of the molten pool were measured. The gamma phase dispersion, dendrite spacing, phase composition, carbide precipitates, dislocation density and distribution, and the presence of randomly oriented grains were determined. Numerical modelling was used to study the solidification

of the molten pool, and the range of solidification temperature rates for which no randomly oriented grains were formed were established.

03-277338

Laser welding Q&A [Questions and Answers] [focused spot size in laser welding].

ENGEL S L

Welding Journal, vol.97, no.9. Sep. 2018. pp.44-45. 3 fig., 3 ref. ISSN: 0043-2296

[in English]

[https://bit.ly/2z7eaHs]

Focus shift and its effects on focused spot size in laser welding is briefly discussed. Focus shift is defined. Sources for focus shift including changes in the laser beam divergence and the build-up of heat in the beam optics are discussed. Solutions for uncontrolled divergence of laser beams are provided which involve installing a collimator or beam expander between the laser and focusing lens. An example is given of an Nd:YAG laser with power increasing from 50 to 500 W, and the distance between the two optics shortened by approximately 3.81 cm to maintain collimation. Methods to solve heat build-up in optics by using metal mirror focusing heads and by controlling the effect of heat (cleaning optical surfaces, use of long focal length optics, and optics coatings) are briefly discussed.

03-277346

Japan develops blue laser for advanced materials processing.

TOJO K; MASUNO S; HIGASHINO R; TSUKAMOTO M

Industrial Laser Solutions for Manufacturing. Sept.-Oct. 2018. pp.27-31. 12 fig., 1 tab., 10 ref. ISSN: 1523-4266

[in English]

An overview of a research and development project in Japan into a next-generation laser processing system based on high-power blue laser diodes is presented. The Development of Advanced Laser Processing with Intelligence Based on High-Brightness and High-Efficiency Laser Technologies (2016-2020) project seeks to develop BLUE IMPACT, a fibre-coupled high-brightness blue diode laser module that combines blue direct diode lasers (B-DDLs) in order to achieve a high power output (100 W from a 0.1 mm diameter fibre). The basic technology, combining technology and characteristics of the B-DDL are discussed, and examples of laser processing, lap welding and 3D printing with a BLUE IMPACT module are described.

03-277355

Experimental measurements and numerical simulations of distortions of overlap laser-welded thin sheet steel beam structures.

ANDERSSON O; BUDAK N; MELANDER A; PALMQUIST N

Welding in the World, vol.61, no.5. Sep. 2017. pp.927-934. 6 fig., 2 tab., 15 ref. ISSN: 0043-2288

[in English]

[https://rd.springer.com/article/10.1007%2Fs40194-017-0496-z]

Distortions in overlap laser welded beam structures of thin sheets of mild steel, used in automotive applications, were investigated experimentally and numerically. Overlap joints were fabricated between thin sheet and U-beam structures of uncoated mild steel VDA-100 CR-3 (0.08%C, 0.5%Mn, 0.3%Ti) by Nd:YAG laser (welding power 2400-4000 W; welding velocity 40-80 mm/s; sheet thickness 1.0-1.5 mm) in intermittent or continuous welding patterns. The influence of intermittent welding, heat input per length, weld length and sheet thickness on vertical and transverse distortions after cooling was examined. The welding distortions and shrinkage of the weld zone during cooling were modelled using finite element simulations and compared with experimental results.

03-277467

Comparison of electron beam and laser welding for safety critical space applications.

MITCHELL T; ALLEN C; NORMAN A

E+E (Electrotechnica & Electronica), vol.53, no.9-10. 2018. Special Issue: Scientific papers from 13th International Conference on Electron Beam Technologies, Varna, Bulgaria, 18-22 June 2018. pp.241-247. 19 fig., 2 tab., 3 ref. ISSN: 0861-4717

[in English]

[https://epluse.tceptt.com/comparison-of-electron-beam-and-laser-welding-for-safety-critical-space-applications/]

Electron beam (EB) and laser welding of stainless steel were investigated and compared, for producing propellant flow control valves (FCVs) used to position satellites for space applications. A 60 kV 4 kW EB welding system with a fixed welding speed (20 mm/s) was evaluated (with and without beam deflection) by identifying suitable welding parameters by beam current adjustment to achieve partial penetrated joints with penetration depths of 0.2-1.5 mm. Multi-kilowatt CW fibre laser welding was evaluated for achieving penetration depths of 0.7-1.5 mm by altering the welding speed (laser power 1.5-2 kW; welding speed 4.5-9.5 m/min). Subkilowatt and pulsed laser welding were evaluated for producing shallow welds (penetration depth 0.2-0.7 mm), using a quasi continuous wave (QCW) fibre laser at a fixed welding speed with heat inputs 5-25 J/mm. Partial penetration butt welds between 347, 430 ferritic and 17-7 martensitic stainless steels (thickness 2 mm or less) were produced. Investigations covered: measurement of penetration depths and surface profiles of the welds; determination of the microstructure (including defects), tensile properties, hardness, stress corrosion cracking tendency, fracture toughness and fatigue crack growth resistance of the welds; nondestructive inspection of the welds; pressure, proof and rupture testing of demonstrator components; and microstructural observations of failed welds after various testing procedures.

07 OTHER JOINING PROCESSES

See also abstracts: 47-277406

07-277326

Effect of post-weld heat treatment on the dissimilar Cu/Al joints produced by high power ultrasonic spot welding.

GU X Y; LIU D F; LIU J

ISIJ International, vol.58, no.9. Sept.2018. pp.1721-1726. 11 fig., 3 tab., 20 ref. ISSNs: 0915-1559, 1347-5460

[in English]

[https://www.jstage.jst.go.jp/article/isijinternational/58/9/58_ISIJINT-2017-694/_article]

Effect of post weld heat treatment (PWHT) temperature on the microstructure and mechanical properties of lap spot ultrasonic welds between sheets of Cu and aluminium alloy was investigated. 1 m thickness sheets of Cu (top) and Al 6082-T6 alloy (Al, 0.4-1%Mn, 0.7-1.3%Si, 0.6-1.2%Mg) were ultrasonically welded at 1.4 kJ, 9.5 micrometres amplitude, 0.4 MPa static pressure, and PWHT at 200-500 deg.C for 1 h with furnace cooling. Sonotrode size was 5.2 x 7.8 mm, and joint overlap was 20 mm. Microstructure, composition,

hardness and shear strength of the weld joints was studied as a function of PWHT temperature, with special emphasis on microstructural changes at the weld interface.

07-277332
Electroslag welding of large-sized press frame.
SHAPOVALOV K P; BELINSKY V A; MERZLYAKOV A E; KOSINOV S N; YUSHCHENKO K A; LYCHKO I I; KOZULIN S M
Paton Welding Journal, no.8. Aug.2016. pp.36-39. 4 fig., 8 ref. ISSN: 0957-798X
[in English and Russian] *(Translated from Avtomaticheskaya Svarka) [https://patonpublishinghouse.com/eng/journals/tpwj/2016/08/07/]*
The electroslag welding of a section of a steel hydraulic press frame, with a mass of 160-200 tonnes, is described. The frame, with a series of longitudinal and transverse ribs, was fabricated by joining two cast sections of 30L carbon steel at their faces (3820 x 3130 mm). Distortion during welding was minimised by the presence of the ribs and by slowly preheating the joint to 500-600 deg.C. The joint gap at the bottom and the top was 36 mm and 40 mm, respectively. Six groups of consumable guides and four power sources were used.

07-277354
A study on the characteristics of FSW [friction stir welding] tool shapes based on CFD [computational fluid dynamics] analysis.
KIM S D; YOON J Y; NA S J
Welding in the World, vol.61, no.5. Sep. 2017. pp.915-926. 13 fig., 2 tab., 20 ref. ISSN: 0043-2288
[in English]
[https://rd.springer.com/article/10.1007%2Fs40194-017-0478-1]
The influence of tool shape on friction stir welding was studied using computational fluid dynamics. A new interface tracking algorithm was introduced in the model, which used a grid based system to express the rotating and moving motions of a tool simultaneously on the workpiece material AA5052. The algorithm was applied to cylinder, screw and tap shapes of the welding tool under FSW (welding speed 50 mm/min; rotational speed 600 rpm) and cylinder shape under friction stir spot welding (FSSW) (rotational speed 1000 rpm). Determined temperature and torque history were compared with FSW and FSSW experimental results. Velocity distribution, viscosity distribution and fluid flow pattern were used to analyse the characteristics of the tool shapes.

07-277365
Decomposition of ultrasonically welded carbon fibre/polyamide 66 and its effect on weld quality.
ZHI Q; TAN X R; LU L; CHEN L Y; LI J C; LIU Z X
Welding in the World, vol.61, no.5. Sep. 2017. pp.1017-1028. 17 fig., 1 tab., 25 ref. ISSN: 0043-2288
[in English] *[See also Weldasearch 275455]*
[https://rd.springer.com/article/10.1007%2Fs40194-017-0482-5]
The influence of weld energy on the strength of ultrasonically welded carbon fibre/polyamide (CF-PA66) composite structures was investigated. Joints were fabricated in carbon fibre/polyamide 66 (4 mm thickness) using ultrasonic welding in a shear lap configuration. Ultrasonic welding was conducted using a machine with different welding modes: energy, time and collapse modes. The samples were welded in each mode using the nominal settings of the machine (power 2.6 kW, frequency 20 kHz, and amplitude 0.025 mm). Ultrasonic weld energy parameters used were 3000-8000 J. Weld quality was assessed from microstructure, indentation, fracture surfaces, interfaces, porosity, temperature profile, and decomposition/degradation. The relationship between weld energy and joint quality was examined and analysed. A decomposition index was also proposed and to evaluate weld quality.

07-277462
Stacking-fault energy, mechanical twinning and strain hardening of Fe-18Mn-0.6C-(0, 1.5)Al twinning-induced plasticity steels during friction stir welding.
LEE S J; SUN Y F; FUJII H
Acta Materialia, vol.148. 15 Apr. 2018. pp.235-248. 10 fig., 3 tab., 45 ref. ISSN: 1359-6454
[in English] *[See also Weldasearch 267571]*
Friction stir welding (FSW) at different welding speeds of twinning induced plasticity (TWIP) steels was investigated, to determine the effect of welding speed, microstructural changes (grain size, dislocation density, twin density), stacking fault energy, and strain hardening rate (SHR) during FSW. Ingots in Fe-Mn-C (Fe, 18%Mn, 0.6%C) and Fe-Mn-C-Al (Fe, 18%Mn, 0.6%C, 1.5%Al) were melted using a high frequency induction furnace, the ingots were solution treated, hot rolled, and then air cooled to room temperature. The plates were then cold rolled at room temperature to a sheet thickness of 2 mm. Cold rolled sheets were subjected to FSW using a tungsten carbide FSW tool (welding speed 50-200 mm/min; rotation speed 400 rpm; loading of 2000 kg; advancing tilting angle 3 degrees). Investigations covered: determination of the microstructure, grain size and distribution, phase content, phase transformations, dislocation density, and misorientation angles of the parent metals and welded joints; measurement of tensile properties and hardness distributions of the welded joints; determination of the SHR, generation and growth of mechanical twins, and deformation induced local misorientation during and after tensile testing of the joints; stacking fault energy and critical stress for mechanical twinning; comparison of the experimental results for the different TWIP steel compositions; and the relationships between microstructural changes and mechanical properties.

08 THERMAL CUTTING

08-277347
Laser machine helps tube fabricator perfect storage system, launch new company - storage rack manufacturer relies on machine's accuracy, repeatability for making precise tube weld joints.
LUNDIN E
Tube and Pipe Journal. Oct.-Nov.2018. pp.18-23. 1 fig. ISSN: 1091-2479
[in English]
The implementation of laser cutting to produce components for the manufacture of storage rack systems is described. The laser cutting machine from BLM Group USA was installed by storage rack manufacturer Technique Inc of Jackson, MI, US, to ensure accuracy, repeatability and speed in making precise tube weld joints. The LT8.10 machine uses a fibre laser to cut low carbon steel (including galvanised), stainless steel, aluminium, copper and brass tube in diameters up to 241.3 mm and lengths up to 8.53 m. The laser machine is also used to make holes along the length of each tube, ready to insert bushings for pins. The company is able to produce storage racks that comply with NASA, OSHA and US Department of Defense standards.
BIG STEEL RACK; BLM GROUP USA

09 SURFACING

See also abstracts: 01-277357, 03-277320, 41-277450, 42-277397, 46-277387

09-277327

Controlling penetration zone formation in arc surfacing.

IVANOV V P; LAVROVA E V

Paton Welding Journal, no.8. Aug.2016. pp.2-6. 9 fig., 1 tab., 8 ref. ISSN: 0957-798X

[in English and Russian] *(Translated from Avtomaticheskaya Svarka) [https://patonpublishinghouse.com/eng/journals/tpwj/2016/08/01/]*

The influence of the process parameters on dilution was studied for submerged arc surfacing to facilitate process modelling. Steel substrates (30 mm thickness) were subjected to submerged arc surfacing using Sv-08A filler material, and AN-60 and AN-348A fluxes. Surfacing was deposited using static or moving electrodes. The surfacing parameters were: wire diameter 1.6-5.0 mm; current 180-800 A; voltage 26-36 V; speed 14-50 mm/s. The specimens were sectioned to determine the penetration depth. Multiple regression analysis was used to relate the depth to the process variables so as to establish optimum values which gave good bonding with minimum dilution, and to develop a process control system.

09-277328

Effect of composition of electrode strip on base metal penetration.

MATVIENKO V N; LESHCHINSKY L K; MAZUR V A

Paton Welding Journal, no.8. Aug.2016. pp.7-9. 4 fig., 1 tab., 8 ref. ISSN: 0957-798X

[in English and Russian] *(Translated from Avtomaticheskaya Svarka) [https://patonpublishinghouse.com/eng/journals/tpwj/2016/08/02/]*

The influences of the electrode melting point and enthalpy on penetration and dilution during arc strip surfacing is discussed with reference to experimental studies. Surfacing deposited using Sv-08kp low carbon steel, Sv-12Kh18N10 stainless steel and copper alloy (Cu, 30%Ni) strip electrodes is discussed. Mathematical models were used to determine flow in the molten pool. The influence of the surfacing enthalpy on penetration and dilution was also studied.

09-277329

Improvement of crack resistance of banded supporting rolls at high-speed surfacing with low heat input.

SHCHETININ S V

Paton Welding Journal, no.8. Aug.2016. pp.10-14. 6 fig., 1 tab., 13 ref. ISSN: 0957-798X

[in English and Russian] *(Translated from Avtomaticheskaya Svarka) [https://patonpublishinghouse.com/eng/journals/tpwj/2016/08/03/]*

The influence of electrode shape and energy input during surfacing of banded supporting rolls on subsequent cracking was investigated. Surfacing heating and cooling rates were of interest with high speed and low energy input parameters. Surfacing was produced using Sv-08A low carbon steel (max. 0.1%C, 0.35-0.60%Mn) wire of 4 mm diameter (current 650-750 A, voltage 31-33 V, speed 5.6-11 mm/s); and using 08kp low carbon steel (0.05-0.12%C, 0.25-0.50%Mn) strip electrodes 0.5 x 45 mm (current 450-550 A, voltage 29-31 V, speed 3.3-6.7 mm/s). The surfacing and the HAZ were characterised by determinations of crystal lattice distortion, dislocation density, microstructure, and microhardness. The influences of heating and cooling rates on phase formation and grain size, and hence on cracking, are discussed. A high speed submerged arc surfacing procedure with low energy input was developed, and 90KhF steel rolls were surfaced using preheating and interrun temperatures of 300-350 deg.C. The deposition of a carbon manganese steel buffer layer using Sv-08G2S filler wire and AN-60 flux was followed by the deposition of a wear resistant layer using cored filler wire PP-Np-25Kh5FMS (energy input 1.1 MJ/m, current 750-800 A, voltage 30-32 V, speed 75 m/h), followed by heat treatment and controlled cooling.

09-277336

Fundamentals of laser cladding.

WOOD G; HAMRE D

Welding Journal, vol.97, no.9. Sep. 2018. pp.26-30. 4 fig., 3 ref. ISSN: 0043-2296

[in English]

[https://bit.ly/2HeVYQZ]

The basics and applications of laser surfacing are discussed. The differences between lasers and plasma arcs are explained. The fundamentals of laser surfacing including definition of lasers, wavelength and out-put power of lasers, absorption of laser radiation, laser power required for surfacing processes, formation of the pool under high power laser beams, creation of the overlay, blown power feed systems, gas shielding, coaxial feed and lateral feed systems and size of typical clads are described. The effects of changes to material and process parameters (power, powder feed rate, travel speed) on the quality of the coating are discussed. Applications of laser cladding are discussed including repair, surface modification, corrosion resistance, additive manufacturing and hybrid manufacturing of Inconel 625 stabiliser blades using wear resistant nickel-tungsten carbide.

09-277341

Development of nickel-added, iron-based, slag-free, self-shielded metal-cored wire.

LIU D; LI L; WU M; LONG W; WEI P; ANDERSON N E; KANNAN R

Welding Journal, vol.97, no.9. Sep. 2018. Supplement: Welding Research. pp.263s-272s. 11 fig., 6 tab., 26 ref. ISSN: 0043-2296

[in English]

[https://bit.ly/2TJeOEM]

The effect of nickel content in an iron-based self-shielded cored wire on the microstructure and wear performance of hardfacing alloys was investigated. Low carbon H08A steel (max. 0.10%C, max. 0.03%Si, 0.30-0.55%Mn) was used to produce the flux-cored wires (diameter 2.4 mm). Five layers of hardfacing alloys containing different level of Ni additions (0.13-4.64%Ni, 2.97-3.33%C, 1.26-1.41%B, 15.4-17.6%Cr, 2.45-2.78%Mn, 0.93-1.06%Si, 74.0-75.2%Fe) were deposited on Q-235 steel plates (0.16%C, 0.5%Mn, thickness 20 mm) using welding current 390-420 A, arc voltage 36-38V, positive electrode polarity, welding speed 0.3 m/min and electrode extension 26-30 mm. The microstructure was analysed, hardness determined and wear performance evaluated. The results are discussed with regard to the effect of Ni on the microstructure, hardness and wear resistance of the hardfacing alloy.

09-277351

Analysis of laser cladding process parameter influence on the clad bead geometry.

GOODARZI D M; PEKKARINEN J; SALMINEN A

Welding in the World, vol.61, no.5. Sep. 2017. pp.883-891. 10 fig., 4 tab., 23 ref. ISSN: 0043-2288

[in English] *[See also Weldasearch 271638 and 270624]*

[https://rd.springer.com/article/10.1007%2Fs40194-017-0495-0]

The effects of laser surfacing process parameters (laser power, surfacing speed and powder feeding rate) on the bead geometry were

investigated. Single-run layers of stainless steel AISI 316L powder (53-150 micrometre particle diameter) were deposited onto structural steel S355 substrate (5 mm thickness) using a multimode fibre laser and argon as carrying gas for the powder. The main laser surfacing parameters were varied: power 2000-4500 W; surfacing speed 400-1000 mm/min; and powder feed rate 20-40 g/min. Design of experiment (DOE) methodology was used to evaluate the effect of parameter variance on the bead layer height, width and side angle.

09-277352

The effect of plastic deformation rate on the wear performance of hardfaced coatings

BENDIKIENE R; KAVALIAUSKIENE L

Welding in the World, vol.61, no.5. Sep. 2017. pp.893-900. 3 fig., 6 tab., 25 ref. ISSN: 0043-2288

[in English]

[https://rd.springer.com/article/10.1007%2Fs40194-017-0476-3]

The influence of plastic deformation rate and heat treatment on the wear characteristics and performance of hardfaced coatings deposited by submerged arc welding was investigated. Substrates of S235 carbon steel (0.14-0.22%C, 0.4-0.65%Mn; 8 mm thickness) were hardfaced using low carbon electrode wire (max. 0.1%C, 0.35-0.6%Mn; 1.2 mm diameter) as filler rod. The hardfacing was carried out in a single run using AMS1 flux (38-44%SiO2, 38-44%MnO, 6-9%CaF2, max. 6.5%CaO, max. 2.5%MgO, max. 5%Al2O3, max. 2%Fe2O3), with optional additions of high speed tool steel, cemented tungsten carbide and/or graphite powder. Hardfacing parameters used were: current 180-200 A; voltage 22-24 V; travel speed 4 mm/s; wire feed rate 7 mm/s. The microstructure, phase evolution and composition, and wear were studied in relation to the influence of the flux powder additions. Hardness, deformation, austenite stability and wear resistance were determined. The effects of tempering at different temperatures on phase composition and wear were also examined.

09-277353

Study of flux-cored arc welding processes for mild steel hardfacing by applying high-speed imaging and a semi-empirical approach.

WILHELM G; GOTT G; UHRLANDT D

Welding in the World, vol.61, no.5. Sep. 2017. pp.901-913. 21 fig., 4 tab., 22 ref. ISSN: 0043-2288

[in English]

[https://rd.springer.com/article/10.1007%2Fs40194-017-0485-2]

The hardfacing of mild steel using flux-cored arc welding was studied experimentally and numerically. Mild steel substrates (10 mm thickness) were hardfaced using three different flux-cored wire electrodes (1.6 mm diameter) and two different welding processes: a pulsed process without short circuits (pulse current 400-540 A; base current 100 A; welding speed 0.8 m/min; wire feed rate 7.8 m/min) and a modified short-arc process (pulse current 400 A; base current 100 A; welding speed 0.6 m/min; wire feed rate 8.0 m/min). Shielding gases comprised mixtures of argon with CO2, O2 or He. The effect of shielding gas and wire variations on seam width and dilution, wire melting, microstructures, weld pool behaviour and material transfer were investigated using high speed imaging. The correlations between energy input, material transfer, dilution, weld metallurgy and weld seam geometry were evaluated by semi-empirical analysis.

09-277460

The effect of particle size on the heat affected zone during laser cladding of Ni-Cr-Si-B alloy on C45 carbon steel.

TANIGAWA D; ABE N; TSUKAMOTO M; HAYASHI Y; YAMAZAKI H; TATSUMI Y; YONEYAMA M

Optics and Lasers in Engineering, vol.101. Feb. 2018. pp.23-27. 10 fig., 1 tab., 14 ref. ISSN: 0143-8166

[in English]

Laser surfacing of Ni-Cr-Si-B alloy powders of different average particle sizes (30-55 micrometres) onto C45 carbon steel at different heat inputs (150-250 J/cm) was investigated, to evaluate the extent of HAZ formation. A diode laser with a flat top beam was used with powders (Ni, 16.3%Cr, 4.3%Si, 4.2%Fe, 3.3%B, 0.9%C) to form surfaced layers onto C45 carbon steel substrate (laser power output 300 W; scanning velocity 1.2-3 cm/s). Investigations covered: examination of spherical morphology and particle size distribution of the powders; use of a high speed video camera to record formation of deposited surfaced layers; examination of the surface and cross-sectional microstructures of the surface layers, wettability of the molten powder on the substrate, parent metal dilution of the surfaced layer, and measurement of the size of the HAZ areas; measurement of the averaged hardness values of the surface layer, HAZ area and parent metal; effect of Ni-Cr-Si-B powder average particle size on the amount of heat input required for surfaced layer formation; influences of average particle size of powder and heat input on the extent of HAZ formation; and identification of ways of reducing the HAZ formation.

12 ANCILLARY OPERATIONS

12-277349

Materials, machinability, and successful weld prep for pipe - understanding an alloy and its characteristics can help to determine the appropriate machining speeds and feeds.

REICHER N

Tube and Pipe Journal. Oct.-Nov.2018. pp.32-34. 1 fig. ISSN: 1091-2479

[in English]

The need to understand the composition, characteristics and machinability of an alloy to ensure successful and effective machining prior to welding of pipes is discussed. These factors can help a manufacturer determine the appropriate machining speeds and feeds to produce a high quality end component for welding. The properties, tensile and yield strength, hardness, ductility, corrosion susceptibility, machinability, and applications of the following materials are examined: steel (0.008-2.14%C); galvanised steels; stainless steel; P91 steel (high Cr and Mo content); duplex stainless steel (containing ferrite and austenite structures); Ni based superalloys, including Inconel; titanium; and aluminium. The influence of compositional elements on machinability is considered.

23 REPAIR AND MAINTENANCE

See also abstracts: 41-277384, 45-277440, 52-277452

23-277348

Weld mill not firing on all cylinders? It might be time for a tune-up - preparing your tube or pipe mill for a service call.

HILLIS J; GODZICKI J

Tube and Pipe Journal. Oct.-Nov.2018. pp.24-26. 1 fig. ISSN: 1091-2479

[in English]

The preventative maintenance and alignment servicing required for tube and pipe milling equipment is described. The need for regular maintenance and alignment is considered, especially to diagnose initial problems and ensure optimal performance and efficiency. The following aspects are discussed: indicators that servicing is required; preparative steps prior to servicing; and key points for ensuring properly maintained tooling. Factors to consider in new applications, newly ground tooling and new shafts for tube and pipe mills are also outlined.

23-277414

Study on promoting use of repair, replacement and mitigation techniques in maintenance activities of nuclear power plants.

DOZAKI K; AOKI T; KOYAMA K; KANNO M; SAEKI R

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84512. 12pp. 8 fig., 2 ref.

[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84512.pdf]*

With the aim of clarifying regulation issues for maintenance activities at nuclear power plant facilities and to help develop structured regulatory/industrial requirements incorporating codes and standards consistent with appropriate corrective measures, an investigation is presented into the relationship between degradation and maintenance and the difference of performance requirements between the plant construction stage and the in-service stage. Topics discussed include systematic development of key maintenance categories, the concept of component maintenance, classification of corrective measures, component maintenance for ageing degradation, maintenance activities in construction and in-service stages, hardware maintenance and regulation, desirable regulatory requirements and corresponding society codes, independent safety enhancement, conformance of maintenance technologies to the national technical standard, and technical evaluation of the RRA chapter in the JSME (Japan Society of Mechanical Engineers) fitness-for-service code.

30 EQUIPMENT [FOR WELDING, ETC.]

See also abstracts: 03-277346, 07-277332, 08-277347, 23-277348

30-277333

Improvement of welding power sources in order to increase burning stability of alternating current arc.

MAKHLIN N M

Paton Welding Journal, no.8. Aug.2016. pp.40-48. 7 fig., 37 ref. ISSN: 0957-798X

[in English and Russian] *(Translated from Avtomaticheskaya Svarka) [https://patonpublishinghouse.com/eng/journals/tpwj/2016/08/08/]*

Improvements in the design of welding power sources for AC arc and plasma welding processes are described. The topics covered include improving the arc stability by pulsing the voltage at the instant of zero current, using inductive-capacitive converters, or by using a rectangular waveform. Circuit designs are discussed, including the facility for non contact arc initiation, and the advantages and disadvantages of thyristor based power supplies are highlighted.

30-277337

Modern bevelling: dedicated handheld tools versus traditional methods.

TUERK T

Welding Journal, vol.97, no.9. Sep. 2018. pp.32-34. 4 fig. ISSN: 0043-2296

[in English]

[https://bit.ly/2P089XT]

Bevelling methods for preparing joints for welding are reviewed. Topics briefly covered include: the bevel angle and depth of bevel; using waterjet or torch cutting to burn a bevel on an edge; the efficiency of using die or angle grinders for bevelling; the use of dedicated handheld electric or pneumatic bevelling tools; stationary bevelling machining and tools that can be attached to the metal plate edge or around a pipe end; tools with adjustable angled guide plates; dedicated bevelling tools which allow the depth of bevel to be set; cordless bevelling tools; and radiused edge requirements for ferrous metals. The advantages and cost savings of using handheld bevelling tools are briefly discussed.

30-277342

Improving cutting speed and edge quality..

STANCZYC N

Industrial Laser Solutions for Manufacturing. Sept.-Oct. 2018. pp.15-16. 1 fig. ISSN: 1523-4266

[in English]

The adoption of the Trumpf Highspeed Eco Nozzle on an 8 kW fibre laser (used for sheet metal cutting) by Custom Laser, a fabrication company based in Lockport, New York, USA is discussed. Use of the Highspeed Eco Nozzle has allowed Custom Laser, which specialises in component part manufacturing, to reduce gas consumption costs and increase cutting speeds without compromising component integrity or quality. The topics addressed include advantages of using nitrogen assist gas in laser cutting, ability to use just one type of nozzle across an entire applicable material thickness range, reductions in unnecessary loss of assist gas during cutting, consistency in high-quality cutting edges, increased cutting speeds and reductions in part cleanup.

CUSTOM LASER INC

30-277343

How to select the right setup for your fibre laser cutting needs.

DIEHL D

Industrial Laser Solutions for Manufacturing. Sept.-Oct. 2018. pp.17-19. 2 fig. ISSN: 1523-4266

[in English]

Advice on choosing the correct setup for fibre laser cutting is provided. The topics discussed include the advantages of high-power fibre lasers, cutting using nitrogen, selecting appropriate assist gas mixtures, choosing appropriate materials handling automation systems and automation friendly storage of materials.

30-277344

Direct-diode lasers create blueprint for company's growth.

SWEARINGEN K

Industrial Laser Solutions for Manufacturing. Sept.-Oct. 2018. pp.20-22. 5 fig. ISSN: 1523-4266

[in English]

The benefits arising from the adoption of direct-diode laser (DDL) cutting technology by Metal Design Systems (MDSI), a speciality metal fabricator based in Cedar Rapids, Iowa, USA, are outlined. Among the topics addressed are the environmentally responsible and conscientious approach taken by MDSI, which fabricates products for

use in the architectural sector, throughout its manufacturing process; the high-quality facades produced by DDL technology; the speed and efficiency of this technology in producing edges; the advantages arising from the combination of wavelength, beam profile and energy efficiency offered by DDLs; and the expanded range of options in terms of materials and services made available to architects by use of the Mazak Optiplex 4020 DDL laser cutting machine.
METAL DESIGN SYSTEMS

30-277345
Fibre laser technology improves metal cutting.
KLINER D; VICTOR B
Industrial Laser Solutions for Manufacturing. Sept.-Oct. 2018. pp.23-26. 4 fig. ISSN: 1523-4266
[in English]
An overview of Corona, an all-fibre laser cutting technology developed by nLIGHT, is presented. Corona allows the fibre laser spot size to be directly and rapidly tuned over a range of sizes and provides beam shapes that improve the cutting quality for various metals. Examples are provided of the use of optimised Corona beam shapes to cut thick mild steel plate into challenging shapes with small features. The reliability of the Corona fibre laser technology is addressed by characterising the Corona lifetime via accelerated life tests. The advantages of the Corona fibre laser system are also summarised.

30-277464
Investigation of RF [radio frequency] and DC [direct current] plasma electron sources for material processing applications.
POZO S del; RIBTON C N; SMITH D R
Paper presented at IVEC2017, 18th International Vacuum Electronics Conference, London, UK, 24-26 Apr. 2017. Publ: IEEE; 2017. 2pp. 5 fig., 2 ref. ISBN: 9781509059157
[in English] *[See also Weldasearch 204615 and WS 270166]*
[https://ieeexplore.ieee.org/document/8289676]
The design and development of a RF plasma cathode electron beam (EB) gun was investigated for material processing applications (e.g. welding, cutting, additive layer manufacturing). Hollow and flat (plasma chamber) electrode designs of the plasma cathode EB gun were examined and used ionised argon gas. RF power from a few watts up to 100 W was supplied to the RF chamber of the EB gun. Different diaphragm apertures (0.7-2 mm) were used. EB currents up to 38 mA at -60 kV were extracted and correlated with optical emission spectroscopy (OES) measurements of the light emitted from the generated plasmas. Argon I and argon II lines were identified in the spectra of the plasma chamber electrodes. Experimental results for the different plasma chamber designs were compared using OES measurements, analysis of argon II ratios, and an analysis of changes in other important plasma parameters (e.g. plasma pressure, excitation power). A RF hollow plasma cathode was compared to a DC plasma cathode (e.g. EB current extracted with increasing energy applied to the plasma; ratio of Argon II lines in the respective RF and DC plasmas; and achieving higher ionisation at lower plasma pressures).

32 MATERIALS, GENERAL

32-277466
Behaviour of high strength steel columns under fire conditions.
WINFUL D; CASHELL K A; AFSHAN S; BARNES A M; PARGETER R J
Journal of Constructional Steel Research, vol.150. Nov. 2018. pp.392-404. 14 fig., 4 tab., 59 ref. ISSN: 0143-974X
[in English]
[https://www.sciencedirect.com/science/article/pii/S0143974X18300506?via%3Dihub]
The structural performance and design of high strength steel (HSS) columns for fire conditions was investigated by numerical simulation. Metallurgical characteristics and especially the strengthening mechanisms used, and different production routes for the fabrication of HSS are discussed, including how they were affected by temperature. Different mathematical representations of the stress-strain response for HSS are mentioned. A modified Ramberg-Osgood model was applied for characterisation and comparison of the elevated temperature stress-strain responses, of S690QL and S700MC HSS grades, based on existing stress-strain data. A numerical model which took geometric imperfections and material non-linearity into account, was developed based on finite element analysis, to predict the ultimate loads of the columns at ambient and elevated temperatures. The model was validated by use of experimental data on HSS at ambient temperature and mild steel grades at elevated temperature. The elevated temperature stress-strain responses of S690QL and S700MC steels were used in a parametric study to: generate structural performance data on S690QL and S700MC steel Class 1 and Class 2 columns at temperatures up to 800 deg.C; evaluate the suitability of Eurocode buckling curves for HSS columns in fire conditions; and identify possible unconservatisms in the Eurocode design approach caused by generalising the material response.

40 TENSILE PROPERTIES, TOUGHNESS

See also abstracts: 52-277405, 52-277433

40-277322
Characterisation of mechanical properties and residual stress in API 5L X80 steel welded joints.
SOUSA LINS A de; SOUZA L F G de; FONSECA M C
Journal of Materials Engineering and Performance, vol.27, no.1. Jan.2018. pp.124-137. 17 fig., 6 tab., 31 ref. ISSN: 1059-9495
[in English]
[https://link.springer.com/article/10.1007%2Fs11665-017-3090-z]
The mechanical properties and residual stress behaviour of MMA welded and flux cored arc welded (FCAW) API-5L-X80 grade pipeline steel with and without shot peening mechanical treatment were analysed and compared. API-5L-X80 steel (0.08%C, 1.74%Mn, 0.166%Cr, 0.014%Ni, 0.117%Mo, 0.015%Ti) plates (300 x 150 x 20 mm) underwent multirun butt welding in a flat position with preheating at 120 deg.C and interpass temperature of 150 deg.C using MMA (root, filler and top position, electrode diameter 3.25-4.00 mm, current 75-150 A, voltage 22-26 V, time 3841 s, speed 1.83-3.64 mm/s, welding energy 0.96-1.29 kJ/mm, 16 runs) and FCAW (root, filler and top position, wire diameter 1.2 mm, current 148-224 A, voltage 23-27 V, time 1151 s, speed 2.76-5.24 mm/s, welding energy 1.03-1.61 kJ/mm), weldments contained 1.5% and 2.6%Ni respectively. Glass shot peening treatment was performed on some specimens. The residual stress and mechanical properties (tensile strength, impact toughness and microhardness) were determined and the microstructure was observed.

40-277358
Toughness assessments of laser arc-hybrid welds of ultra high strength steel.
INOSE K; YAMAOKA H; NAKANISHI Y; MINAMI F
Welding in the World, vol.61, no.5. Sep. 2017. pp.955-961. 15 fig., 5

tab., 15 ref. ISSN: 0043-2288
[in English] *[See also Weldasearch 269715 and 269713]*
[https://rd.springer.com/article/10.1007%2Fs40194-017-0483-4]
Hybrid laser-arc welding experiments were undertaken on HT980 (0.14%C, 1.19%Mn, Cr, Mo, V, B) and HT780 (0.09%C, 0.95%Mn, Cr, Ni, Mo, Nb, Cu, B) ultra high strength steels and the toughness and brittle fracture properties of the welded joints were investigated. Charpy tests were conducted on side groove and standard V-notch specimens in order to prevent fracture path deviation. Three point bending tests, double edge notch tensile tests and deep notch tests were performed to measure the critical CTOD at brittle fracture initiation. Issues discussed include the dependence of critical CTOD on loading mode and safety assessment against brittle fracture.

40-277404
Experimental study on mechanical properties and microstructure of 2.25Cr1Mo0.25V steel by the influence of heat treatment and welding.
LI Q; CHENG G X; QIN M; ZHANG Z X
In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84437. 8pp. 9 fig., 1 tab., 10 ref.
[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84437.pdf]*
In relation to hydrogenation reactor applications, an experimental investigation was undertaken to examine the influence of heat treatment and welding process conditions on the macroscopic mechanical properties and microstructure of a 2.25Cr1Mo0.25V steel (0.1-0.16%C, 0.27-0.63%Mn, 1.95-2.6%Cr, 0.87-1.13%Mo, 0.23-0.37%V). Submerged arc welding was used for butt welding with a control current of 580 A. PWHT (post weld heat treatment) involved annealing at a temperature of 700 deg.C for hold times of 0-32 h. The evolution of microstructure and precipitates was observed by SEM. Mechanical properties were characterised by tensile tests. Issues discussed include the effect of heat treatment time on specimen strength and plasticity, carbide precipitate formation and weld metal morphology.

40-277468
Material properties of high strength steel under fire conditions.
WINFUL D; CASHELL K A; AFSHAN S; BARNES A M; PARGETER R J
In: Eurosteel 2017. Proceedings, 8th International Conference on Steel and Composite Structures, Copenhagen, Denmark, 13-15 Sep. 2017. Publ: Berlin, Germany; Ernst & Sohn Verlag fur Architektur und Technische Wissenschaften GmBH; 2017. vol.1, no.2-3. Paper 10.18. pp.2668-2677. 6 fig., 7 tab., 24 ref. ISSN: 2509-7075
[in English] *[See also Weldasearch FNK019 and FNK025]*
[https://onlinelibrary.wiley.com/doi/full/10.1002/cepa.316]
Mechanical properties of high strength steels (HSS) under fire conditions were investigated and compared for ambient, isothermal and anisothermal tensile tests conducted at temperatures between 20-800 deg.C. Two HSS studied were: quenched and tempered S690QL plate (max. 0.2%C, max. 1.6%Mn, max. 1.5%Cr, max. 2.1%Ni, max. 0.6%Mo, max. 0.1%V, max. 0.05%Ti; thickness 16 mm) and thermomechanically control processed and cold formed S700MC plate (max. 0.08%C, max. 2%Mn; thickness 12 mm). Experimental results were presented in the form of reduction factors at elevated temperatures for the main parameters related to stiffness and strength which were: 0.2% proof strength, effective yield strength based on the strain level at 2% (according to the Eurocode approach); and elastic modulus. A reduction factor was computed as the ratio between the value of the parameter at elevated temperature and its corresponding value at ambient temperature. Results in terms of reduction factors were compared with existing experimental data and EN1993-1-2 (2005) Eurocode 3 Part 1-2, and the differences are discussed in relation to the guidance for the elastic modulus under isothermal conditions.

40-277469
Flexural buckling behaviour of high strength steel columns under fire conditions.
WINFUL D; AFSHAN S; CASHELL K A; BARNES A M; PARGETER R J
In: Eurosteel 2017. Proceedings, 8th International Conference on Steel and Composite Structures, Copenhagen, Denmark, 13-15 Sep. 2017. Publ: Berlin, Germany; Ernst & Sohn Verlag fur Architektur und Technische Wissenschaften GmBH; 2017. vol.1, no.2-3. Paper 10.33. pp.2797-2805. 5 fig., 4 tab., 17 ref. ISSN: 2509-7075
[in English] *[See also Weldasearch FNK019 and FNK023]*
[https://onlinelibrary.wiley.com/doi/abs/10.1002/cepa.330]
Flexural buckling behaviour of square and rectangular hollow section columns in grade S690QL and S700MC high strength steels (HSS) were investigated at temperatures up to 800 deg.C in fire conditions, by developing a numerical model based on finite element analysis, to predict the high temperature resistance of HSS columns. Existing experimental data were used for model validation. A parametric study was conducted on S690QL and S700MC HSS columns of different lengths and cross-sectional properties. The measured high temperature stress-strain curves of S690QL and S700MC HSS obtained from a previous experiment, were modified into true stress versus plastic strain values, and then used in the parametric study. Results of the parametric study on the buckling behaviour resistance of Class 1 and Class 3 columns at temperatures up to 800 deg.C, were compared with buckling curves and recommendations contained in EN1993 Eurocode 3 Part 1-2, for assessment of the suitability of these curves for HSS columns. The use of 0.2% proof stress instead of stress at 2% total strain is discussed, for devising buckling curves in fire conditions.

41 FATIGUE

See also abstracts: 45-277363, 50-277374, 60-277375, 60-277410

41-277362
Fatigue evaluation of ship structures considering change in mean stress condition.
YAMAMOTO N
Welding in the World, vol.61, no.5. Sep. 2017. pp.987-995. 10 fig., 2 tab., 28 ref. ISSN: 0043-2288
[in English]
[https://rd.springer.com/article/10.1007%2Fs40194-017-0461-x]
The effects of mean stress on the fatigue strength and fatigue damage in side longitudinal stiffeners of single-hull large crude oil carriers were investigated. Mean stress, residual stress and material yield strength were evaluated. Butt, cruciform and longitudinal gusset joints were examined. Fatigue evaluation analysis was applied to existing fatigue test data of as-welded joints and high-frequency mechanical impact (HFMI)-treated joints. The fatigue strength of end connections of the stiffeners was calculated and correlated with the occurrence of fatigue damage.

41-277370

New fatigue screening criteria for the fitness-for-service assessment of in-service process piping vibrations.

BIFANO M F P; BREAUX L; FELLER A J; BRODZINSKI R

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84669. 13pp. 15 fig., 1 tab., 17 ref.

[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84847.pdf][See also Weldasearch 274654]*

Vibration fatigue screening criteria are presented to assess the risk in process piping associated with bending mode type vibrations and to provide a foundation for a future proposed Level 1 fitness-for-service (FFS) procedure for inclusion in ASME FFS-1/API 579. Finite element analysis (FEA) results from 20000 randomly generated candidate-piping models and high-cycle welded joint fatigue curves for both constant amplitude and variable amplitude loading were employed to form the stress limits and basis for the proposed criteria. Mainline piping was separated into two categories based on stress concentration factors (SCFs) less than or equal to 3 and SCFs between 3 and 8. The allowable stress basis incorporated periodic and random vibrations making it applicable to mechanically induced, two-phase flow induced, turbulent-induced vibration of single-phase process fluid, or wind-induced situations. Limits were set for butt-welded and non-butt welded mainline piping to prevent use of a single blanket limit.

41-277372

A comprehensive structural strain method incorporating strain-hardening effects: from LCF [low cycle fatigue] to ratcheting evaluations.

PEI X J; DONG P S; SONG S P

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84860. 14pp. 16 fig., 29 ref.

[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84860.pdf]*

In relation to the treatment of low-cycle fatigue in pressure vessel and piping components, an enhanced structural strain method incorporating material nonlinearity was applied to a weldment with plate sections (e.g. a gusset weld or cruciform weld) and a weldment with beam sections (e.g. a pipe structure). A modified Ramberg-Osgood equation was derived to incorporate the nonlinear stress-strain behaviour and numerical algorithms were used to deal with the complex stress state induced by the structural effect. Application to fatigue data analysis involved experimental data on double-sided longitudinal gusset joint specimens, cantilever bending fatigue tests on welded pipes with two girth butt welds and fatigue tests on TIG and MIG welded titanium and aluminum carried out in the high cycle fatigue regime using fillet welded cruciform specimens. Ratcheting analysis of thin-walled pipe structures was considered by revisiting the Bree problem and taking into account the strain hardening effect.

41-277376

Application of the enhanced reference stress method to fatigue propagation of a surface crack in a plate subjected to cyclic bending.

YAMASAKI I; FUJIOKA T; SHINDO Y; KANEKO Y

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84233. 6pp. 5 fig., 4 tab., 13 ref.

[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84233.pdf]*

With regard to cyclic bending tests on wide-plate specimens containing a semi elliptical surface crack conducted to validate the enhanced reference stress method for calculating fatigue J-integral ranges, an investigation is presented into representative simplified methods for estimating the elastic-plastic J-integral and their application to crack propagation prediction. The experimental tests involved surface-cracked type 304 stainless steel plates (thickness 50 mm) subjected to cyclic strain-controlled bending and crack depth measured using the pulse potential drop method. Limit load correction factors to improve the accuracy of the reference stress method were estimated by elastic-plastic finite element analysis. A fully plastic solution approach using the Yagawa-Ueda equations was also examined. The fatigue crack propagation rate for low-cycle fatigue loading was calculated by a Paris law-type relation.

41-277377

Fatigue monitoring: case studies in nuclear power plant.

BOURGUIGNE G; SCHROETER F

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84007. 7pp. 16 fig., 1 tab., 5 ref.

[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84007.pdf]*

With regard to the use of cumulative usage factors to estimate fatigue damage during the design of Class I components in nuclear power plants (NPPs), a fatigue monitoring system was employed to undertake detailed stress and fatigue analyses following the rules of the ASME Boiler & Pressure Vessel Code, Section III, Division 1, Subsection NB-3200 to take into account environmental effects. The events considered comprised high cycling in the pressuriser spray nozzle, high cycling during normal operation in the volume control system connection to primary circuit lines and thermal stratification in feedwater lines. Issues discussed include the environmental assisted fatigue correction factor for austenitic stainless, carbon and low-alloy steels, the fatigue monitoring system in the Atucha 1 NPP, temperature-time histories for different measuring sections and finite element models for steam generators.

41-277384

Analysis of a weld overlay to address fatigue cracking in a stainless steel nozzle.

MARLETTE S E; UDYAWAR A; BROUSSARD J

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84722. 6pp. 9 fig., 2 tab. 15 ref.

[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84722.pdf]*

In relation to the use of structural weld overlays (SWOL) to repair and mitigate fatigue cracking within stainless steel pressurised water reactor (PWR) components such as nozzles, an investigation performed using ASME Section XI Code Case N-504-4 was undertaken to determine the design life of a SWOL repair applied to a boron injection tank (BIT) line nozzle attached to the cold leg of an operating PWR. Analyses were conducted to calculate the residual stresses associated with the original fabrication and the subsequent SWOL repair. Post-SWOL operating stresses were examined to confirm that the overlay did not invalidate ASME Section III design rules for the nozzle

and attached pipe. The operating and residual stresses were employed as input for fatigue crack growth analysis in order to establish the design life of the overlay. Weld shrinkage from the application of overlay was evaluated for potential impact on the attached piping, restraints and valves within the BIT line.

41-277436

Fatigue life of welded joints of AISI 347 stainless steel under thermomechanical and variable amplitude loading.

BOSCH A; SCHACKERT S; VORMWALD M; SCHWEIZER C

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Design and Analysis. Paper PVP2018-84705. 10pp. 9 fig., 16 tab., 20 ref.

[in English] *[DVD; PVP2018-trk-3\trk-3\PVP2018-84705.pdf]*

A comprehensive test programme was undertaken to investigate different influences on variable amplitude loading of hourglass and welded specimens of AISI 347 (X6CrNiNb18-10, 1.4550) austenitic stainless reactor pressure vessel steel. Welded specimens were produced by turning a notch into cylindrical rods and filling the notch with layers of welding material. On the basis of the measured load history from a thermomechanical loaded flange, the local strain history was computed by a rain flow algorithm. The measured load spectrum was ordered in blocks or arbitrarily as an operational load spectrum for tests performed on two types of specimens. Fatigue lifetime was assessed using Miner's rule and two different damage parameters determined from calculations based on strain amplitudes, mean stresses and fracture mechanics short crack growth. Numerical results were obtained for smooth and welded specimens under the SoftGild load spectrum, for eight-block tests and operating load tests.

41-277450

A proposal of cladding materials for coke drum based on fatigue tests.

NABESHIMA H; SHISHIDO Y; KOUNO N; MURAKAMI T

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Design and Analysis. Paper PVP2018-84357. 7pp. 11 fig., 7 tab., 5 ref.

[in English] *[DVD; PVP2018-trk-3\trk-3\PVP2018-84357.pdf]*

In relation to the occurrence of major cracking in coke drums on the inside surface of circumferential welds along the fusion line between the restoration weld and the cladding, an experimental investigation based on fatigue tests was undertaken on coupons made from 410S stainless steel and Alloy 625 cladding materials to simulate the circumferential weld seam of coke drums. The parent metal was a 1.25%Cr, 0.5%Mo low alloy steel and the cladding was applied by electroslag, FCA or MIG/MAG surfacing. The fatigue strength of each material was determined from fatigue curves based on the Manson-Coffin equation for a low cycle fatigue test. High temperature tensile tests were conducted at coke drum operating temperatures (480 deg.C) to complement the room temperature fatigue test results. Other issues discussed include HAZ microstructures, fatigue fracture surfaces and repeated thermal load tests.

41-277455

Weld rod fatigue analysis using effective notch stress method.

KARPANAN K; KIRK A W; HERSHMAN G

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. High-Pressure Technology. Paper PVP2018-84122. 12pp. 17 fig., 6 tab., 12 ref.

[in English] *[DVD; PVP2018-trk-5\trk-5\PVP2018-84122.pdf]*

With regard to fatigue failure as a critical failure mode for welded joints in subsea equipment, an investigation is presented into the fatigue analysis of fillet welds in bore inserts using the effective notch stress (ENS) approach in which stress analysis is carried out by finite element analysis (FEA) and the stresses on the notch along with the appropriate fatigue curve are used to estimate the weld root fatigue life. Verification of the ENS method was conducted using an IIW partial penetration fillet weld and a DNV fillet welded cruciform joint by comparing stress concentration factors calculated by FEA with those given by the codes. Subsea Christmas Tree weld rod fatigue analysis was conducted by employing a CAD model of the weld rod assembly and linear elastic FEA of the weld rod with keyholes under an internal pressure of 138 MPa. Fatigue analysis of the weld plug was carried out using the DNV-ENS method.

42 OTHER MECHANICAL PROPERTIES

See also abstracts: 32-277466, 52-277431, 52-277442

42-277368

Influence of joint thickness on Type IV cracking behaviour of modified 9Cr-1Mo steel weld joint.

SAKTHIVEL T; CHANDRAVATHI K S; LAHA K; MATHEW M D

Materials at High Temperatures, vol.36, no.3. 2019. pp.265-274. 15 fig., 2 tab., 18 ref. ISSNs: 0960-3409, 1878-6413

[in English] *[See also Weldasearch 253530]*

[https://www.tandfonline.com/doi/full/10.1080/09603409.2018.1536410]

The influence of specimen thickness on the Type IV cracking behaviour of MMA welded grade 91 high alloy ferritic steel (0.096%C, 0.46%Mn, 8.72%Cr, 0.1%Ni, 0.90%Mo, 0.22%V, 0.08%Nb) plate was studied. Butt joints in plate of 30 mm thickness, double V-preparation, were MMA welded using basic covered matching electrodes. PWHT was applied at 760 deg.C for 1 h. Specimens with thicknesses in the range 1-17 mm, but otherwise of equal dimensions, were prepared and subjected to creep testing at 650 deg.C under a tensile stress of 50 MPa. Times to creep failure were determined. The specimens were characterised by hardness measurements and metallography. The results are discussed with reference to creep deformation and cavitation in the HAZ and their relationship to specimen thickness.

42-277397

The mechanical interaction of clad and base metal for molten salt reactor structural components.

MESSNER M C; PHAN V T; JETTER R I; SHAM T L

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84101. 12pp. 10 fig., 1 tab., 15 ref.

[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84101.pdf]*

With regard to the use of structural component cladding with a corrosion resistant material to enhance the design life of molten salt reactors, an investigation was undertaken into the mechanical interaction between parent metal and cladding under creep-fatigue

conditions. A simplified analysis method for clad structures was formulated incorporating simplifications to the continuum problem, discretisation and a solution method. The methodology was verified on a case study of a thin-walled, cylindrical, clad pressure vessel with a hemispherical cap. Stress and strain profile results were obtained with the simplified model and by axisymmetric finite element simulation. Paths towards designing clad components without long-term testing were studied with respect to creep compliant cladding and elastic cladding with refractory metals.

42-277424

Review of mechanical and sealing performance aspects of commercially available PTFE [polytetrafluoroethylene] based gasket materials.

RICE D A; FIZTGERALD WATERLAND A

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Computer Technology and Bolted Joints. Paper PVP2018-84082. 14pp. 9 fig., 7 tab., 11 ref.

[in English] *[DVD; PVP2018-trk-2\trk-2\PVP2018-84082.pdf]*

A short review is presented of the mechanical and sealing performance of various PTFE (polytetrafluoroethylene) gasket materials, such as virgin PTFE and glass-, silicon- or barium-filled PTFE, with an emphasis on such criteria as relaxation, gasket tightness/leak rate and safe reserve operating temperature. Issues considered include tensile strength, compressibility and recovery according to the ASTM F-36 standard test method, the influence of compressibility/recovery on sample thickness, creep relaxation (ASTM F-36), the hot blowout test, and predicted emission rates of PTFE gasket materials. Estimation of tightness and predicted leakage rates using the fugitive emissions calculator model, employing room temperature testing data and an ASME/PVRC draft empirical equations set, is discussed.

42-277430

Comparison of predicted cyclic creep damage from a multi-material weldment FEA [finite element analysis] model and the traditional R5 volume 2/3 weldment approach.

ELAGHA F; TANNER D; KNOWLES D

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Design and Analysis. Paper PVP2018-85120. 8pp. 19 fig., 3 ref.

[in English] *[DVD; PVP2018-trk-3\trk-3\PVP2018-85120.pdf]*

Cyclic creep defect initiation damage at a fillet weld toe was investigated using a multi-material finite element model (FEM) of the weldment and the results were compared with those predicted using the traditional R5 V2/3 approach, in which only the parent material properties were employed to derive the weld toe strain range in combination with the weld strain enhancement factor. The system assessed incorporated a thin-walled 316H austenitic stainless steel boiler tailpipe (outside diameter 63.5 mm), a fillet weld joining a high temperature tube to an anti-vibration strap, pressure loading in the tube and displacement loading due to thermal expansion. The FEM included material properties associated with both the parent and weld metals, such as elastic modulus, plastic yield properties, creep deformation and creep ductility. The domination of parent-weld interaction by the mismatch in elastic modulus is discussed.

42-277437

Premature degradation and failure of steam-methane reformer heater system components.

AUMULLER J J; CARUCCI V

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Design and Analysis. Paper PVP2018-84006. 9pp. 6 fig., 5 tab., 13 ref.

[in English] *[DVD; PVP2018-trk-3\trk-3\PVP2018-84006.pdf]*

With regard to the effects of creep rupture and high temperature cycling service conditions on the catalyst-filled tubes, tube outlet pigtails, subheader train and downstream steam generator in steam-methane reformer headers for the petrochemical industry, a report is presented into a reconciliation between application of industry design practices (e.g. API 530 and API TR 942-A standards) and equipment performance. Issues discussed include the design of high temperature components, design criteria for design in the creep range, reliability performance of outlet pigtails, design evaluation of failed outlet pigtails, through-wall stress distribution in outlet pigtails, stress rupture life using Tresca stress, evaluation of catalyst tubes, outlet pigtail cracking failures, stress analysis of hairpin bend pigtails/terminations, stress rupture life at failed bends and socket weld fittings, and notch sensitivity.

42-277441

Effects of primary and secondary creep formulations on API 579-1 residual life evaluation.

SCANO L; ESPOSITO L

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Design and Analysis. Paper PVP2018-84407. 9pp. 9 fig., 2 tab., 13 ref.

[in English] *[DVD; PVP2018-trk-3\trk-3\PVP2018-84407.pdf]*

With regard to the importance of the material constitutive equation for the residual life evaluation of pressure components operating in the creep range, an investigation is presented into the effects of primary creep in the constitutive equation for the ASTM A335 P22 low alloy steel used in the manufacturing of an HRSG (heat recovery steam generator) header operating at 10.4 MPa. Two welded components were considered: header to hemispherical head and header to finned-tube. Steady-state creep analysis was performed using ANSYS finite element software and implementing three user subroutines aimed at calculating the API 579-1 creep damage according to the Larson-Miller criterion for secondary and primary+secondary creep formulations. A final comparison between the results obtained with different methodologies was undertaken to assess their conservatism in relation to residual life evaluation.

43 CORROSION

See also abstracts: 52-277350

43-277401

Erosion-corrosion of a carbon steel elbow in a natural gas gathering pipeline.

WU W; QIAO Q; CHENG G X; PEI T G; LI Y; YIN H L; LIU D P

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical

Engineers]; 2018. Codes and Standards. Paper PVP2018-84262. 7pp. 10 fig., 4 tab., 8 ref.
[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84262.pdf][See also Weldasearch 276181]*
Failure associated with erosion-corrosion in a steel elbow from a natural gas gathering pipeline in north-east China was investigated by macroscopic and microscopic observations, chemical composition analysis, metallographic examination, and numerical simulation methods. The failed elbow was part of a mild steel pipe (outside diameter 76 mm, wall thickness 12 mm). Surface morphology of the elbow intrados and extrados with corrosion scale was observed by SEM and the chemical composition of the surface deposits was analysed by X-ray diffraction. Natural gas flow in the elbow was numerically simulated using computational fluid dynamics. Issues discussed include severe localised erosion-corrosion in the extrados of the elbow resulting from a combination of the aggravating multiphase flow condition and the CO2 corrosion environment and mitigation of the erosion-corrosion problem by increasing the elbow wall thickness.

43-277422
SCC [stress corrosion cracking] propagation analyses in a welded joint under various assumed residual stresses and anisotropic SCC propagation law.
OKADA H; KIKUCHI M; ONO M; YUSA Y; KAMAYA M
In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Computer Technology and Bolted Joints. Paper PVP2018-84238. 9pp. 15 fig., 1 tab., 24 ref.
[in English] *[DVD; PVP2018-trk-2\trk-2\PVP2018-84238.pdf]*
In relation to the occurrence of a surface crack at a dissimilar material welded joint of a mock-up of a pressurised water reactor (PWR) pressuriser nozzle, an investigation is presented into the evaluations of stress intensity factor and natural SCC (stress corrosion cracking) growth simulations under welding residual stresses. The effects of residual stress distribution and anisotropy in the SCC propagation law on the distributions of the stress intensity factor along the crack front and crack propagation behaviour were examined. The analytical procedures incorporated a finite element model with a crack generated at the start of each crack propagation step by an automatic meshing scheme. SCC growth and variations of stress intensity factor for "safe end/no safe-end, no repair/ID backweld" scenarios are discussed.

43-277438
Fitness for service assessments on cracked heavy wall reactors.
KELTJENS J; VAN ZYL G; MUDHAYEQ F
In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Design and Analysis. Paper PVP2018-84037. 6pp. 13 fig., 2 tab., 4 ref.
[in English] *[DVD; PVP2018-trk-3\trk-3\PVP2018-84046.pdf]*
In relation to the occurrence of severe stress corrosion cracking in the high-strength low-alloy steel shells of heavy wall reactors, an investigation is presented into FFS (fitness-for-service) assessments undertaken to keep the reactors running safely, NDT methods required to obtain the necessary crack size information under operating conditions, failure modes and repair options. Material properties of the SA 543 Type B Class 1 grade steel were considered with respect to tensile and yield strengths and fracture toughness. Stress analysis at the crack location was conducted including stress distribution at the top tubesheet connection and around the nozzle. Weld simulations were performed in ANSYS to obtain residual stress profiles. Online phased array ultrasonic testing (PAUT) was used to determine crack length and depth. Using the information on failure mechanism, stresses, and defect size, FFS assessments were performed on individual cracks according to API 579-1/ASME FFS-1.

43-277445
Sulphidation rate prediction on tube-to-tubesheet joints in a waste heat boiler in a sulphur plant.
JU F; MILLER A; YUEN S; TKACHYK B
In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Design and Analysis. Paper PVP2018-85070. 5pp. 7 fig., 1 tab., 11 ref.
[in English] *[DVD; PVP2018-trk-3\trk-3\PVP2018-85070.pdf]*
Finite element heat transfer analysis, incorporating the representative unit cell concept, and ASSET (Alloy Selection System for Elevated Temperatures) corrosion simulation software were employed to predict sulphidation corrosion rates of carbon steel tubes at the tube-to-tubesheet joints of waste heat boilers in sulphur plants. An alternative tube-to-tubesheet joint design was developed in which the welded joint was moved towards the cold-side face of the tubesheet closer to the boiler feed water, stainless steel cladding was applied and a stainless steel tube-hole sleeve was installed selectively at high-temperature locations. A case study was used to determine the temperature distributions of the conventional and alternative tube joint designs and the global heat transfer efficiency of the boiler. Use of the alternative tube joint configuration was shown to facilitate reductions in maximum tube temperature and predicted corrosion rate.

44 WELDABILITY AND METALLURGY

See also abstracts: 01-277323, 01-277325, 01-277331, 03-277330, 07-277326, 12-277349

44-277360
Switch back technique enhances the productivity of the TIG welding process.
SCHWEDERSKY M B; GONCALVES E SILVA R H; DUTRA J C; WEIZENMANN G de S; BONACORSO N G
Welding in the World, vol.61, no.5. Sep. 2017. pp.971-977. 6 fig., 1 tab., 27 ref. ISSN: 0043-2288
[in English]
[https://rd.springer.com/article/10.1007%2Fs40194-017-0465-6]
The use of the switch back technique (oscillation of the torch) in TIG welding at high currents was studied. Bead on plate weld samples were fabricated on ASTM A36 steel (12.7 mm thickness) using conventional linear welding and the switch back technique (TIG welding parameters used were: current 300 A; welding speed 5 mm/s; workpiece distance 3 mm; argon shielding gas flow rate 15 L/min). The development of the robotic infrastructure for the switch back welding process is described. Heat distribution for each technique was observed and the incidence of humping, level of penetration and differences in the fusion profiles were also evaluated using thermography and metallography.

44-277367

Mechanical properties characterisation of dissimilar joint of high-temperature materials using Thermo-Calc Classic (TCC) diagram analysis.

LAKSHMANAN V; SATHIYA P; ARIVAZHAGAN B

Materials at High Temperatures, vol.36, no.3. 2019. pp.195-211. 24 fig., 3 tab., 16 ref. ISSNs: 0960-3409, 1878-6413

[in English]

[https://www.tandfonline.com/doi/full/10.1080/09603409.2018.1503442]

Filler material choice and process parameter optimisation were determined for manual TIG welding of Incoloy 800HT to P91 steel. Butt welds in 4 mm thickness sheet with 70 deg groove angle, 1.5 mm root face and 1 mm root opening were made between Incoloy 800HT (Ni, 46.2%Fe, 20.63%Cr) and P91 steel (0.11%C, 0.46%Mn, 9.46%Cr, 0.88%Mo) using ER505 or ERNiCr-3 filler wires. Current, voltage and travel speed were adjusted to give three heat inputs in each case (1.5-2.5 kJ/mm). Microstructures were determined using optical and scanning electron microscopy with microprobe analysis with equilibrium phase diagrams calculated using Thermo-Calc Classic analysis. Tensile, impact and hardness properties of parent metal, weld metal and HAZ were determined. Optimum materials and treatment were established.

44-277379

Effect of pre-heat treatment on hydrogen concentration behaviour of y-grooved weld joint based on a coupled analysis of heat transfer-thermal stress-hydrogen diffusion.

OZEKI G; YOKOBORI A T; OHMI T; KASUYA T; ISHIKAWA N; MINAMOTO S; ENOKI M

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84178. 10pp. 24 fig., 3 tab., 24 ref.

[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84178.pdf]*

With regard to the use of pre-heat treatment (PHT) to mitigate hydrogen induced cracking (HIC) during post-welding cooling, a coupled analysis incorporating heat transfer, thermal stress and hydrogen diffusion combined with the alpha multiplication method was undertaken for a Y preparation welded joint model under various PHT conditions. Heat transfer analysis was conducted by the finite difference method and the temperature at each grid obtained was interpolated to each node for thermal stress analysis by the finite element method. Thermal stress calculated for each node using the interpolated temperature was interpolated to each grid point for hydrogen diffusion analysis and the interpolated thermal stress was used for stress-driven hydrogen diffusion analysis. 2D hydrogen concentration and hydrostatic stress distributions were determined under different PHT conditions. The effects of hydrostatic stress gradient and the diffusion coefficient gradient induced by temperature distribution are discussed.

44-277380

Hydrogen diffusion concentration behaviours for square groove weld joint.

OHMI T; YOKOBORI A T; OZEKI G; KASUYA T; ISHIKAWA N; MINAMOTO S; ENOKI M

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84192. 9pp. 13 fig., 3 tab., 21 ref.

[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84192.pdf]*

With regard to the influence of hydrogen diffusion and concentration on the occurrence of hydrogen induced cracking (HIC) during post-welding cooling, a coupled analysis incorporating heat transfer, thermal stress and hydrogen diffusion combined with the alpha multiplication method was undertaken for a square preparation welded joint. Heat transfer analysis was conducted by the finite difference method and the temperature at each grid obtained was interpolated to each node for thermal stress analysis by the finite element method. Thermal stress calculated for each node using the interpolated temperature was interpolated to each grid point for hydrogen diffusion analysis and the interpolated thermal stress was used for stress-driven hydrogen diffusion analysis. By conducting these sequential calculations, hydrogen diffusion and concentration behaviour during cooling was analysed. The importance of local thermal stress gradient and diffusion coefficient gradient is discussed.

44-277403

The notched C-ring test to evaluate reheat cracking susceptibility of CGHAZ [coarse grained heat affected zone] in 2 1/4Cr-1Mo-1/4V steel welded joints.

HUANG Y; XU C; CHEN J; LIU C J; CHEN J J; ZHANG L

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84331. 5pp. 8 fig., 8 tab., 11 ref.

[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84331.pdf]*

With regard to the safety of hydrogenation reactors in the petroleum industry, a notched C-ring test based on the weld C-ring test and the Gleeble thermomechanical test was developed to evaluate the reheat cracking susceptibility of the CGHAZ (coarse grained heat affected zone) in a 2.25Cr-1Mo-0.25V steel (0.11-0.15%C, 1.95-2.6%Cr, 0.87-1.13%Mo, 0.25-0.35%V). Plates were joined by submerged arc welding at a current of 500-660 A, voltage of 32 V, travel speed of 5.5 mm/s and heat input of 25.9-34.2 kJ/mm. Different Gleeble thermal simulation cycle conditions were employed to achieve grain size, microstructure and hardness similar to the actual CGHAZ at various heat inputs. According to the fitting relationship between reduction of area and critical stress, a criterion was proposed to determine the reheat cracking susceptibility.

44-277408

Research on reheat cracking criterion of CGHAZ [coarse grained heat affected zone] in 2.25Cr1Mo0.25V steel.

LIU C J; ZHOU S; TAN J P; ZHANG H Y

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84583. 6pp. 14 fig., 4 tab., 18 ref.

[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84583.pdf]*

In relation to the occurrence of reheat cracking with intergranular characteristic in the CGHAZ (coarse-grained heat affected zone) of 2.25Cr1Mo0.25V steel associated with creep strain accumulation during stress-relieving PWHT (post weld heat treatment), an investigation incorporating a stress relaxation test, a notched C-ring test and finite element analysis (FEA) was undertaken to elucidate the strain criterion of reheat cracking. Stress relaxation testing was conducted on CGHAZ materials prepared by a Gleeble thermomechanical simulator and the critical strain was determined

using the relationship between stress reduction and creep deformation. Additionally, self-loaded notched C-ring specimens extracted from the welding structure were employed to assess reheat cracking susceptibility and to evaluate critical strain by combining with finite element modelling and multiaxial creep coefficient results. Critical creep strain values are discussed with respect to the non-elastic strain limits in ASME-NH.

44-277415

Development of improved equations for weld heat input and dilution control: Part 2

TATMAN J K

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-85154. 16pp. 17 fig., 6 tab., 19 ref.

[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-85154.pdf][See also Weldasearch 263853]*

A report is presented into techniques used to develop an improved understanding of welding factors affecting substrate weld heat input and dilution, incorporating improved calculation methods warranted in ASME Boiler & Pressure Vessel Code Section XI repair and replacement welding activities such as mitigation of hot cracking (dilution control) and optimisation of temper bead welding (heat input control). Limitations of the theoretical heat input and power ratio equations that are used to control substrate heat input and weld dilution, respectively, are examined. Factors affecting heat input for consumable welding processes are outlined and illustrated for the case of ERNiCrFe-7A filler material. Other issues discussed include transfer and melting efficiency for bead-on-plate TIG welding trials, validation of the true power ratio equation and the correlations between welding current, melting efficiency and dilution for Alloy 690 trials.

45 RESIDUAL STRESSES

See also abstracts: 40-277322, 43-277422, 46-277393

45-277363

Engineering model for the quantitative consideration of residual stresses in fatigue design of welded components.

HENSEL J; NITSCHKE-PAGEL T; DILGER K

Welding in the World, vol.61, no.5. Sep. 2017. pp.997-1002. 5 fig., 3 tab., 16 ref. ISSN: 0043-2288

[in English] *[See also Weldasearch 263327 and 258379]*

[https://rd.springer.com/article/10.1007%2Fs40194-017-0467-4]

A numerical model is presented for determining residual stresses in the fatigue design of welded components. The procedure considers the combined effects of load mean stresses and cyclically stabilised residual stresses. The residual stresses were analysed before and after fatigue loading, and the residual stress relaxation due to mechanical loading was evaluated. Experimental studies were conducted on longitudinal stiffeners of S355 NL and S960 QL steels, which were GMA welded using solid wire filler of matching strength. Residual stresses were determined in the as-welded, annealed and pre-loaded in tension conditions.

45-277371

A residual stress profile estimation method for narrow groove girth welds.

SONG S P; DONG P S

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84858. 11pp. 12 fig., 3 tab., 32 ref.

[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84858.pdf]*

A finite element residual stress modelling procedure based on a sequentially coupled thermomechanical analysis was employed to determine residual stress distributions in narrow gap welded joints in pressure vessels and pipe components, covering wall thickness from 25.4-254 mm, radius to wall thickness ratio from 2 to 100, and linear welding heating input from 300-18 000 J/mm. Using a residual stress decomposition technique, the component radius to wall thickness ratio and the characteristic heat input density were identified as key parameters governing through-thickness residual stress distributions in terms of their membrane and bending content. A unified functional form for representing the residual stress profile in narrow gap weldments was developed for supporting fitness for service assessment. Thermomechanical finite element residual stress analyses were undertaken for various narrow gap girth weld cases.

45-277416

HRSG [heat recovery steam generator]-header welds residual-stress evaluation and creep-assessment through the application of Italian code, American standard.

GRISOLIA O; SCANO L

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84662. 14pp. 14 fig., 6 tab., 26 ref.

[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84662.pdf]*

With the aim of understanding the influence of residual stress on creep redistribution and creep relaxation, an investigation is presented into stress and creep analyses for ASTM A 335 Grade P22 steel (2.25%Cr, 1%Mo) finned-tube joint welds in the high temperature section (superheater/reheater) lower headers of the bottom-supported heat recovery steam generator (HRSG) of a combined cycle power plant. The maximum tangential stress applied normally on the circumferential weld was evaluated by finite element thermal analysis. Welding process modelling of the finned-tube joint was conducted for a TIG process. The best-approximation polynomial model was assessed by considering a master curve method in the Italian creep code. Creep life results for the finned-tube joint weld assuming a strength reduction factor of 0.9 were compared with those incorporating residual stress increases in stress analysis.

45-277421

Analytical evaluation of residual stresses in the transition zone of expanded tube-to-tubesheet joints.

BOUZID A H; POURREZA M

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Computer Technology and Bolted Joints. Paper PVP2018-84044. 11pp. 17 fig., 1 tab., 12 ref.

[in English] *[DVD; PVP2018-trk-2\trk-2\PVP2018-84044.pdf]*

An analytical model was developed to evaluate the residual axial and

hoop stresses in the transition zone of hydraulically expanded tube-to-tubesheet joints based on an elastic-perfectly-plastic material behaviour in order to predict the stress state under the maximum expansion pressure and after the completion of the expansion process. The model was formulated by dividing the transition zone into fully plastic, partially plastic and elastic regions and by considering unloading of elastic and plastic regions. The model was validated by numerical modelling using the general purpose finite element program ANSYS workbench 16.2. The cases of elastic recovery at the expansion zone during unloading and reverse yielding in the expansion zone during unloading are discussed.

45-277440

Three dimensional finite element analyses of welding residual stresses of a repaired weld.

CHEN M Y; YU W W; XUE F; KU F; CHEN Z L; SHI J H

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Design and Analysis. Paper PVP2018-84343. 6pp. 14 fig., 1 tab., 12 ref.

[in English] *[DVD; PVP2018-trk-3\trk-3\PVP2018-84343.pdf]*

With the objective of correcting installation nonconformance of a surge line using the excavation and re-weld method, an investigation is presented into a welding residual stress simulation technique using a 3D finite element model (FEM) to simulate weld bead sequencing and the excavation jacking displacement. The surge line material was a Z2CND18-12N2 austenitic stainless steel. An MMA (shielded metal arc) welding process was used to fill the groove with multiple runs of ER316L metal. The simulation method employed a non-axisymmetric model and considered the deformation caused by external jacking loads. Issues discussed include the vertical defection induced by the repair process meeting the design requirements, the acceptability of strain damage caused by the welding repair and the reduction of circumferential residual stress by the repair process.

45-277443

Estimation of residual stress levels in fitness for service evaluations of linepipe.

ANDREWS R; SLATER S

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Design and Analysis. Paper PVP2018-84973. 10pp. 2 fig., 3 tab., 22 ref.

[in English] *[DVD; PVP2018-trk-3\trk-3\PVP2018-84973.pdf]*

An overview of the major manufacturing routes for steel linepipe is presented to facilitate the prediction of allowable residual stress levels for use in the assessment of axial cracks in transmission pipelines, based on the recommendations for the mechanical relaxation of residual stress given in Annex O of the BS 7910 standard but adjusted to take account of linepipe manufacturing method. Assessment procedures for axial cracks in pipelines are summarised with respect to elastic-plastic fracture mechanics models and failure assessment diagram methods. Assumed residual stress levels for fitness-for-service assessments are outlined. Code recommendations relating to the relaxation of uniform residual stress are described for uncracked and cracked pipes. Linepipe manufacturing routes and associated residual stress levels are discussed for seamless pipe, expanded longitudinally submerged arc welded (SAWL) pipe, non-expanded SAWL pipe, helical or spiral SAW pipe, electric welded pipe, flash butt welded pipe and furnace welded pipe. Skelp end welds, PWHT and repair welds are also considered.

45-277446

Influence of weld residual stresses on ductile crack behaviour in AISI Type 316LN stainless steel weld joint.

NAMBURU S D; CHEBOLU L R; SUBRAMANIAN A K; PRAKASH R; GOMATHY S

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Design and Analysis. Paper PVP2018-84693. 7pp. 5 fig., 1 tab., 12 ref.

[in English] *[DVD; PVP2018-trk-3\trk-3\PVP2018-84693.pdf]*

An investigation incorporating 2D plane strain finite element modelling and X-ray diffraction measurements was undertaken to study the effect of welding residual stress on ductile crack growth behaviour in AISI 316LN austenitic stainless steel welded compact tension specimens, and the relationships between residual stresses, load bearing capacity, crack size and porosity were examined. Welding was performed by an MMA (shielded metal arc) technique with 316L stainless steel electrode sticks. Welding residual stresses were mapped onto the finite element model using the residual mapping technique. The GTN (Gurson-Tvergaard-Needleman) model was employed to estimate ductile crack initiation and growth under loading and to develop load bearing behaviour.

46 FRACTURE MECHANICS

See also abstracts: 41-277376, 45-277446, 52-277369, 52-277420, 60-277382

46-277356

Evaluation of solidification cracking susceptibility in ERNiCr-3 (Filler Metal 82) weld metal using the cast pin tear test.

ORR M R; LIPPOLD J C; ARGENTINE F

Welding in the World, vol.61, no.5. Sep. 2017. pp.935-944. 12 fig., 4 tab., 12 ref. ISSN: 0043-2288

[in English] *[See also Weldasearch 234502]*

[https://rd.springer.com/article/10.1007%2Fs40194-017-0473-6]

The solidification behaviour and cracking susceptibility of the filler metal ERNiCr-3 (FM82) (Ni, 19.27-19.68%Cr, 2.82-2.84%Mn, 2.37-2.47%Nb, 1.05-1.14%Fe), widely used for welds in pressurised water reactor components for the nuclear power industry, were investigated using the cast pin tear test. The microstructure, phase composition and solidification behaviour were examined using metallography and fractography, and differences between resistant and susceptible heats of FM82 were evaluated. Three heats of FM82 with varying composition were studied: AB8573 (cracking susceptible); YB8908 (resistant); and B8142 (resistant). The effects of dilution of a resistant heat by a susceptible heat filler metal were determined. The solidification temperature range fraction eutectic that formed at the end of solidification was estimated using Thermo-Calc software and thermodynamic calculations.

46-277381

Mechanical behaviour of a forged ferritic steel shell containing numerous hydrogen flakes.

JACQUEMOUD C; DELVALLEE-NUNIO I

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84087. 11pp. 15 fig., 2 tab. 18 ref.

[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84087.pdf]*
In relation to the discovery of flaws in two Belgian reactor pressure vessels, a test programme was undertaken to investigate the mechanical properties of a forged steam generator vessel shell containing numerous hydrogen flakes in comparison with flawless components in the ductile-to-brittle transition and ductile ranges. The chemical composition of the VB395 test specimen was 0.18%C, 1.46%Mn, 0.25%Cr, 0.72%Ni, 0.5%Mo, 0.05%Cu. Fracture toughness was determined from 85 tests in the ductile range (100 deg.C) according to ASME E1820 and the ductile-to-brittle transition range (-130 to -80 deg.C) according to ASME E1921. Statistical distributions of fracture toughness in flaked and flawless specimens were obtained. Uniaxial large bending tests were also performed on specimens with multiple tilted flakes. Experimental results were compared with elastic and elastoplastic extended finite element method simulations.

46-277386
Assessment of master curve material inhomogeneity using small data sets.
WALLIN K
In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84297. 10pp. 13 fig., 13 ref.
[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84297.pdf]*
In relation to the use of the master curve methodology to characterise the brittle fracture toughness of inhomogeneous materials, an investigation is presented into the possibility of using multi-modal analysis with small data sets and a procedure to facilitate conservative accounting for possible inhomogeneities. The procedure described combines a log-likelihood screening criterion with a conservative estimate of an effective master curve reference temperature corresponding to a correct 5% lower bound. Aspects of multimodal and bimodal master curve analysis are outlined, and the uncertainty of the multi-modal method for small data sets is examined. Re-assessment of HSST 02 fracture toughness data is reported, censoring only specimens showing deviation from linear elastic fracture mechanics. The use of the multi-modal method with data sets consisting of only 6 uncensored data points is discussed.

46-277387
Fracture toughness evaluation of heat-affected zone under weld overlay cladding in reactor pressure vessel steel.
HA Y S; TOBITA T; TAKAMIZAWA H; HANAWA S; NISHIYAMA Y
In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84535. 6pp. 11 fig., 1 tab., 16 ref.
[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84535.pdf]*
A stainless steel strip cladding was applied to an A533B class 1 type reactor pressure vessel steel (0.2%C, 1.32%Mn, 0.17%Cr, 0.68%Ni, 0.53%Mo, 0.16%Cu) by submerged arc surfacing and the fracture toughness of the HAZ under the cladding was investigated. In order to determine the fracture toughness of the total HAZ area, 0.4T-compact tension specimens (thickness 10 mm) at locations relative to certain target cladding positions and mini-compact tension specimens in locations near or away from the cladding region were considered. The HAZ distribution was confirmed by finite element analysis. Issues discussed include the fracture toughness of coarse-grained and fine-grained HAZ dominant areas, Vickers hardness tests to confirm HAZ microstructural changes, initiation points on fracture surfaces, master curves, and reference temperatures of HAZs and parent metal.

46-277388
Master curve testing on reconstituted surveillance Charpy specimens.
GILLEMOT F; HORVATH M; HORVATH A; SZENTHE I; KOVACS A
In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84749. 5pp. 9 fig., 1 tab., 7 ref.
[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84749.pdf]*
In relation to the use of the master curve method for fracture toughness testing of small specimens, an investigation is presented into a testing procedure to measure data using the remnants of irradiated surveillance Charpy specimens and a comparison of the data calculated from CMOD and LLD (load line displacement) on irradiated reactor pressure vessel (RPV) materials and weldments. The WWER-440 V213 RPV steel was 15Kh2MFA (0.13-0.18%C, 0.3-0.6%Mn, 2.5-3%Cr, 0.6-0.8%Mo, 0.25-0.35%V). Specimens were subjected to fatigue precracking using a servohydraulic tensile testing machine. Master curve testing was conducted according to the ASTM 1921-15 standard. Video microscopy was used to observe the fatigue crack front and to check for material defects. Issues discussed include the reliability of the reconstitution technology using stud welds and comparisons between master curve reference temperatures obtained on reconstituted unirradiated and irradiated Charpy specimens.

46-277389
Use of mini-CT [compact tension] specimens for fracture toughness characterisation of low upper-shelf Linde 80 weld before and after irradiation.
SOKOLOV M
In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84804. 6pp. 3 fig., 2 tab., 15 ref.
[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84804.pdf]*
In relation to the use of mini-compact tension (mini-CT) specimens for direct measurement of the fracture toughness of reactor pressure vessel (RPV) materials in the transition region using master curve methodology, an investigation was undertaken on mini-CT specimens machined from previously tested Charpy specimens of the Midland low upper-shelf Linde 80 double-V submerged arc weldment in both unirradiated and irradiated conditions. Testing was performed under carefully controlled conditions in accordance with ASTM E1921 such that the results were comparable with the fracture toughness performance of previously tested large specimens. Post-test examination of the fracture surfaces was conducted to assess the extent of precracking. The ability of a small number of mini-CT specimens to determine the fracture toughness reference temperature of a low upper-shelf material is discussed.

46-277390

Trial study of the master curve fracture toughness evaluation by mini-C(T) [compact tension] specimens for low upper shelf weld metal Linde-80.

YAMAMOTO M

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84906. 8pp. 7 fig., 5 tab., 17 ref.

[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84906.pdf]*

In relation to the use of mini-compact tension (mini-CT) specimens for direct measurement of the fracture toughness of ferritic reactor pressure vessel (RPV) materials using the master curve method, an investigation was undertaken into two sets of 15 mini-CT specimens machined and precracked from irradiated Linde-80 beltline weld metal in order to establish the feasibility of obtaining valid results for fracture toughness and master curve reference temperature from such a small data set. Servo-hydraulic fatigue machines were used for the fracture toughness tests conducted at temperatures of 5, -5 and -25 deg.C. Two laboratories were involved with the testing to evaluate fracture toughness and the results were compared with those obtained from 1T-CT, 0.5T-CT and precracked Charpy specimens. Issues discussed include the occurrence of ductile crack growth and the number of mini-CT specimens for the master curve determination for low upper shelf material.

46-277391

Inter-laboratory results and analyses of mini-C(T) [compact tension] specimen testing of an irradiated Linde 80 weld metal.

SERVER W; SOKOLOV M; YAMAMOTO M; CARTER R

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84950. 5pp. 3 fig., 1 tab., 11 ref.

[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84950.pdf]*

An irradiated low-upper-shelf Linde 80 weld metal was tested by four laboratories as part of an inter-laboratory assessment to investigate the validity and use of miniature compact tension (mini-CT) test specimens for master curve fracture toughness evaluation of irradiated reactor pressure vessel (RPV) material according to ASTM E1921. The material studied was a Linde 80 flux weld metal from the Midland RPV circumferential weld in which the low upper shelf in the irradiated condition resulted in a tendency for ductile crack growth initiation prior to cleavage-initiated fracture. Two load-line measurement methods (front face machined knife edges and direct outboard load-line) were examined. Fracture toughness results were compared with those obtained for 0.5T-CT, 1T-CT and precracked Charpy specimens.

46-277392

Fracture toughness characterisation of low upper-shelf Linde 80 weld using mini-C(T) [compact tension] specimens.

ICKES M R; HALL J B; CARTER R

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84967. 6pp. 7 fig., 3 tab., 7 ref.

[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84967.pdf]*

Mini-compact tension (mini-CT) specimens machined from a reactor pressure vessel (RPV) weld were tested to provide fracture toughness characterisation of an irradiated low-upper-shelf Linde 80 weld (WF-70) utilised in the Midland beltline. The WF-70 material comprised a submerged arc weld wire heat 72105 with Linde 80 type flux from lot 8669. The ASTM E1921 methodology was applied to the testing and data analysis, incorporating a servo-hydraulic materials testing system load frame controlled by an Instron 8800 fast track controller as well as Instron Console software and Instron DAX software. Two gauges were employed to measure displacement in the test specimens. The results were compared with previous test data from larger fracture toughness specimens. The sensitivity of the reference temperature to the ASTM E1921 censoring value is discussed.

46-277393

Effects of non-normal input distributions and sampling region on Monte Carlo results.

TSEMBELIS K; EOM S; JIN J; COLE C

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84767. 10pp. 21 fig., 6 tab., 17 ref.

[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84767.pdf]*

With regard to the development of probabilistic fracture mechanics (PFM) codes invoking the Monte Carlo method to identify governing parameters which could affect licensing basis margins of pressure retaining components in the nuclear industry, an investigation was undertaken to demonstrate how the choice of prescribed input distributions (e.g. normal, log-normal, Weibull) and sampling areas of the system function may affect the uncertainty propagation into the final variables of interest. A single system function was chosen based on the transverse through-wall residual stress of a welded region on a 25.4 mm thickness pipe. Annex C.10 of the FITNET fitness-for-service procedure was employed to provide relations for the transverse through-wall residual stress distribution of austenitic pipe butt welds. Monte Carlo simulations were performed using the open source R-studio version 1.1.383 to identify the uncertainty of the residual stress at three distinct locations through the thickness (5, 11.5 and 17.5 mm from the inside surface of the weld).

46-277394

Development of probabilistic fracture mechanics analysis code PASCAL version 4 for reactor pressure vessels.

LU K; MASAKI K; KATSUYAMA J; LI Y S; UNO S

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84964. 10pp. 6 fig., 4 tab., 35 ref.

[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84964.pdf]*

With regard to the development of the probabilistic fracture mechanics (PFM) code PASCAL for structural integrity assessment of Japanese reactor pressure vessels (RPVs) taking into account neutron irradiation embrittlement and pressurised thermal shock (PTS) transients, an investigation is presented into analysis functions incorporated into PASCAL Version 4 for evaluating the failure frequency of RPVs. Issues discussed include the structure and modules in PASCAL 4, the flowchart of crack initiation frequency and through-wall cracking frequency calculations using PASCAL-Manager, and the main analysis functions in PASCAL 4 incorporating confidence level evaluation, stress intensity factor solutions for cracks, stress intensity factor calculation for complicated stress distributions and a neutron

irradiation embrittlement prediction method. A PFM analysis example using PASCAL 4 is described for the core region of a Japanese model RPV under several PTS transients.

46-277412

Development of crack evaluation models for probabilistic fracture mechanics analyses of Japanese reactor pressure vessels.

LU K; MASAKI K; KATSUYAMA J; LI Y S

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84965. 8pp. 10 fig., 3 tab., 23 ref.

[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84965.pdf]*

In relation to the development of the PASCAL Version 4 probabilistic fracture mechanics analysis code for structural integrity assessment of reactor pressure vessels (RPVs) in Japan, an investigation is presented into finite element analyses (FEA) to verify the stress intensity factor calculations of cracks in PASCAL 4 and the applicability of crack evaluation models such as the location of embedded cracks, crack shape and depth of surface cracks, and the increment of crack propagation. 3D FEA were performed for different embedded cracks and the calculated stress intensity factor results from Abaqus 2016 were compared with those from PASCAL 4. The crack evaluation models were assessed with respect to sensitivity analyses and through-wall cracking frequency evaluation of RPVs. Welding conditions utilised in Japanese RPV fabrication are also considered.

46-277413

Sensitivity study on the effects of nondestructive examinations on failure probabilities of reactor pressure vessels.

ARAI K; KATSUYAMA J; LI Y S

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84989. 7pp. 13 fig., 3 tab., 12 ref.

[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84989.pdf]*

Sensitivity analyses were undertaken to determine the effects of NDE (nondestructive examination) flaw detection capability on the failure frequencies of reactor pressure vessels (RPVs) using the probabilistic fracture mechanics code PASCAL, taking into account simplified probability of detection (POD) curves in terms of minimum detectable flaw size, the lowest probability of non-detection (PND), and flaw size where the POD value reaches the lowest PND. The methodology incorporated calculation of the time histories of temperature and stress distributions through the wall thickness of the RPV during pressurised thermal shock (PTS) events, determination of the conditional probabilities of crack initiation and failure assuming a single flaw and a single transient, and through-wall cracking frequency calculation by considering flaw size density distribution and neutron fluence distribution in the RPV core region and multiple transients and their occurrence frequencies. The contribution of flaw depth to total failure frequency is discussed for parent and weld metals.

46-277418

Verification of probabilistic fracture mechanics analysis code through benchmark analyses.

LI Y S; UNO S; MASAKI K; KATSUYAMA J; DICKSON T; KIRK M

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84963. 11pp. 16 fig., 8 tab., 27 ref.

[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84963.pdf]*

With regard to the development of the PASCAL probabilistic fracture mechanics (PFM) analysis code to evaluate failure probabilities and failure frequencies of Japanese reactor pressure vessels (RPVs) under pressurised thermal shock (PTS) events and neutron irradiation embrittlement, benchmark analyses using the PFM code FAVOR were undertaken to verify the applicability of PASCAL version 4. The benchmark analyses incorporated typical conditions of a Japanese three-loop pressurised water reactor and two typical PTS transients (the LBLOCA-type and SOV-type transients). Results were obtained with respect to conditional probability of crack initiation and conditional probability of failure for single cracks and for frequency of crack initiation and through-wall cracking frequency considering crack distributions and fluence variation. Differences between the two codes in terms of stress intensity factor solutions, probabilistic distribution of chemical composition, incremental value of crack propagation and crack propagation judgment model are discussed.

46-277419

PTS [pressurised thermal shock] on embedded rotated cracks and projection rules.

STEFANINI L; BLOM F J

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84055. 6pp. 9 fig., 11 tab., 7 ref.

[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84055.pdf]*

An investigation was undertaken to examine the effect of pressurised thermal shock (PTS) events on a reactor pressure vessel (RPV) with embedded axial cracks and various analyses were carried out to define the behaviour of different skewed axial cracks with different rotation. An elliptical embedded crack was postulated in a cylindrical geometry simulating the RPV. Thermal and structural analyses were conducted for the axial crack and skewed embedded axial crack configurations (30, 45 and 65 deg.). ANSYS finite element analyses were carried out for two variants: no-heat transmission and total heat transmission through the crack. Stress intensity factors were calculated for skewed and projected axial cracks. Shortcomings of the ASME approach described in the Non-Mandatory Appendix C Article C-2400 for PTS loading of the cracks are discussed.

46-277429

Establishing fracture mechanics based minimum allowable temperatures for low temperature applications of ASME B31.3 piping.

KUMMARI S R; MACEJKO B; SHIPLEY K S; PRUETER P E; EVANS G; JAMAL N

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Design and Analysis. Paper PVP2018-84797. 14pp. 20 fig., 15 ref.

[in English] *[DVD; PVP2018-trk-3\trk-3\PVP2018-84797.pdf]*

A fracture mechanics methodology published in Welding Research Council (WRC) Bulletin 562 was employed to develop step-by-step Level 1 and Level 2 procedures for establishing minimum allowable temperatures (MATs) for low-temperature applications of ASME B31.3 piping by explicitly considering the maximum longitudinal

stresses permitted by the code of construction. The methodology was formulated by considering API 579 FAD (failure assessment diagram)-based fracture mechanics, reference flaw size, general primary membrane stress, welding residual stress (for both as-welded and PWHT conditions) and fracture toughness master curve. For the Level 1 methodology, MAT screening curves were developed based on the assumption that the stresses in the piping component were maximum code allowable stresses in both the hoop and longitudinal directions. For Level 2, stress ratio verses temperature reduction curves were derived to consider the effect of lower operating stresses. Level 1 and Level 2 MATs were established for A-106 Grade B and A-333 Grade 6 steel NPS 14 piping systems (wall thickness 19 mm).

46-277447

Proposed methodology changes to determine minimum design metal temperature of ASME/API impact tested materials based on fracture mechanics.

KUMMARI S R; MACEJKO B; PRUETER P E

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Design and Analysis. Paper PVP2018-84795. 10pp. 11 fig., 20 ref.

[in English] *[DVD; PVP2018-trk-3\trk-3\PVP2018-85795.pdf]*

In relation to the use of Charpy V-notch impact testing of parent material and/or weldments to establish the minimum design metal temperature (MDMT), two examples are described to highlight the inadequacies of the impact test requirements and a methodology for estimating MDMT based on fracture mechanics, consistent with Welding Research Council (WRC) Bulletin 562, is presented. The case studies involved calculating the minimum allowable temperature for a pressure vessel using fracture mechanics or impact testing and then considering PWHT stress relief. The fracture mechanics methodology was based on an API 579 failure assessment diagram approach, taking into account PWHT effects and the influence of welding residual stress on crack driving force. Other issues discussed include a means of adjusting MDMT for in-service impact tested materials and an alternative procedure for establishing impact test requirements for ASME/API consideration.

47 NONDESTRUCTIVE TESTING

47-277373

Three approaches to quantification of NDE [nondestructive examination] uncertainty and a detailed exposition of the expert panel approach using the Sheffield elicitation framework.

FONG J T; HECKERT N A; FILLIBEN J J; DOCTOR S R

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84771. 15pp. 11 fig., 7 tab., 37 ref.

[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84771.pdf]*

With regard to the uncertainty of NDE (nondestructive examination) methods employed for pre-service and in-service inspections associated with factors such as NDE equipment type and age, the operator's level and experience, probe angle and flaw type, an investigation is presented into three approaches for uncertainty quantification in NDE risk-informed decision making. The methods considered were a regression model approach to analyse round-robin experimental data on intergranular stress corrosion cracking detection and austenitic stainless steel testing, a statistical design of experiments approach and an expert knowledge elicitation approach. The expert panel approach was implemented by employing a software package called the Sheffield Elicitation Framework. The approaches were compared with respect to subsurface crack length estimation in a pressure vessel head.

47-277395

A treatise on weld evaluation.

CHANDIRAMANI D K; NARAYANA S

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84109. 12pp. 20 fig., 6 ref.

[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84109.pdf]*

A treatise is presented with the aim of providing structured guidelines to welding engineers, inspectors and quality control personnel to ensure that weldments are produced knowledgeably, based on requirements of service conditions of the vessel and the use of appropriate NDE (nondestructive examination) and inspection techniques to verify that all welds finally accepted are defect-free. The requirements of construction codes are outlined. Welding technology is summarised in relation to filler metals and preheat temperature. Quality assurance was examined with respect to hot cracking in cruciform test pieces and visual and radiographic examination of butt joints with intermittent or continuous undercut. Experimental studies incorporating radiography and ultrasonic testing were conducted on sample test plates prepared by MMA welding with artificially induced defects such as lack of side wall fusion and incomplete penetration.

47-277400

Research on phased array ultrasonic testing for the girth weld of 4mm-10mm austenitic stainless steel pipeline.

ZHOU L Y; FU M H; XU W P

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84201. 7pp. 8 fig., 5 tab., 5 ref.

[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84201.pdf]*

An investigation incorporating experimental measurements and CIVA software simulations was undertaken to examine the feasibility of phased array ultrasonic testing (PAUT) of girth butt welds in type 304 austenitic stainless steel pressure piping (wall thickness 4-10 mm). PAUT process design involved choice of ultrasonic phased array probe frequency and choice of main acoustic beam angle. Linear calibration of the testing system and sensitivity calibration of the distance-amplitude curve were carried out. The validity and reliability of probe component and detection system parameters were assessed by a verification test. Eighteen groups of stainless steel butt weld simulation samples were studied by PAUT and radiographic testing with respect to the detection of natural defects such as incomplete penetration, lack of fusion and cracking.

47-277402

Development of small diameter and thin-walled tube docking girth joint ultrasonic testing probe and block.

ZHOU L Y; FU M H; XU W P

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84275. 5pp.

12 fig., 3 tab., 5 ref.
[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84275.pdf]*
With regard to the development of an ultrasonic quantitative testing technique for the joint ring weldments of thin-walled pipes, an investigation is presented into a small-bore and sheet steel tube docking girth joint ultrasonic testing probe and a test block designed for the testing of the probe's technical indicators. The design of probe parameters is discussed with respect to probe frequency, crystal size selection (length, width and curvature), wedge design and probe resolution. Block design is outlined for standard and auxiliary reflectors. Probe performance tests (i.e. beam axis and transverse resolution test, K value and probe front test and location test) are described along with test verification by distance-amplitude curve, scanning sensitivity and site verification. Ultrasonic test performance on a petrochemical storage pipeline is compared with that of radiographic testing in relation to the detection of incomplete penetration.

47-277406
The research on automatic defect recognition for phased array ultrasonic inspection of polyolefin butt thermal-fusion joint.
ZHONG H J; GUO W C; MIAO C J; SHI J F; HOU D S
In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84497. 5pp. 12 fig., 9 ref.
[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84497.pdf]*
On the basis of the defect classification of polyolefin butt thermal-fusion joints, an ultrasonic phased array testing technique was proposed, in which a liquid immersion coupling method was employed to overcome the difficulty caused by the severe acoustic attenuation of polyethylene material and the acoustic energy dissipation in the detecting interface. Defect classification distinguished four categories: cracks, holes, contamination of the fusion interface and process defects (e.g. cold welding, over-heat welding and misalignment). In order to establish the reliability of the phased array technique, joint specimens containing typical defects were fabricated and the defect location detected by ultrasonic testing was dissected to observe the morphological characteristics of the defect profile. Analysis of ultrasonic images identified spot defects, strip defects and planar defects.

47-277407
Research and application of ultrasonic guided wave with L(0,2) mode for elbow tube defect inspection.
DING J; ZHANG M; LIU S H; TANG C H; WANG J L; REN B; YANG B; DU Y N
In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84548. 6pp. 16 fig., 16 ref.
[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84548.pdf]*
With regard to the use of ultrasonic guided wave inspection technology for long distance pipeline inspection, an investigation is presented into a method of L(0,2) mode guided wave excitation based on the magnetostrictive effect and the optimisation of the magnetisation sensor arrangement. The guided wave detection system comprised a set of permanent magnets, exciting and detecting coils, a power amplifier, a computer and a signal generator. Magnetic yoke arrangements were studied to facilitate improved magnetic field homogeneity and intensity. Experimental and numerical simulation results are discussed with respect to defect detection in carbon steel pipe elbows.

47-277463
Hybrid active focusing with adaptive dispersion for higher defect sensitivity in guided wave inspection of cylindrical structures.
LOWE P S; SANDERSON R; BOULGOURIS N V; GAN T H
Nondestructive Testing and Evaluation, vol.31, no.3. 2016. pp.219-234. 11 fig., 2 tab., 40 ref. ISSNs: 1058-9759, 1477-2671
[in English]
[https://www.tandfonline.com/doi/full/10.1080/10589759.2015.1093628]
High sensitivity focusing technique was developed for use in low frequency ultrasonic guided wave (UGW) inspection of cylindrical structures. It was called hybrid active focusing (HAF) technique and consisted of a combination of numerical simulation with the active focusing and time reversal concept, and operated at low frequency and compensated for dispersion. The performance of HAF technique for defect detection was compared with the performances of existing techniques (active, time reversal and synthetic focusing) by use of an empirically validated finite element method (FEM). The defects consisted of fully penetrating, part-circumferential crack like defects in Schedule 40 steel pipe (outer diameter 219.1 mm, wall thickness 8.18 mm). Results of the FEM were validated by using 3D laser vibrometry measurements and UGW unfocused excitation. Sensitivity in defect detection achieved by use of the HAF technique is discussed.

47-277465
Investigation of high temperature performance of ultrasonic guided wave system for in-service condition monitoring of pipework in thermal power plants.
DHUTTI A; GAN T H; MOHIMI A; KANFOUD J
Paper presented at WCCM 2017, 1st World Congress on Condition Monitoring, London, UK, 13-16 June 2017. Publ: British Institute of Non-Destructive Testing, Northampton, UK, 2017. Session 2A: Condition Monitoring and NDT Methods and Technologies. pp.312-318. 7 fig., 9 ref. ISBN: 9781510844759
[in English] *[See also Weldasearch 270589]*
The performance and defect detection capability of an ultrasonic guided wave (UGW) system using T(0,1) wave mode was investigated, for structural health monitoring of high temperature (HT) pipework, under the influence of temperature (up to 150 deg.C) and temperature over time (over 3 months). A UGW transducer array consisted of transducers which used PZT5A piezoelectric material with a Curie temperature of approximately 350 deg.C. HT performance of the transducer array was evaluated using a test pipe specimen with heating mats in HT monitoring experiments (e.g. at a target temperature for extended time periods to assess thermal ageing stability; ultrasonic measurements conducted at a target temperature of the simulated growth of an artificial saw cut defect in the test pipe over a four week period, for assessment of the defect sensitivity of the transducer array at the target temperature). Investigations covered: how increasing temperature changed the ultrasonic response; HT effects on ultrasonic response over time; and temperature compensation for defect detection and monitoring.

48 QUALITY CONTROL

See also abstracts: 02-277324, 47-277395

48-277364

Quality control and assurance in fabrication of welded structures subjected to fatigue loading.

STENBERG T; BARSOUM Z; ASTRAND E; OBERG A E; SCHNEIDER C; HEDEGARD J

Welding in the World, vol.61, no.5. Sep. 2017. pp.1003-1015. 17 fig., 2 tab., 24 ref. ISSN: 0043-2288

[in English]

[https://rd.springer.com/article/10.1007%2Fs40194-017-0490-5]

Procedures for the weld quality control and assurance of welded structures are overviewed. The limitations of various quality control standards, international weld quality standards and guidelines used in weld production are discussed. The following standards are briefly examined: SS-EN ISO 5817; Volvo Group STD 181-0004; and IIW guideline on weld quality in relation to fatigue strength. Criteria to ensure design and fabrication for purpose are outlined. Different manual gauges for assessing weld surface geometries are reviewed as well as the use of computers to visually scan the welded joints. An online system, ONWELD, is presented as a robotic method of geometrical weld quality assurance, and the methods for verification of the system under weld production conditions are discussed. Potential future development of the ONWELD system is briefly outlined.

50 NUCLEAR ENGINEERING

See also abstracts: 23-277414, 41-277377, 41-277384, 42-277397, 43-277422, 46-277381, 46-277387, 46-277388, 46-277389, 46-277390, 46-277391, 46-277392, 46-277393, 46-277394, 46-277412, 46-277413, 46-277418, 46-277419, 60-277375, 60-277383, 60-277385, 60-277396, 60-277409, 60-277411

50-277374

ASME Section XI Appendix L: Flaw tolerance evaluation of pressurised water reactor piping systems to support second licence renewal (80-years operation).

UDYAWAR A; TOMES C; CAROLAN A; MARLETTE S; MEIKLE T; BAMFORD W

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84346. 7pp. 4 fig., 4 tab., 14 ref.

[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84346.pdf]*

With regard to the requirement to assess the effects of reactor water environment on fatigue during Subsequent Licence Renewal of nuclear power plants, an investigation is presented into a flaw tolerance evaluation based on ASME Section XI Appendix L for auxiliary piping systems of a typical PWR (pressurised water reactor) plant, taking into account the piping geometry, materials, loadings, crack growth mechanism and inspection detection capabilities. Six piping systems were identified for consideration: safety injection line nozzle location, accumulator line nozzle location, residual heat exchanger piping, charging line nozzle location, spray piping connected to pressuriser and surge line location. The analysis incorporated loading conditions and stress analysis, fracture mechanics, aspect ratio determination, allowable flaw sizes and fatigue crack growth. The allowable operation period for the piping systems based on ASME Section XI Appendix L was calculated.

50-277417

Proposed review framework for design of pressure retaining systems and components (PRSC) in small modular reactor (SMR).

EOM S; SADEK N; CHAUDHRY K; COLE C; AWAD R; DUAN X J

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-85106. 10pp. 19 ref.

[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-85106.pdf]*

In relation to the importance of a well-designed research and development programme to address knowledge gaps in material behaviour during the design of small modular nuclear reactors (SMRs) and the incorporation of potential/plausible degradation mechanisms to ensure the structural integrity of pressure retaining systems and components, a report is presented into a proposed framework based on key findings from the pre-licensing vendor design review of SMR designs in Canada. Issues discussed include the review framework for focus area 1 (i.e. plant description, defence in depth, safety goals and dose acceptance criteria), focus area 2 (classification of structures, systems and components), focus area 10 (safety analysis, including accident prevention, plant safety characteristics and postulated initiating events), focus area 11 (pressure boundary design, e.g. ageing and wear, seismic classification and in-service testing, maintenance, repair, inspection and monitoring), and focus area 16 (the vendor research and development programme).

50-277449

Cooperative design and optimisation of reactor coolant system piping supports under static and dynamical load conditions.

XIONG F R; LAN B

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Design and Analysis. Paper PVP2018-84026. 12pp. 14 fig., 4 tab., 23 ref.

[in English] *[DVD; PVP2018-trk-3\trk-3\PVP2018-84026.pdf]*

With regard to the cooperative design and optimisation of pressurised water reactor coolant system piping supports by taking account of piping responses under static and dynamic loads, the optimal design task was formulated as a multi-objective optimisation problem with the stress level at key elbows and weld seams of the main pipes as objectives and various parameters of each supporting device as design variables. A single support sampling strategy was proposed to study the influence of one supporting device and clustering algorithms were applied to investigate patterns from the single support sampling pool. A 3-snubber-3-stop main pipe support layout was determined using unsupervised clustering algorithms and parameter design was carried out with a surrogate model-based approach. Simulation results of the optimal piping support design were compared with stress level predictions of the ASME Boiler and Pressure Vessel Code.

50-277454

Prediction of transient hydrodynamic loads on the PWR [pressurised water reactor] steam generator tubes at a main feed water line break accident.

JO J C; JEONG J J; YUN B J

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Fluid-Structure Interaction. Paper PVP2018-84152. 11pp. 13 fig., 32 ref.

[in English] *[DVD; PVP2018-trk-4\trk-4\PVP2018-84152.pdf]*

Computational fluid dynamics (CFD) analyses were undertaken to predict the transient hydrodynamic loads exerted on the steam generator (SG) tubes and the thrust forces on the broken pipe during a main feed water line break accident at a pressurised water reactor (PWR) power plant. To take into account severe transient hydrodynamic loads, the break was assumed to occur at the circumferential weld line between the feed water nozzle and the main feed water pipe so that compressed sub-cooled water would be discharged through the short broken pipe. Numerical simulation results were obtained with respect to transient pressure and velocity responses, flow-induced vibration of SG tubes, transient hydraulic loads on the SG tubes and transient thrust force on the pipe. Blowdown models based on subcooled liquid non-flashing, saturated liquid flashing and subcooled liquid flashing discharges were calculated by CFD.

52 PIPES, PIPELINES AND VESSELS

See also abstracts: 12-277349, 40-277404, 41-277370, 41-277372, 41-277436, 41-277450, 42-277430, 42-277437, 42-277441, 43-277401, 43-277438, 43-277445, 44-277403, 45-277416, 45-277421, 45-277440, 45-277443, 46-277429, 46-277447, 47-277373, 47-277400, 47-277402, 47-277407, 60-277382, 60-277398, 60-277410, 60-277435, 60-277439

52-277334

Calculation of two-layer billet of spherical bottoms for high-pressure vessels.

PROKOFIEV A S; GUBATYUK R S; MUZHICHENKO A F; BARANOVSKY V N

Paton Welding Journal, no.8. Aug.2016. pp.49-53. 3 fig., 4 tab., 10 ref. ISSN: 0957-798X

[in English and Russian] *(Translated from Avtomaticheskaya Svarka) [https://patonpublishinghouse.com/eng/journals/tpwj/2016/08/09/]*

The circumferential stress and radial deformation of a two layer hemispherical end for a welded pressure were determined by numerical modelling for different steel combinations. The internal diameter of the vessel was 147.5 mm and the wall thickness of the inner layer was 2.25 mm. The wall thickness of the outer layer depended upon the strength characteristics of the steel grade. The inner and outer layers were presumed to be in contact. The circumferential stress and radial deformation were calculated for operating pressure of 20 MPa, for pressure vessels with an inner layer of low carbon structural steel 08kp or 20, and an outer layer of high strength steel, low carbon steel 20 or 08kp. The circumferential stress distribution and radial deformation were determined by finite element modelling.

52-277350

Failure is not an option [duplex stainless steel for gas production].

NAUMAN M

World Pipelines, vol.19, no.1. Jan. 2019. pp.63-64. 1 fig. ISSN: 1472-7390

[in English]

A case study is reported in which the causes of corrosion in a duplex stainless steel pipeline transporting sour wet gas with high chloride content were investigated. Linepipe in periodic use since 1984 was found to exhibit internal corrosion and pitting corrosion near the HAZ of girth welds. Pipe material was type 2205 duplex stainless steel, TIG welded under Ar rich shielding gas. Materials analysis, mechanical testing, microstructural examination and corrosion testing revealed erroneous use of SS309 filler, resulting in inferior performance in the HAZ and weld root zones. Lessons to be learnt from this error are briefly discussed.

52-277369

Initial developments for LBB [leak before break] application to HTHA [high temperature hydrogen attack] sensitive non-stress relieved carbon steel girth welds in refinery plants.

WILKOWSKI G; HIOE Y; KURTH E; PUNCH E; UDDIN M; BRUST F; BAGNOLI K; PIOSZAK G

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84669. 12pp. 24 fig., 1 tab., 29 ref.

[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84669.pdf]*

In relation to the occurrence of high temperature hydrogen attack (HTHA) in refining industry piping and pressure vessels, an investigation is presented into the application of leak-before-break (LBB) to non-stress relieved seamless carbon steel piping girth welds susceptible to HTHA cracking. Drawing on analyses, results and experience from LBB efforts in the nuclear industry over the past 30 years, results from both mechanical testing and detailed modelling are employed to assess the efficacy of LBB technology for refinery piping systems with circumferential cracks. Issues discussed include fracture surfaces showing a double-ended guillotine break, a comparison of as-welded residual stress pattern and crack occurrence relative to stop-start position, the temperature for onset of upper-shelf behaviour for axial and circumferential flaws in ferritic steel parent metals and weldments, HTHA ductile fracture behaviour in SENT (single-edge notched tension) specimens, and leak rate evaluations for HTHA cracks under realistic service conditions.

52-277378

Introduction of technical document in Japan for safe use of ground storage vessels made of low alloy steels for hydrogen refuelling stations.

FUKUMOTO H; WADA Y; MATSUNAGA H; SANO T; KOBAYASHI H

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84099. 7pp. 11 fig., 1 tab., 23 ref.

[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84099.pdf]*

In relation to the safe use of low alloy steels for pressurised hydrogen ground storage vessels, a report is presented into a technical document (as an industrial standard prior to regulation) describing the required

types of testing as performance requirements for confirming hydrogen compatibility, such as controlling tensile strength in an appropriate range, confirming leak-before-break, and determining vessel life and inspection term by fatigue testing/fatigue crack growth analysis. Issues discussed include stress-stroke properties of low alloy steels, the definition of allowable stress, hardness tests, Charpy impact tests, definition of stress amplitude in fatigue analysis, end-of-life cycles in ground storage vessels, fatigue crack growth analysis in the design phase and based on an initial allowable defect, and the stop point of fatigue crack propagation analysis. Examples of ground storage vessel NDT and fatigue crack propagation analysis are outlined.

52-277399

Development of lightweight design and manufacture of heavy-duty pressure vessels in China.

CHEN X D; FAN Z C; CHEN Y D; ZHANG X H; CUI J; ZHENG J Y; SHOU B N

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84176. 12pp. 22 fig., 3 tab., 41 ref.

[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84176.pdf]*

Progress in the lightweight design and manufacturing technology of heavy duty pressure vessels in China is reviewed with respect to adjustment of material allowable strength, applications of high strength steel, matching of strength and toughness, the cold stretch technique for austenitic stainless steels, multi-parameter coupled structural optimisation of heat exchangers, and applications of composite materials. Issues discussed include cracking of pressure vessels during hydraulic tests, material allowable strength coefficient for carbon steel and low alloy steel pressure vessels, impact toughness, residual stress and reheat cracking sensitivity of 12Cr2Mo1VR high strength low alloy (HSLA) steel, fatigue strength design curve of cold stretched pressure vessels, super-large heat exchangers for chemical engineering, carbon fibre composite pressure vessels, and the fatigue life of composite gas cylinders.

52-277405

Light-weight mechanism of pressure strengthening of cryogenic vessels from austenitic stainless steel.

LU Q J; HUANG G; WU Y Z; DING H M; ZHENG J Y

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84451. 8pp. 6 fig., 5 tab., 21 ref.

[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84451.pdf]*

With regard to the use of pressure strengthening technology to facilitate increased allowable stress and reduced weight of austenitic stainless steel cryogenic pressure vessels, the influence of low temperature on the cryogenic mechanical properties of S30408 stainless steel (0.02%C, 18.3%Cr, 8.05%Ni) and its welded joints was investigated and a numerical analysis was performed to assess the influence of pressure strengthening of a large transportable cryogenic storage tank. Welding was conducted using a combined plasma-MIG/MAG process. Mechanical properties at cryogenic (-196 deg.C) and room (20 deg.C) temperatures were characterised by tensile tests to determine engineering stress-strain curves and tensile and yield strengths. The effects of low temperature and pre-strain and the mechanism of pressure strengthening technology are discussed.

52-277420

A methodology for constructing complex 3D cracked body finite element models efficiently.

VORSTER W J J; MANN A

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Computer Technology and Bolted Joints. Paper PVP2018-84908. 8pp. 10 fig., 3 tab., 5 ref.

[in English] *[DVD; PVP2018-trk-2\trk-2\PVP2018-84908.pdf]*

With regard to the construction of finite element models (FEMs) for complex components such as branches and branches located on pipework bends during structural integrity fitness for purpose assessments, a procedure was developed for creating and manipulating FEMs to enable inserting cracks in areas of structural discontinuities or significant curvature. The fracture mechanics methodology was formulated in relation to longitudinal cracks in 90 degree pipe bends subjected to in-plane or out-of-plane loading. Nodal rotations within the crack region were considered to ensure that J-integral contours were normal to the crack front. The method was applied to model external surface-breaking axial defects in straight pipes (outside diameter 323.9 mm, wall thickness 9.53 mm) and bends. Comparisons between stress intensity factors calculated from the FEM J-integral and published works for the plain pipes are discussed.

52-277423

A simple calculation method of the load factor and a bolt preload determination satisfying allowable leak rate for bolted pipe flange connections with gaskets subjected to internal pressure.

SAWA T; SATO K; MABUCHI T

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Computer Technology and Bolted Joints. Paper PVP2018-84217. 10pp. 9 fig., 4 tab., 18 ref.

[in English] *[DVD; PVP2018-trk-2\trk-2\PVP2018-84217.pdf]*

With regard to the prediction of residual contact gasket stress and load factor in bolted pipe flange connections with gaskets under internal pressure, an investigation was conducted into a calculation method based on circular plate theory taking into account the reaction force distribution at the gasket interfaces and the effect of flange hub and in which the effect of the flange hub was analysed as a coupled problem between a cylindrical shell (hub) and the circular plate. A model of the circular plates and cylindrical shell, incorporating Hooke's formula and elastic circular plate theory, was derived in order to obtain the spring constants and load factor. The load factor was calculated for JIS 10K pipe flange connections (weld neck) and ASME B16.5 pipe flange (weld neck), and the numerical results were compared with those using a 3D finite element method. Experiments to measure the load factor and amount of leakage were undertaken for a 24" (609.6 mm) connection.

52-277425

Case studies on the use of thermal-mechanical finite element analysis to evaluate weld ring gasket and diaphragm seal designs.

PRUETER P E; DAVIS R C; RODERY C D; McJONES S F; BRODZINSKI R P; HAVEKOST J; FEDDELER D E

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Design and Analysis. Paper PVP2018-84910. 13pp. 29 fig., 34 ref.

[in English] *[DVD; PVP2018-trk-3\trk-3\PVP2018-84910.pdf]*
An investigation incorporating an axisymmetric thermal-mechanical finite element analysis (FEA) methodology to determine bolt loads, internal pressure and steady-state operating temperature and gasket behaviour simulation using contact surfaces was undertaken to assess different weld ring gasket designs and diaphragm seal configurations for bolted joints on a high-pressure heat exchanger. Characteristics such as bolt pre-tension, pressure-temperature loading, sensitivity to lip seal design, temperature profile and assumed friction coefficient between sealing surfaces were studied. Fat and hollow lip weld ring gasket geometries were compared in relation to design recommendations for different applications. The design of a diaphragm seal on a flat heat exchanger channel cover was evaluated using FEA techniques, with sensitivity analysis on the size of the external fillet weld and diaphragm material specification.

52-277426
Gasket catastrophic failure modes.
BROWN W; KNIGHT N
In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Design and Analysis. Paper PVP2018-85002. 8pp. 20 fig., 1 tab., 4 ref.
[in English] *[DVD; PVP2018-trk-3\trk-3\PVP2018-85002.pdf]*
In relation to the occurrence of catastrophic blow-out of pressure boundary bolted joints in gaskets, an investigation is presented into catastrophic failure modes, an attempt to re-create one of the failure modes using physical testing, and critical factors for blow-out of corrugated metal with covering layer (CMCL) gaskets. The characteristics of CMCL gasket substrate blow-out, grooved metal with covering layer gasket substrate blow-out, spiral wound gasket blow-out, fibre sheet gasket blow-out and stress corrosion cracking of metal substrates are described. Leakage testing was conducted on an NPS 8 class 150, raised face, weld neck flanged joint with mechanically wasted studs incorporating graphite-coated corrugated metal gaskets (thickness 1-1.79 mm). Joints were tested pneumatically and gasket failure level was determined with respect to bolt torque, flange moment and internal pressure. Recommendations for considering the failure modes in both pressure boundary bolted joint design and risk assessment are discussed.

52-277427
Pneumatic testing of piping: managing the hazards for high energy tests.
ARTI B; WEYER R; DANG T; TAAGEPERA J
In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Design and Analysis. Paper PVP2018-84078. 7pp. 3 fig., 2 tab., 7 ref.
[in English] *[DVD; PVP2018-trk-3\trk-3\PVP2018-84078.pdf]*
In relation to the use of pneumatic pressure testing during the construction of LNG (liquefied natural gas) plants to avoid problems caused by water in the piping system, an investigation is presented into a risk-based approach supported by additional engineering and hazard analysis to conduct high stored energy pneumatic tests and two calculation methods employed to check whether exclusion zones for blast wave pressure are adequate for fragment throw. Issues discussed include codes and standards requirements with respect to ASME B31.3, ASME PCC-2 and AS 3788, exclusion zones as a function of stored energy, an explosion at the Deep-Water Port construction site in Shanghai, the F3D method for analysing small items on branch connections, Baum's method for end caps, the importance of the test medium in pneumatic testing and an example of a high stored energy test.

52-277428
Application of finite element in accurate calculations of stresses in expansion joints.
GANGULY S
In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Design and Analysis. Paper PVP2018-84320. 10pp. 14 fig., 13 tab., 9 ref.
[in English] *[DVD; PVP2018-trk-3\trk-3\PVP2018-84320.pdf]*
With regard to the use of thick-wall type expansion joints in fixed tubesheet shell and tube heat exchangers, a C++ computer program based on the finite element method (FEM) with 8-node isoparametric axisymmetric elements was developed to evaluate the stiffness and perform detailed stress analysis of thick-wall flange and flued expansion joints. The methodology was based on the 9th edition of the TEMA standard for linear static finite element analysis (FEA). Stiffness calculations were performed for eight different flexible shell element (FSE) geometries and stress analysis was conducted for various FSE geometries, meshing, boundary and loading conditions. Possible integration of the finite element engine to the pressure vessel and heat exchanger mechanical design software, AutoPIPE Vessel, is discussed.

52-277431
A novel approach for assessment of pressurised equipment for slow depressurisation during fire.
EBRAHIMI K; MOFRAD S R; MILLET B; KIRKPATRICK K; MILLER G
In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Design and Analysis. Paper PVP2018-84236. 9pp. 13 fig., 5 tab., 6 ref.
[in English] *[DVD; PVP2018-trk-3\trk-3\PVP2018-84236.pdf]*
With regard to depressurisation calculations for pressurised equipment in the event of an over-pressurising scenario or during emergency shut-downs, an investigation is presented into a methodology based on the provisions in the latest editions of API 521 and API 579-1/ASME FFS-1 standards and finite element analysis (FEA) to identify the necessary steps for assessment of pressurised equipment under slow depressurisation. Issues discussed include depressurisation calculations for fire and cold cases, mechanical check and feedback to cold depressurisation calculations, mechanical creep analysis for fire case and feedback to depressurisation calculation and finite element analysis for plastic collapse and/or creep failure of major welded connections. A sample high pressure vessel (adsorber) was analysed for both cold and fire depressurisation.

52-277432
Transient thermal stress and temperature change rate analysis of fixed tubesheet.
WANG Z J; SHI Q Y; LI Q; WAN L P; TANG H
In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Design and Analysis. Paper PVP2018-84328. 5pp.

13 fig., 2 tab., 7 ref.
[in English] *[DVD; PVP2018-trk-3\trk-3\PVP2018-84328.pdf]*
With regard to the influence of thermal stress on fatigue damage during system startup and shutdown in fixed tubesheet heat exchangers, simplified and accurate finite element models (FEM) were established to facilitate transient thermal and stress analyses using the ANSYS Workbench and the effect of temperature change rate on thermal stress was investigated. Tubesheets (inside diameter 1200 mm, thickness 150 mm) were made from SA 508 Gr.3 carbon steel. Transient thermal analysis for a quarter sector was conducted by applying adiabatic boundary conditions and temperature distributions were calculated. Thermal-mechanical analysis results were represented by von Mises stress distributions. Issues discussed include the heat transfer rate of the thin gap between tubesheet and tubes and the influence of thermal stress on the tubesheet stress state.

52-277433
Buckling assessment of carbon steel pressure vessels during PWHT [post weld heat treatment].
KATAOKA S
In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Design and Analysis. Paper PVP2018-84571. 8pp. 14 fig., 4 tab., 9 ref.
[in English] *[DVD; PVP2018-trk-3\trk-3\PVP2018-84571.pdf]*
Experimental elevated temperature tensile tests and constant stress creep-strain tests and numerical analyses using the isochronous stress-strain curve were undertaken on an A516-Gr.70 pressure vessel steel (0.2%C, 0.33%Si, 1.08%Mn) in order to investigate the influence of creep deformation on structural integrity during PWHT (post weld heat treatment) operation. Hot tensile stress-strain tests were conducted at 22-650 deg.C and constant stress creep-strain tests at temperatures of 600 and 650 deg.C. The elevated temperature profiles were compared with API 579/ASME FFS-1, Eurocode 3 and AIJ standards in relation to yield strength, creep strain rate and stress-strain curve. Structural integrity assessment based on the isochronous stress-strain curve was performed for an infinite length unstiffened cylinder in a PWHT furnace and local PWHT of the circumferential joint of a pressure vessel in the vertical position. Temperature distribution, the buckling eigenmode due to axial load and the collapse mode were obtained from elastic-plastic stress analysis.

52-277434
Mechanical design of electrical isolation joint.
RICCO G
In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Design and Analysis. Paper PVP2018-84947. 8pp. 14 fig., 6 tab., 3 ref.
[in English] *[DVD; PVP2018-trk-3\trk-3\PVP2018-84947.pdf]*
By considering the electrical isolation joint as a pressure vessel, a short report is presented into the mechanical design of the joint according to ASME VIII Div.1, Appendix 2, "Rules for Bolted Flange" and design guideline suggestions to be included in the code. The geometry of typical electrical isolation joints and stress distribution due to internal pressure are summarised. The design of an isolation joint of nominal diameter 24" (609.6 mm) is outlined as per ASME VIII Div.1 Appendix 2 for items subjected to internal pressure and a comparison of the results with finite element analysis calculations according to ASME VIII, Div.2 part 5 is described for design validation. Other issues discussed include butt welding of hub items to a pipe, von Mises stress distributions and the equivalent maximum working pressure.

52-277442
Root cause and FFS [fitness for service] analysis of a dent in a 22mm thick elliptical head.
SCHREURS P; KUSTERS S
In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Design and Analysis. Paper PVP2018-84516. 7pp. 18 fig., 3 ref.
[in English] *[DVD; PVP2018-trk-3\trk-3\PVP2018-84516.pdf]*
In relation to the occurrence of failure at a nozzle weld on the inner pressure vessel shell of a jacketed pressure vessel operating at 1.6 MPa, an investigation is presented incorporating finite element analysis (FEA) of local buckling at the elliptical head (thickness 22 mm) and a level 3 assessment according to ASME VIII Div 2 Part 5 to determine the vessel's fitness for service (FFS). Elastoplastic FEA using ABAQUS and taking into account strain hardening and large displacement theory was conducted to determine the effects of over-pressurisation of the jacket area. A limit load assessment was performed using a strain hardening material law and by increasing the pressure in the jacket until failure. The reactor was assessed to consider plastic collapse, local failure, collapse from buckling and fatigue. FFS analysis was performed for both static integrity and remaining life.

52-277444
Fitness for service assessment and repair of the liner of a high pressure heat exchanger.
VAN ZYL G; AL-HARTHI S
In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Design and Analysis. Paper PVP2018-85001. 9pp. 18 fig., 1 ref.
[in English] *[DVD; PVP2018-trk-3\trk-3\PVP2018-85001.pdf]*
With regard to the observation of surface-breaking cracks at the partition plate to liner weldments in a bulged region of a high pressure carbamate condenser (HPCC) shell and tube heat exchanger with a stainless steel liner, an investigation incorporating deformation measurements with a handheld 3D geometry scanner and finite element modelling was undertaken to perform a level 3 fitness for service (FFS) assessment of the bulged liner. The tube side components (channel, nozzles, tube sheet) of the HPCC were fabricated from thick-walled SA-516 Grade 70 carbon steel and the inlet/outlet channel was protected from corrosion by a Type 310 austenitic stainless steel liner. The FFS assessment was performed by finite element analysis as per Annex B1 of API-579. Geometric measurements were made with a Creaform HandySCAN 700 3D geometry scanning instrument. Results were obtained with respect to protection against plastic collapse, local failure and ratcheting. Finite element analysis was also used to develop a suitable repair procedure.

52-277448
Load carrying capacities of pressurised 90 degree mitre and smooth bends subjected to monotonic in-plane bending moments.
ABDALLA H F; ROSHDY M A
In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018.

Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Design and Analysis. Paper PVP2018-85071. 13pp. 18 fig., 9 tab., 26 ref.
[in English] *[DVD; PVP2018-trk-3\trk-3\PVP2018-85071.pdf]*
Numerical finite element analysis (FEA) was employed to investigate the generation of limit bending moment boundaries and load carrying capacities of single-, two- and three-weld 90 deg. mitre pipe bends and 90 deg. smooth bends subjected to a spectrum of steady internal pressures and monotonic in-plane closing (IPC) and in-plane opening (IPO) bending moments. A limit load finite element validation study was conducted against experimental test results of pressurised 90 deg. smooth bends subjected to monotonic IPC and IPO bending loading modes. Subsequently, mitre and smooth bends were analysed for limit moments using the ASME twice-elastic-slope method and by adopting the major geometric parameters of the experimentally tested smooth bends and their associated material flow stress. The enhancement of load carrying capacity with increased number of mitre welds is discussed.

52-277451
Correlating coke drum profiles with observed surface damage.
ARAQUE E D; RUTT D K; LOVE D R; PARK S M; CLARK R D; DAWSON J J
In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Design and Analysis. Paper PVP2018-84766. 7pp. 16 fig., 2 tab., 6 ref.
[in English] *[DVD; PVP2018-trk-3\trk-3\PVP2018-84766.pdf]*
In relation to the increased frequency and extent of vessel bulging and cracking in delayed coke drums, an analysis of hundreds of laser scans spanning 25 years was undertaken to correlate vessel bulging with observed surface damage. Specific categories of bulge profiles, and their proximity to circumferential weld seams, were calibrated against examples of drum damage and failure, including through wall cracking and stress cracking of the cladding as well as the triggers for repair strategies implemented by refiners. Two examples of different 1.25%Cr, 0.5%Mo steel coke drums with full surveys of surface damage, including confirmed shell-penetrating cracks, were considered. Recorded damage was divided into confirmed cracks penetrating through the cladding and into the backing shell material, and "all damage" which included confirmed cracks as well as "elephant skin" surface cracking. Case studies, involving the use of sharpness in real time to optimise the visual inspection to identify coke drum surface damage and mid-course cracks identified during a laser mapping inspection using the bulge sharpness, are discussed.

52-277452
Microstructural characterisation of base material and welded joints of serviced and non-serviced coke drums.
ROMO S A; BARBORAK D; BEDOYA J; PENSO J; RAMIREZ A J
In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Design and Analysis. Paper PVP2018-84859. 10pp. 19 fig., 1 tab., 25 ref.
[in English] *[DVD; PVP2018-trk-3\trk-3\PVP2018-84859.pdf]*
With regard to the occurrence of plastic deformation leading to bulging and cracking associated with low cycle fatigue in coke drums under cyclic thermomechanical loading service conditions, an investigation was undertaken into the evaluation of full excavation and partial excavation crack weld overlay repairs executed on a 1.25%Cr, 0.5%Mo steel coke drum after six months of service. The repair procedures involved removing the cracks using grinding and then filling the V-groove pocket with Alloy 625 filler metal or partially removing the cracks by grinding and applying an Alloy 625 multilayer weld overlay, respectively. Repairs were performed using MMA (shielded metal arc) welding and a temper-bead weld sequence was employed to avoid PWHT. Specimens were characterised by microstructure observations of circumferential welds and weld repairs and microhardness and nanoindentation measurements. Thermodynamic equilibrium and para-equilibrium calculations were used to study the carbide formation sequence, and SEM analysis was employed to characterise the carbides present on as-fabricated and aged microstructures.

52-277453
Analysis of the influence of the cooling patterns and the shape of the bulges on the levels of stress in the cylindrical section of delayed coke drums.
VIVAS G A; MORET A J; BELLO R E; MELIAN L M; BEDOYA J J
In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Design and Analysis. Paper PVP2018-85009. 11pp. 26 fig., 4 tab., 7 ref.
[in English] *[DVD; PVP2018-trk-3\trk-3\PVP2018-85009.pdf]*
With regard to the occurrence of low cycle fatigue in delayed coke drums associated with thermal loading, an investigation was undertaken into the relationship between the spatial thermal gradients and the axial and circumferential stresses generated. The coke drums considered were pressure vessels with an internal diameter of 8.53 m, height of 26.6 m and thickness varying from 38 mm (bottom) to 26 mm (top). The drums were instrumented with two arrays or grids, each having thermocouples and strain gauges in zones with distinct bulges. Geometric models based on ANSYS software were used to reproduce the instrumented zones with their actual deformations obtained by laser scanning. Finite element models were developed using a sequentially coupled thermo-mechanical analysis to determine the transient temperature and stress distributions. The effect of circumferential thermal gradients on stress levels in the instrumented cylindrical sections was analysed for a perfect cylinder (without deformation) and one containing bulges.

52-277456
Importance of connections in high-pressure barricade design.
KOSTECKI J; EDEL M; MONTOYA J
In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. High-Pressure Technology. Paper PVP2018-84765. 8pp. 9 fig., 2 tab., 8 ref.
[in English] *[DVD; PVP2018-trk-5\trk-5\PVP2018-84765.pdf]*
With regard to the importance of engineered structural connections and consideration of global structural response in the design of protective barricades to mitigate pressure testing hazards, an investigation is presented into structural models focusing on impact loading of steel plates and bolted connections and comparison of theoretical and test results in terms of effective barrier response. The ASME PCC-2 and HSE 168 documents are outlined in relation to recommended guidance for barricade design and personnel protection. Test results from a case study on a pressure vessel involving the intentional sudden release of liquid pressure and launching of a projectile are considered. Issues

discussed include the relationships between structural response (e.g. flexure), connections, support framing and lateral stability and accurate predictions of structural response using the SDOF (single degree of freedom) method.

52-277457
A polished performance [hardbanding selection].
MILLER B; HUBER M
Oilfield Technology, vol.12, no.5. May 2019. pp.35-38. 5 fig. ISSN: 1757-2134
[in English]
The optimum performance of hardbanding applied to components used in drilling operations in the oil and gas industry is explained, with reference to performance criteria and evaluation methods applied in the laboratory and in the field. Hardbanding involves applying discrete deposits of metallurgical welding alloy to drilling components (tool joints of drill pipe, drill collars, heavyweight drill pipe, upset connections of completion tubing). Topics covered were: performance criteria defining key attributes; essential features of hardband weld deposits and using the recommended welding procedures; laboratory evaluation of the performance of a hardbanding weld (abrasion, hardness, casing wear, and compression ring adhesion testing; and inspection by magnetic particle testing); and evaluation criteria to aid in the selection of suitable welding alloys and hardfacing products (non-cracking performance; weldability and reapplication; casing wear information, wear resistance data).

52-277459
Impact of welding defects on integrity of equipment and piping.
FANDEM Q
Inspectioneering Journal, vol.25, no.1. Jan-Feb. 2019. pp.35-39. 7 fig., 2 tab., 14 ref. ISSN: 1082-6955
[in English]
Welding defects developed during the manufacture of pressure vessels and piping systems for the petrochemical industry, their effects on the structure and integrity of welded components, possible crack initiation and failure of components during service, and the use of nondestructive testing (NDT) and pressure testing to ensure the structural integrity of these components were overviewed. Different types of welding defects occurring in fillet and butt welds during manufacture of mechanical equipment (e.g. by TIG or MMA welding) were explained. Welding defects were categorised according to fracture mechanics into: crack-like flaws which can cause a fracture; flaws which act as crack initiation sites and initiate fatigue cracking during service; and flaws which have no effect on fracture and fatigue life. Acceptance criteria for welding defects according to different codes (API, ASME) were compared for pressure vessels, piping and tanks. Engineering critical assessment methods were considered for welding defects beyond acceptance limits for components that were already in service (e.g. crack in external circumferential weld of a SA106 Grade B (2003) steel pipe (outside diameter 508 mm, wall thickness 9.53 mm)). Merits and limitations of different NDT methods for assessing the soundness of welds were discussed. Pressure testing of newly constructed systems to ensure their reliability, strength and safety was mentioned.

60 CODES AND STANDARDS

See also abstracts: 52-277378

60-277375
Nuclear fatigue codified design rules: development status, margins and screening criteria.
FAIDY C
In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84698. 7pp. 10 fig., 27 ref.
[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84698.pdf]*
With regard to the revision of fatigue rules in nuclear codes and standards, a review is presented of existing ASME and ACFEN RCC-M codified rules in major nuclear codes, incorporating historical background and field experience, and a summary of present day fatigue road maps to evaluate margins and screening criteria in order to facilitate reliable codified design fatigue life evaluation is described. Issues considered include operational feedback from tests on real components and analytical mock-ups, uncertainties and conservatism of existing ASME rules, mechanical properties of materials, the Fen factor, flaw tolerance, the consequences of updated fatigue rules on class 1 codified fatigue design rules, a strategic plan and priority proposal for fatigue design rules, and code consistency with respect to fatigue criteria for design and operational rules.

60-277382
RSE-M - ASME XI - API 579: comparison of failure assessment diagrams (FAD).
FAIDY C
In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84703. 10pp. 10 fig., 2 tab. 13 ref.
[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84703.pdf]*
A short report is presented into the first step of a project dedicated to a comparison of flaw evaluation methods and failure assessment diagrams in 3 major codified rules, ASME Boiler & Pressure Vessel Code Section XI Appendices A-C-H (nuclear components), API 579-1/ASME FFS-1 Part 9 (non-nuclear pressure vessels) and AFCEN RSE-M Appendix 5 (nuclear). Cracked components are described by a dedicated diagram for margin evaluation of ductile tearing resistance of the components: the elastic stress intensity factor of the crack normalised by the toughness of the material on one axis and applied stresses normalised by a reference stress in the other axis. Issues discussed include acceptance criteria, a J evaluation scheme based on the reference stress method, and fitness-for-service assessment procedures based on Level 1 (crack-like flaws in pressurised cylinders), Level 2 (crack-like flaws in general shell structures) and Level 3 (other) assessments.

60-277383
Evaluation of reactor internals integrity and lifetime according to the NTD [normative technical documentation] ASI [Czech Association of Mechanical Engineers].
BRUMOVSKY M
In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018.

Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84140. 5pp. 4 fig., 1 tab. 2 ref.
[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84140.pdf]*
With regard to the development of the IAEA VERLIFE procedure as the main regulatory document for lifetime assessment of WWER components in the Czech Republic (Czechia) as part of the NTD (normative technical documentation) ASI (Czech Association of Mechanical Engineers), a short report is presented into the evaluation of nuclear reactor internals integrity and lifetime under high neutron irradiation conditions causing possible irradiation-assisted stress corrosion cracking, embrittlement and dimensional changes. Issues discussed include damage mechanisms, strength calculation and serviceability analysis, non-destructive in-service inspection, and non-mandatory annexes based on analysis of experimental data from reactor internal materials (including tensile properties, radiation swelling and creep, fatigue, unstable crack growth and constitutive equations to calculate viscoplastic behaviour).

60-277385
2018 RCC-MRX code edition: context, overview, on-going developments.
PETESCH C; LEBARBE T; GELINEAU O; VALLOT D; BLAT-YRIEIX M
In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84706. 8pp. 9 fig., 4 tab. 11 ref.
[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84706.pdf]*
A short review is presented of the evolution, development, modifications and future perspectives associated with the 2018 edition of the AFCEN RCC-MRx Code, encompassing rules applicable to research reactor components. Issues discussed include the importance of feedback from the Jules Horowitz Reactor, ASTRID, ITER and MYRRHA projects, modifications incorporated into the new edition, developments in response to project needs, feedback of the CEN Workshop 64, harmonisation with other codes and standards, clarification of code applicability with respect to irradiation definition and innovative installations, and mechanical tests performed for welding procedure qualification.

60-277396
2025 nuclear code: the vision for the future of ASME nuclear codes and standards.
MATTHEWS D E; HILL R S; BRUNY C W
In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84031. 7pp. 1 fig., 2 ref.
[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84031.pdf]*
With regard to the future of nuclear power and plant designs under development, such as gas-cooled and liquid metal-cooled high temperature reactors, small modular reactors and fusion energy devices as well as variations of current light water reactor (LWR) technology, a report is presented into the 2025 Nuclear Code initiative with the aim of modernising ASME's Nuclear Codes and Standards to adopt new technologies in plant design, construction, and life cycle management. Issues discussed include consolidation and simplification of construction codes, modernised fatigue analysis, design methodology, a complete life cycle code, risk-informed design, the evolution of reactor technologies, alternatives to weld repair of fabrication defects, revised design margins, the expansion of internationalisation efforts, and modernised publishing and distribution of codes.

60-277398
Anisotropic materials use in the ASME Boiler and Pressure Vessel Code.
CAMERON J
In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84823. 9pp. 10 fig., 1 tab., 6 ref.
[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84823.pdf]*
A review is presented of the past history, current status and future directions of ASME Boiler and Pressure Vessel Code requirements with respect to the anisotropic properties of bars. Issues discussed include the nature and causes of anisotropic mechanical properties, the role of inclusions and porosity, the definition of a bar in the pressure equipment industry in relation to ASTM material specifications, and the current status and future directions of bars in the ASME Code with respect to Sections I, II, III, VIII-1 and VIII-2.

60-277409
RCC-M Code: main evolutions from the 2016 to 2018 editions.
TRIAY M; LEFEVER B; QUERE J; GOBERT J-L; CHANTELAT E; PUYBOUFFAT S; CADITH J; MEISTER E
In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84409. 10pp. 1 fig., 18 ref.
[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84409.pdf]*
A report is presented into the general approach adopted by the RCC-M nuclear code of AFCEN (the French Society for Design, Construction and In-Service Inspection Rules for Nuclear Island Components) in codes and standards setting from technical and organisational points of view, the main evolutions expected in the 2018 edition of the RCC-M code and topics of activity of the RCC-M subcommittee. Issues discussed include the industrial experience integrated into the RCC-M code, conformity with European and French regulatory requirements, environmental assisted fatigue in austenitic stainless steels and nickel alloys, welding, fabrication and surface technology, phased array and TOFD (time-of-flight diffraction) ultrasonic testing techniques, nonlinear analysis, qualification of active mechanical equipment, and the use of safety factors in design.

60-277410
Thermal fatigue evaluation based on the methods for structural stress determination according to EN 13445-3 Annex NA: comparison with other codes.
TRIEGLAFF R; BECKERT M; RUDOLPH J; FRIERS D
In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-84904. 9pp. 18 fig., 5 tab., 21 ref.
[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-84904.pdf]*
With regard to methods for fatigue assessment of unwelded and welded components in the revised European Pressure Vessel Standard EN 13445-3, an overview is presented of recommendations for the thermal fatigue evaluation given in the informative annex NA "Instructions for

structural stress oriented finite element analyses (FEA) using brick and shell elements" and of proposed approaches for structural stress determination in the draft annex. Issues discussed include the overall fatigue assessment process, application of the structural hot-spot stress concept in EN 13445-3, Clause 18 and Clause 17 for thermal loading, and comparisons of fatigue assessment for thermal loads between KTA (Germany), ASME III (USA), RCC-M (France) and the European Boiler Code EN 12952-3 with respect to fatigue strength reduction factors, design fatigue curves and correction factors. Validation examples involving a flat head with a cylindrical shell and an austenitic stainless steel pipe with girth butt welds are discussed.

60-277411

Normative technical documentation of Association of Mechanical Engineers, Czech national code of equipment and piping of nuclear power plants of WWER type.

JUNEK L

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Codes and Standards. Paper PVP2018-85155. 7pp. 3 ref.

[in English] *[DVD; PVP2018-trk-1\trk-1\PVP2018-85155.pdf]*

A report is presented into the development of Normative Technical Documentation of the Association of Mechanical Engineers (NTD ASI), comprising a set of regulations for the production, assembly, reconstruction and operation (maintenance and repair) of equipment and piping in WWER-type nuclear power plants in the Czech Republic (Czechia). Issues discussed include the background of the Czech code, the rules of NTD ASI development, and a description of the sections of NTD ASI, namely welding (incorporating procedure qualification and evaluation of filler materials), mechanical characteristics and physical properties of materials, strength assessment, a unified procedure for lifetime assessment in relation to non-ductile and ductile fracture, fatigue and mechanical corrosion damage under operational conditions, destructive and nondestructive tests of materials and weldments used in the manufacture, repair, reconstruction or replacement of parts and components, air conditioning systems, NDT controls and conventional power plants.

60-277435

A general comparison of the design margins and design rules for ASME Section VIII, Division 1 and 2.

BARKLEY N

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Design and Analysis. Paper PVP2018-84974. 10pp. 7 fig., 6 tab., 21 ref.

[in English] *[DVD; PVP2018-trk-3\trk-3\PVP2018-84974.pdf]*

With regard to pressure vessel design according to the ASME Boiler and Pressure Vessel Code, Divisions 1 and 2, a review is presented of the procedure for deriving the allowable stresses of materials under tensile loading based on the required design margins for each Division and Class and of the effect of differing design margins on component design. Issues discussed include design margins for tensile loading, allowable tensile, yield and stress rupture strength values, allowable stress for SA-516-70 carbon steel, design of cylinders for different pressure ranges, design of elliptical heads, design of nozzle reinforcement, and maximum allowable working pressure for openings in cylinders and elliptical heads.

60-277439

Comparison of ASME XI and BS7910 allowable surface flaw size evaluation procedures in piping components.

KUUTTI J; OINONEN A

In: Proceedings, ASME Pressure Vessels and Piping Division Conference (PVP2018), Prague, Czech Republic, 15-20 July 2018. Publ: New York, USA; ASME [American Society of Mechanical Engineers]; 2018. Design and Analysis. Paper PVP2018-84276. 10pp. 8 fig., 2 tab., 3 ref.

[in English] *[DVD; PVP2018-trk-3\trk-3\PVP2018-84276.pdf]*

A failure assessment diagram (FAD) and crack size-based comparison of the ASME Boiler and Pressure Vessel Code Section XI (Nonmandatory Appendices C and H) and the British Standard BS 7910:2013 Option 1 assessment methods is presented with respect to the determination of limits for allowable flaw sizes in piping components subjected to mechanical loads. Appendix C includes a procedure to evaluate plastic collapse, combined collapse and fracture and brittle-type fracture separately, whereas Appendix H and BS 7910 procedures consider the failure mechanisms simultaneously by using the FAD approach. An analysis of 24 case studies incorporating different pipe sizes, material types (austenitic and ferritic), flaw types (inside surface circumferential and axial flaws), load types (hoop or axial stress) and safety factor is outlined. A methodology involving yearly limit lines is shown to produce both a qualitative approach in ranking the crack growth potential of different components and a quantitative approach in assessing the crack growth rate of a flaw and remaining lifetime of the component.

63 HEALTH AND SAFETY

See also abstracts: 52-277456

63-277339

Fact sheet: safeguarding against mechanical hazards.

AMERICAN WELDER

Welding Journal, vol.97, no.9. Sep. 2018. p.87. ISSN: 0043-2296

[in English] *(Adapted from AWS Safety and Health Fact Sheet no.8, available through the AWS website www.aws.org) [https://bit.ly/2Z0qxo7]*

Safety recommendations to protect against mechanical equipment hazards are presented. The nature of the hazard and welders' knowledge of proper use of power tools, cranes, positioners and other material handling equipment are briefly discussed. The recommendations outlined include guidelines to follow for personal safety (such as clothing and eye protection) and grinding wheel safety. Tool safety is addressed such as using good quality tools, using the right tool for the job, inspecting tools before use, gripping tools firmly to prevent slipping, not overloading or forcing a tool beyond it capabilities, anticipating the reactive force from tools, not bypassing safety interlocks on equipment, and storing tools in a safe place.

63-277458

Artificial optical radiation photobiological hazards in arc welding.

GOURZOULIDIS G A; ACHTIPIS A; TOPALIS F V; KAZASIDIS M E; PANTELIS D; MARKOULIS A; KAPPAS C; BOUROUSIS C A

Physica Medica, vol.32, no.6. Aug. 2016. pp.981-986. 7 fig., 1 tab., 19 ref. ISSN: 1120-1797

[in English]

Occupational photobiological hazards caused by exposure to artificial

optical radiation (AOR) during typical welding procedures were investigated in a controlled environment, and the results were compared with the exposure limit values defined in the European Directive 2006/25/EC on protecting workers from AOR. A robot of six-degrees of freedom was used in a robotic welding system to represent welding positions of a human operator. Welding experiments were bead-on-plate FCA welding of steel plates using EN758:T464PM1 H10 flux cored rutile type steel wire electrode of diameter 1.2 mm under a shielding gas mixture of Ar, 18%CO2. Welding was conducted using different typical distances between the welding point and possible human operator welding positions (e.g. 1.6-10 m). Welding conditions were chosen to obtain smooth weld bead shapes without defects or excessive spatter. Sensors for the ultraviolet and blue light ranges were used to measure emitted radiation, in connection with radiation exposure of unprotected skin and eyes under different welding conditions (current 123-285 A; voltage 25-41 V; welding speed 200-400 mm/min). Experimental measurements and the exposure limit values for non-coherent AOR in 2006/25/EC, were used for calculating the maximum permissible exposure time of unprotected skin and eyes to photobiological hazards.

AUTHOR INDEX

COMPANY INDEX

SUBJECT INDEX