Effect of Hybrid Post-Sinter Treatment on Sinter Hardened (SH) Structural Parts from PM Steels

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ABSTRACT

With the introduction of high hardenability alloying additives such as chromium, manganese, molybdenum and nickel prealloyed into an iron matrix, the technique of sinter hardening (SH) in powder metallurgy (PM) enables the combination of both the sintering and heat treatment of structural PM parts into one processing step. Standard MPIF SH grade materials typically provide tensile strengths in the range of 450-1250 MPa (70-185 ksi). However, for demanding strength applications, the SH process also utilizes the method of copper infiltration (CI) during sintering to ensure sufficient mechanical properties. While CI generally enhances tensile strength, fatigue and ductility of the PM part, it can result in corrosion sensitivity, dimensional inconsistency, and is also costly. Conversely, a newly developed hybrid processing method, which comprises partial CI with subsequent post sinter vacuum impregnation by an inorganic sealant (IS) compound has proven to be a cost-efficient alternative to sealing residual porosity of the SH parts while simultaneously improving final mechanical characteristics and corrosion properties .

INTRODUCTION

The process of sinter hardening is defined as a technique in which a ferrous material is sintered and cooled at a rate sufficient enough to produce a predominately martensitic microstructure.[1] Typically, to achieve the necessary effective cooling rate on a PM sinter furnace, an accelerated or convective cooling unit is placed after the high heat section of the furnace in order to rapidly cool the product. These units generally provide a cooling rate of 1.0-1.8 ºC/s (2.0-3.0 ºF/s) from the austenite solid solution phase (~800C, 1472F) to the start of the martensite phase, or M_S temperature, of 200-300 ºC (392- 572 ºF). Unfortunately, this rate of cooling is not adequate enough for a eutectoid or hypo-eutectoid ferrous-carbon (Fe-C) chemistry to completely form the martensitic phase. The required cooling rate for such materials is best described by looking at the time-temperature-transformation (TTT) diagram to calculate the phases present in the resultant Fe-C microstructure. A typical TTT diagram for both a eutectoid and hypo-eutectoid Fe-C material is shown in Figure 1 (a) and (b) respectively.[2]

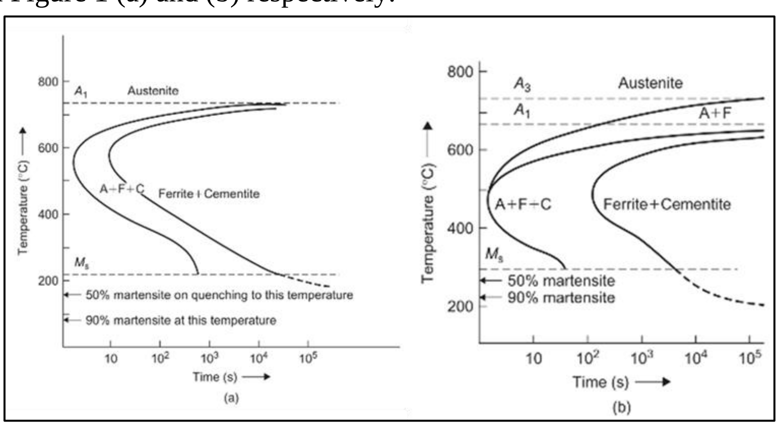

Figure 1. TTT diagram for Fe-C chemistry at the (a) eutectoid and (b) hypo-eutectoid phase composition[2]