PREFACE

The development, processing and characterization of high chromium irons are attracting the attention of materials scientists for wear resistant applications especially in thermal power plants such as mills, impellers, rolls, mining in recent years. But these materials posses lower impact characteristics as they tend to fracture under loading conditions. To improve the impact behaviour coupled with good wear resistance property, manganese addition to chromium iron was identified as a good choice in view of manganese being less expensive and a good austenite stabilizing agent. Hence, the same has been tried in the present investigation. Further, manganese addition beyond 4.4% to chromium iron has not been investigated so far. Keeping these factors in view, four broad objectives were framed, of which, the first one is focused on the effects of inclusion of manganese greater than 4.4% into 16 – 18 wt. % chromium iron system, at two levels (i.e., 5 and 10 % manganese), secondly, the influence of metal and sand moulds on the end product, third one, the influence of cast section size variation and finally the effect of heat treatment on the microstructure of the iron and hence mechanical properties to establish structure-property relationships. Also, a novel non destructive technique like positron annihilation spectroscopy (PAS) is used to quantify the defects and their influence on the tribological properties.

To achieve the above objectives, the alloys containing the above mentioned compositions of chromium and manganese are produced in metal and sand moulds by induction melting and casting route in the laboratory. The metal castings of section sizes 12, 24 and 40 mm in 5 % manganese bearing sample and 12 and 24 mm section sizes in 10 % manganese were produced. The sand mould castings having section size of 24 mm were also produced. The test samples of the required dimensions were made to carry out the material characterization work such as microstructure, hardness, abrasion, erosion, slurry erosion and impact energy. The optical and scanning electron microscopy along with positron annihilation spectroscopy was used to substantiate the wear and mechanical data.
The important finding in the present investigation is that, the use of manganese as an alloying addition at 5 and 10 wt. % to chromium in chromium-iron system has increased the absorption of impact energy without much sacrificing the wear resistance characteristics. They are dependent on the microstructural features, defect size and concentration. To get optimum microstructure with less defect size and low defect concentrations, one has to go for trade off between wear and impact properties. The processing routes (i.e., type of mould employed) adopted have resulted in reducing the lower wear losses and higher impact energy absorption for the metal mould case and they are strongly dependent on the microstructural features like carbide size, defect sizes and concentrations obtained. The inference is that microstructural approach involving PAS seems to be the right path to evolve an ideal combination of wear and impact properties.

Regarding mould size effect, the wear losses are very much influenced by the casting section size, the resulting structure as well as defect size and defect concentrations. However, the impact energy values are dictated by varied cooling rates adopted microstructures. Hence, a section size mid way between 12 and 40 mm (preferably 24 mm) is the preferred choice to achieve optimum level of wear and impact properties.

The thermal treatment effect reveals that, irrespective of the manganese content, type of mould and casting size employed, brings in superior wear and impact behaviour due to the microstructural transformations such as matrix toughening, spheroidization of carbides, lower defect sizes and less concentration levels etc. Thus, heat treatment is a key factor influencing the wear and impact properties.

The efforts made in this work have beneficial effect on the foundry industries in terms of design aspects, processing route as well as achieving optimum level of properties.

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