APPLICABILITY OF A MULTIPARAMETER FORMALISM IN INTERPRETING THE THERMODYNAMIC BEHAVIOUR OF TERNARY SYSTEMS

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ABSTRACT

An analytical expression of the excess free energy function for the concentrated ternary solution is described by incorporating the higher order ternary parameters. The appropriate functional form associated with these parameters is derived based on the concept of the interaction parameter formalism. The present equations are capable of interpreting the experimental activities in the Ag-Au-Cu and Fe-Cr-Ni systems at 1350 K and 1873 K respectively. Using the second order parameters, it has been shown that there exists a decreasing trend in the standard deviations in terms of the experimental excess properties of the systems relative to those of the conventional function involving first order parameters. The derived values of various constants are susceptible to Physico-Chemical interpretation based on the central atoms model.
STEEL REFINING THROUGH SUBMERGED LIQUID SLAG INJECTION: EFFECT OF PARTIAL INJECTION BY A COLD MODEL STUDY

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ABSTRACT

Injection of powder with inert carrier gas is commonly practiced in industry to decrease the impurity level of steels in a more efficient and inexpensive way. However, the advantages of submerged powder injection process are limited by the fact that powder particles can only penetrate partially into the liquid melt, while most of the particles ascend through the melt as "particles inside the bubble" without contributing much to the mass transfer process. In this regard, submerged liquid slag injection is considered as a potential area of research. Simulation of the submerged liquid slag injection in steel melt has been carried out using a cold model in the laboratory. In such a study, water, paraffin oil and benzoic acid have been used as the low temperature analogous for steel melt, slag and the transferable species, respectively. The effect of partial injection of oil on the efficacy of the mass transfer process has been investigated. The pertinent results have been analyzed by using the mathematical model of Ohguchi and Robertson after required modification. At higher volume fraction of oil, partial injection do not seem to be very effective, while at lower volume fraction, the partial injection process is proved to be quite effective in the transfer of benzoic acid from the aqueous phase to the oil phase.
STRATEGIES FOR THE PRODUCTION OF LOW SILICON AND LOW SULPHUR HOT METAL AT ROURKELA STEEL PLANT

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ABSTRACT

Modern steelmaking technology demands superior quality hot metal through BOF - Continuous Casting Route. Silicon and Sulphur contents of hot metal are considered to be the two major parameters for the quality of hot metal. This has received greater momentum in recent years throughout the world specially for the production of quality steel and its further processing to finish product. Rourkela Steel Plant (RSP) has four blast furnaces and has fixed a target to achieve a productivity level of 1.0t/m3/day with a coke rate of 580 kg/THM. Silicon and Sulphur contents in hot metal have been aimed at 0.09% and 0.045% respectively for the year 2002-2003. To achieve this, a number of process optimisation measures have been undertaken. A few key parameters have been identified which control production of low silicon and low sulphur hot metal and RSP has taken the challenge to fulfil this requirement. The present paper deals with the various factors which contribute towards low silicon and low sulphur hot metal production. Strategies are also described in the paper.
EFFECT OF 0.1 wt% N ON THE PITTING AND STRESS CORROSION CRACKING BEHAVIOUR OF AS WELDED AND POST WELD HEAT TREATED AUSTENITIC STAINLESS STEEL WELD

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ABSTRACT

The present study deals with the effect of heat treatment on the pitting and stress corrosion cracking behavior of type 316L stainless steel weldment containing no nitrogen and 0.1wt% nitrogen. Tungsten Inert Gas (TIG) welding of 316L stainless steel was carried out with 317L filler wire. Nitrogen was introduced in the Argon shielding gas to an extent as to obtain 0.1wt% N in the resultant weld. Welds were also prepared without nitrogen in the shielding gas. Welds were subjected to pitting scan in 3.5 wt% NaCl solution and Stress Corrosion Cracking (SCC) studies conducted in acidic chloride solution of 5N H2SO4 and 0.5N NaCl. To investigate the effect of nitrogen, when welds are exposed to high service temperatures, the above tests were also conducted on the welds heat treated at 973K for 5 h. Presence of nitrogen considerably reduced the retained δ-ferrite in the welds. Nitrogen addition and aging did not alter the pitting tendency of the welds. However, the beneficial effect of nitrogen was more apparent in promoting SCC resistance of thermally aged welds.
EFFECT OF PRE-TREATMENT ON CORROSION RESISTANCE OF CHROMATE CONVERSION COATED AND ANODIZED AA2219 ALLOY

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ABSTRACT

The study pertains to the effect of prior surface copper removal treatment on the corrosion resistance of chromate conversion coated (CCC) and anodized AA2219 Aluminium-copper alloy. Pre-treatment of test samples was done using AC Polarization in nitric acid to remove the copper rich precipitates from the surface. Pitting resistance of the base metal with and without copper rich phase was evaluated by potentiodynamic polarization test and transmission electron microscopy. Significant improvement in pitting resistance of base metal (T6) was observed after the copper removal. Two layers of organic coatings have been given on chromate conversion coated and normal anodized base metal with and without the copper removal. Zinc rich self etching and strontium chromate based primers are used as under coats. Epoxy based alkyd and polyurethane based finish coats have been used as topcoats. Electrochemical impedance spectroscopy has been used to evaluate the corrosion resistance of the coated surfaces. It has been found that CCC is more effective after the copper removal treatment. Lower corrosion resistance of CCC on base metal without copper removal may be attributed to the heterogeneous microstructure and partial covering of CCC on the intermetallic compounds. The copper removal treatment is not effective in improving corrosion resistance of anodized surfaces which has been attributed to possible consumption of base metal and nature of the growth of the anodic oxide layer.
BARRELLING IN SQUARE BILLETS OF ALUMINIUM DURING COLD UPSET FORGING UNDER DISSIMILAR FRICTION

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ABSTRACT

In upset cold forging the existence of frictional constraints between the dies and the work piece directly affect the plastic deformation of the latter. The friction at the contact faces retards the plastic flow of metals and the surfaces and in its vicinity. A conical wedge of a relatively undeformed metal is formed suffers high strain hardening and bulges out in the form of barrel. This work has been taken up to generate data on the cold upset forging of square billets of annealed aluminium under dissimilar frictional conditions. Experiments were conducted by applying lubricant at one end of the square specimen and the other end with dry friction (with no lubrication). By the application of differential lubrication, a barrel and a truncated part near the unlubricated surfaces have been developed. The measured radius of curvature of the barrel was found to confirm with the calculated value. The calculations were made on the assumption that the curvature of the barrel followed the geometry of circular arc. Relationship is established between the measured radius of curvature of the barrel and the stress ratio parameter.
TENSILE PROPERTIES OF INTERCRITICALLY ANNEALED 14 mm THICK Nb - BEARING MICROALLOYED STEEL

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ABSTRACT

Intercritical annealing of a 14 mm thick Nb-bearing microalloyed steel has been carried out at temperatures ranging from 740°C to 820°C following four different treatment routes. It has been found that the tensile properties of intercritically annealed microstructures are strongly influenced by prior thermal treatment and intercritical annealing temperature. Best strength-ductility combination is obtained on intercritical annealing of prior martensitic structure at 760°C. Multistage deformation behaviour with low work hardening exponent during the first stage of deformation has been noticed in all materials.
MODELLING CORED WIRE INJECTION IN STEEL MELTS

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ABSTRACT

Cored wire injection is an essential feature of liquid steel processing. An estimation of the time for melting of the wire sheath (casing) and the subsequent release of the filling material cannot be done without resorting to an elaborate mathematical model due to the complexity of the heat transfer from the bath to the wire. In particular, the formation of a solid shell around the wire and the consequent lowering of the heat transfer needs to be addressed accurately. A mathematical model developed for calculating the melting time of the casing at the Research & Development Division of Tata Steel describes the freezing and melting process during the travel of the cored wire in the steel bath. The model has been validated against both published information as well as plant data. However, owing to the complexity of obtaining a direct validation in the operating plant, a novel indirect method has been adopted. Several new findings with respect to the casing thickness, wire diameter and the speed of injection have been obtained. It has been shown that the impact of different grades of liquid steel on the melting behaviour of the cored wire both on account of different superheat as well as the melting temperatures of the solidifying shells, is significant. In order to ensure that the wire releases powder at the same depth, the casing thickness of the wire used for injection into low carbon grade steel needs to be twice as much compared to that required for a high-carbon grade steel. Apart from providing deeper insight into the melting behaviour of cored wire, the model has also helped in formulating new specification of cored wire for Tata Steel.
EFFECTS OF AGEING TREATMENT ON THE MICROSTRUCTURE AND MECHANICAL PROPERTIES OF Cu - ADDED Ti, B MICROALLOYED STEELS

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ABSTRACT

The present investigation concerns the influence of Cu on the ageing behavior of the Cu - added Ti, B microalloyed steels subjected to air cooling and water quenching after hot rolling. The microstructural evolution and mechanical properties achieved in the cases of Cu - added and Cu - less steels has unveiled the favorable role of Cu in forming the ferrite – martensite dual phase structure after air cooling and bainitic structure after water quenching of the hot rolled steel. The Cu - added samples after hot rolling followed by air cooling and water quenching are subjected to the isochronal ageing at appropriate temperatures with and without 15% cold deformation prior to the ageing. After carrying out ageing treatment of the hot rolled samples without any cold deformation, nominal improvement in the hardness value has been recorded at the peak ageing temperatures. Air cooled and water quenched samples after 15% cold deformation have yielded significant improvement in hardness by subsequent ageing treatment. It has also been demonstrated that a suitable amount of cold deformation prior to the ageing treatment aids in lowering the peak ageing temperature in comparison to the samples aged without any prior cold deformation.
LOW CYCLE FATIGUE BEHAVIOUR OF AN UNDERAGED Al-Li-Cu-Mg ALLOY

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ABSTRACT

Fully reversed, total axial strain controlled low cycle fatigue tests were conducted on aluminium-lithium alloy plate of AA8090 composition in underaged (UA, T3) condition at strain amplitudes ranging from 0.0045 to 0.015. The properties studied include cyclic stress response behaviour, cyclic stress-strain data and fatigue life variation with plastic strain amplitude (\(\Delta e_p/2\)), average stress amplitude (\(\Delta \sigma/2\)) or average plastic strain energy per cycle (\(\Delta W_p\)). The fatigue data obtained for the underaged alloy have been compared with those of a peakaged (PA, T8E51) temper alloy plate of similar composition. The alloys in the two ageing conditions exhibit similar cyclic stress response behaviour, which varies with applied strain amplitude. Initial cyclic hardening was followed by cyclic stability till fracture at lower strain amplitudes, while cyclic softening followed initial hardening at higher strain amplitudes. A comparison of the fatigue life data of the two alloys with reference to \(\Delta e_p/2\), \(\Delta \sigma/2\) or \(\Delta W_p\) reveals that the underaged alloy possesses lower fatigue resistance than the peakaged alloy. The UA alloy exhibits bilinear fatigue life power-law relationships with power-law constants at lower strain amplitudes being higher than those at higher strain amplitudes, in a manner similar to that reported earlier for the PA condition. The observed transition in the fatigue life power-law relationships is attributable to changes in the deformation and/or deformation-assisted fracture modes.