

ABSTRACT

Laboratory as well as pilot plant scale experiments have been conducted to establish the process of production of electrolytic iron powder from sponge iron fines (<3mm). The scale varied between a few grams to 25kg./day/cell. The anode fines were packed in polypropylene bags with multiple titanium anode contact and electrolysed in ferrous chloride solution using a wide range of current density. The deposit was obtained on stainless steel cathode.

Extensive investigations have been undertaken to optimise the electrolytic process parameters. It has been observed that low metal ion concentration (Fe^{2+}) and high pH of the electrolyte favoured the formation of the powdery deposit. The application of high cathodic current density has produced finer deposits with improved cell productivity and multiple titanium anode contact has been found to lower the cell voltage significantly.

The favourable chemistry of the sponge fines viz. higher metallisation and low tramp elements together with judicious selection of the electrolytic process variables produced deposits of high purity with higher energy efficiency and cathodic yield. A remarkable observation has been the negligibly small ferric ion formation in the electrolyte even on extended run of the cell (over a month) - a very desirable feature of the process.

The anodic dissolution characteristics of sponge iron fines significantly differs from that of conventionally used mild steel/MS scrap/Armco iron (relatively purer iron) with regard to its response towards higher

current density and energy consumption. This is due to the porous nature of the electrode and the homogeneity in the distribution of pores. The microstructure of the material following appropriate anodic dissolution time confirmed this view. The open circuit potential of sponge iron fine anode is more negative and thus the anodic reaction is depolarised to a greater extent compared to the conventional anode.

For a wide range of current densities, the structural morphology remains predominantly dendritic, the occurrence of branching of dendrites in the secondary & tertiary directions could be manipulated through the control of electrolytic parameters.

High current efficiency and high cathodic yield have been obtained in all scales of operation of the cells. It has further been assessed through a variety of tests on the powder that purity improved on higher scale of operation (25kg./day/cell).

The characteristics of the as-deposited and annealed powders were studied with X-ray diffraction. The microstress measured by the width of the interference lines showed lowering upon annealing compared to the as-received value. The integrated intensity of the X-ray lines were used to evaluate texture and it was found that there is a slight texturing towards 200 in the annealing. The as-deposited powder showed excellent amenability to processing. The deposit being fine required a lower degree of additional comminution and the stress relieving hydrogen annealing cycle was much short. The powder possessed very low residual iron oxide, adequate flow, acceptable apparent density, superior compressibility and high green strength.

The sintered properties and the dimensional stability of the powder at conventional compacting pressures indicated high performance of the products particularly in the manufacture of engineering components. The copper coated iron powder upon sintering exhibited very good sintered properties compared to sintered iron powder blended with copper under identical conditions of compaction and sintering.

The structure-property correlation indicated that ellipsoid and faceted growth morphologies were associated with excellent technologically important powder properties, the former showing a pronounced effect.