## ABSTRACT

The effect of process parameters on mechanical properties of AISI 4335 steel has been examined in order to understand the influence of the amount of inclusion content and tramp elements on the mechanical properties particularly fracture toughness values of this steel in order to ensure its integrity during service. A large number of specimens taken from 225 heats of conventional and radial forged V-added AISI 4335 steel have been selected to establish the above. The experimental work involved material characterization with emphasis on the assessment of the amount of inclusion content and tramp elements and determination of mechanical properties with emphasis on the measurement of fracture toughness. Microstructural and inclusion characterisation of the representative specimens of the selected steels have been carried out using optical and scanning electron microscopes. Determinations of tensile properties and impact toughness of these steels have been done using standard ASTM methods. Measurements of plane strain fracture toughness values have been carried out using CT specimens whereas the estimation of dynamic fracture toughness for the selected grade of steel has been done out using pre-cracked standard Charpy V-notch specimens with the help of an instrumented impact testing machine.

The major inferences drawn from the analyses of the obtained results are: (a) the influence of the amount of inclusions and tramp elements on toughness and ductility parameters is considerable unlike that on strength, (b) processing route i.e. conventional or radial forging, insignificantly influences the mechanical properties of the selected grade of steel, (c) the estimated fracture toughness values of all the batches of the investigated steels lie in the range of 116 MPa $\sqrt{m}$ - 162 MPa $\sqrt{m}$ ; conditional fracture toughness (K<sub>0</sub>) having values less than 139 MPa<sup>1</sup>m meets the validity criteria for plane strain fracture toughness as per ASTM Standard E 399, (d) the estimated value of dynamic fracture toughness (K<sub>ID</sub>) is in close agreement with that of the estimated quasi static plane strain fracture toughness ( $K_{IC}$ ) values for the selected grade of steel, and (e) the variation of impact toughness with tempering temperature reveals temper embrittlement at around 480°C whereas that of temperature derivative of fracture toughness with tempering temperature reveals temper embrittlement at around 500°C. Based on the above observations it can be concluded that (i) the control of inclusion content and tramp elements governs the mechanical properties of V-added AISI 4335 steels; tramp elements are found to have more deleterious effect than inclusions. (ii) the nature of variation of impact toughness with tempering temperature directly reveals temper embrittlement whereas similar variation of fracture toughness with tempering temperature reveals the same indirectly.