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Study on Densification Behaviour under Cold Forging of Sintered High Carbon Alloy Steels

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Abstract. Densification behaviour of sintered Fe-0.8%C-1%Si-0.8%Cu powder metallurgy steel under the influence of two different aspect ratios subject to cold forging is studied in the present investigation. The critical evaluation of cold deformation exercise revealed that induced strains are linearly contributing to enhance densification till the specimen fracture; however overall resistance to deformation of material is exhibiting in three different responses with respect to improvement in densification. That is at initially, high resistance to deformation followed by high kinetics of deformation and finally exhibiting little resistance against overall deformation. Although, the aforementioned criteria is common for both the aspect ratios, the applied deformation is little homogeneous when aspect ratio is less that directly contributes to enhance the rate of attainment of densification as little faster in the later stage of densification on the other hand the higher aspect ratio preform is bit non-linear in nature and retards stress in the later stage.

Introduction

Powder forging is one of the secondary deformation technique through which density of the powder preforms can be enhanced and hence the performance of the component in structural application [1]. Forging processes produce little or no scrap and generate the final part geometry in a very short time, usually in one or few strokes of a press or hammer. Parts produced by forging exhibit better mechanical and metallurgical properties and hence their reliability is more than the parts manufactured by other methods. Especially, cold deformation techniques possess several advantages such as yielding good surface finish, no need of secondary machining operation; free from the oxidation problems and with enhancement in strength through geometric work hardening as well as through matrix work hardening, compared to hot or warm deformation processes [2]. In cold forging exercise, it was found to be reported that the material and the voids begin to elongate in the perpendicular direction of loading and thus an extending the deformation induces the material to begin to flow into the pores under the influence of compressive loading [3,4]. It is therefore the particle deformation would be different within the component and just below the surfaces of the component consequently the densification mechanism is also non-linear in nature or inhomogeneous [5]. In addition the deformation and densification behaviour are influenced by the process and operation parameters such as aspect ratio, initial density and friction conditions and so on. In addition, pore shape, size and its distribution also type and mode of loading are found to influence the mechanism [6]. It is reported elsewhere that understanding the densification behavior of porous metals during forming is essential to achieve a quality products. In other words, uneven density distribution in powder compacts gives rise to distortion of parts after sintering and the presence of pores in the final parts are detrimental to their mechanical properties [7]. Thus the present investigation is concentrated on the preparing preforms of two different aspect ratios on Fe-0.8%C-1%Si-0.8%Cu through primary powder metallurgy operations and subjected to secondary operations such as cold forging to delineate densification behaviour as well as the influence of aspect ratios in it.