Additives for Improved Machining of Copper PM Steels

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Presented at PowderMet 2012
Nashville, TN June 10-13

ABSTRACT

Copper-containing PM alloys are the most widely used PM steels on the market. As such, there are many applications that utilize these alloys and require secondary machining, such as connecting rods and VVT components. Machinability additives can be easily admixed into the powder to improve cutting performance of the final part. The expectation of a machinability additive is to improve machining, be non-reactive and have no negative effect on the mechanical properties of the component. This paper discusses the effect of several additives on both the drilling and turning performance of iron-copper-carbon PM steels.

INTRODUCTION

Machinability is an important consideration in the production of many ferrous PM components. While PM structural part manufacturing is generally considered a net or near net shape process, machining to achieve high precision features has become necessary in certain applications, such as VVT components. Additionally, certain features, such as transverse holes and undercuts, can not be compacted using conventional press technology. The machinability of PM steels differs from that of wrought steel due to the presence of porosity and the often heterogeneous microstructure [1]. To achieve similar strengths as wrought products, PM alloys typically contain higher levels of carbon ranging from 0.5 to 0.8% sintered carbon. The resulting higher micro-indentation hardness in combination with the porosity is most responsible for the different machining response of PM compared with wrought steels. Additions of up to 2% copper in steels greatly strengthen the ferrite phase and further reduce machinability. Higher additions of copper in conventionally sintered parts will leave some free copper in the part and will result in an improvement in machinability. Copper-infiltration is an extreme example of free copper in parts and is generally accepted as a highly machinable production route. FC-0208, with nominally 0.8% sintered carbon and 2% copper, falls within the group of higher carbon, little to no free-copper, difficult to machine alloys.

PM, however, has the advantage of being able to admix materials into ferrous alloys, and both powder producers and part makers have taken advantage of this ability by incorporating machinability additives