ADVANCEMENTS OF CARBONYL METAL POWDER PRODUCTION: AN OVERVIEW

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ABSTRACT

This article reviews global advancements of carbonyl metal powder production, including carbonyl nickel powders, carbonyl iron powders, and carbonyl ferronickel powders. The availability and varieties of carbonyl metal powder products is expanding especially following the recent technological progress in the Chinese carbonyl metal refining industry. Carbonyl metal powders are widely used in powder metallurgy, metal injection molding, hard metal binders, battery and fuel cell electrodes, welding rods, conductive paints and plastics, anti-seize lubricants, EMI/RFI shielding, diamond synthesis, magnetorheological fluids for shock/vibration damping and precision polishing, additive manufacturing, and other applications.

INTRODUCTION

Carbonyl nickel refining was first commercialized in 1902 by the Mond Nickel Company Ltd, with carbonyl iron powder production being developed in 1925 by Germany’s BASF (formerly I G Farben). Today, carbonyl nickel powders are widely used in Powder Metallurgy, battery and fuel cell electrodes, hard metal binders, welding rods, high-temperature filters, conducting additives, electronic materials, anti-seize lubricants, chemicals and catalysts (Figure 1). Typical applications of carbonyl iron powders include Metal Injection Molding (MIM), magnetic cores, hard metal binders, radar absorption materials, magneto-rheological fluids for shock/vibration damping, precision polishing, industrial diamond synthesis and health supplements.

Global carbonyl nickel powder production capacity has reached around 37,000 metric tons per year, with the main producers being Vale in Canada and Wales, China’s Jinchuan and Norilsk in Russia. Carbonyl iron powder production capacity is reported to be around 29,000 metric tons per year, with BASF being the largest manufacturer. However, nearly half of the current carbonyl iron powder capacity is represented by recent additions from China.

Carbonyls of nickel and iron, of molecular forms Ni(CO)₄ and Fe(CO)₅, were discovered by Dr. Ludwig Mond and his colleagues in 1890 and 1891, respectively [1, 2]. Subsequently, carbonyl nickel refining, or the Mond process, was first commercialized in 1902 by the Mond Nickel Company in Clydach, South Wales, to produce high-purity nickel pellets [3]. Carbonyl nickel powder production was an invention of the German company BASF in the late 1920s with nickel matte feedstock acquired from the Mond Nickel Company [4].

The International Nickel Company (Inco) acquired the Mond Nickel plant in the 1920s and, in 1943, commercial nickel powder production began. In 1973, Inco opened a second carbonyl plant in Sudbury, Canada, the site of its major nickel mining operations [5]. These plants have been continually modernized and now operate under the ownership of the Brazilian mining giant Vale SA. This mature process is acknowledged as the best available technology for refining pure nickel. The three main reasons for this