Utilisation of carbon dioxide for electro-carburisation of mild steel in molten carbonate salts

Abstract

The CO_2 gas was utilised as a source of carbon for electro-carburisation of mild steel in carbonate containing molten salts at 800C. In the process, the mild steel to be carburised was made the cathode. An inert anode of SnO 2 was used to ensure oxygen gas as the by-product. Two molten salt baths, i.e. Na 2CO 3-NaCl (molar ratio 4:1) and Li 2CO 3-K 2CO 3 (molar ratio 1:1), were investigated as the electrolyte and also the medium for CO 2 absorption. Microstructural changes in the electro-carburised samples, as revealed by either optical or scanning electron microscopy, were featured by the increase of the carbon rich cementite phase (Fe 3C) at the expense of the original ferrite phase near the surface of the samples. Micro-hardness profiles measured from the surface to the centre of the electro-carburised sample presented clear evidence of carbon penetration as a function of the electrolysis voltage, and the activity of carbonate ions in the molten salts. The carbon-hardened case was up to 0.60 mm in thickness with the carbon content in the near surface region reaching saturation (Fe 3C, 6.69 wt.). The current efficiency of electro-carburisation depended on the cell voltage, and possible causes are discussed with the aid of a simple model correlating the hardness and carbon content.