Effect of Inclusion Content on Magnetic Properties of Soft Magnetic Iron-Cobalt-Vanadium Alloy for Aerospace and Aeronautical Applications

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The Soft magnetic materials constitute an important class of engineering materials since it can easily be magnetized and demagnetized under a small external field. Metallic soft magnetic alloys constitute a major part due to its high permeability low coercivity and excellent formability. Iron-Cobalt alloy exhibits the highest saturation magnetization among the commercial magnetic materials. In addition, they exhibit high Curie temperature, good permeability, good strength and are ideally suited for applications requiring high flux density and reduction in weight specifically for aeronautical and aerospace applications.

Processing of Fe-Co alloy (50 Cobalt- 50 Iron) is very tricky [1] due to ordering transformation which makes the alloy brittle at room temperature. Third element like vanadium is added to restrict the ordering transformation though vanadium reduces saturation flux density and permeability. Melting this alloy needs special attention due to inclusion arising from the refractory of the vacuum Induction melting furnace or any other impurity coming from the deposit of the previous heat. This type of inclusions reduces the magnetic properties drastically. A detailed study was conducted from different industrial heats taken and variation of magnetic properties was analyzed. The inclusion content in different heats was studied using scanning electron microscope and Edax. The types of inclusion contents and chemical composition were observed in different heats and magnetic properties like permeability was correlated with the inclusions observed. Figure 1 shows magnetic permeability against the number of inclusions. It was observed that permeability is higher as the number of inclusion reduces and that matches well with the theoretical estimation that lesser is the inclusion content, higher is the permeability [2].

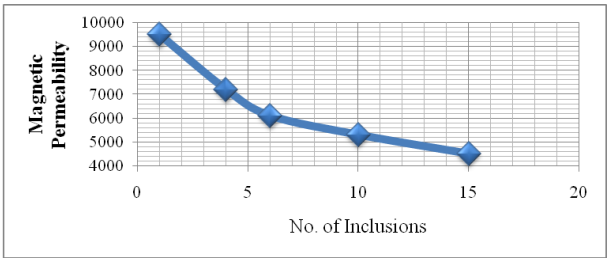

Figure 2. Relation between Permeability and number of inclusions

The origin of inclusion was determined from the chemical analysis of the inclusions. Most of the inclusions were originated from the absorbed material in the refractory lining which came out during melting of the iron cobalt vanadium alloys.

Processing of the alloy to finer strips and heat treatment for aeronautical applications were standardized. The process parameters for melting and subsequent processing were finalized. Based on the findings some more heats were taken and the properties were found satisfactory. In India manufacturers are supplying Iron-Cobalt-Vanadium alloy regularly to different strategic sectors.

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References

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