OPTIMIZATION OF TOOL LIFE FOR CLOSED TYPE FORGING TOOL

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***Abstract** -- In this review paper, some of the commercially available die materials were compared based on their hardness data available in material data sheets. These materials are used for hot and warm forging in mechanical presses. This paper also includes the results of a study by ERC/NSM, in which wear and plastic deformation on warm forging dies was successfully estimated by using Finite Element Analysis. Some of the studies on ceramic die materials presented in literature were reviewed. Surface treatment techniques such as nitriding and weld overlays, as well as ceramic coatings, are also discussed. In hot and warm forging, mainly hot work die steels are used due to their ability to retain their hardness at elevated temperatures with sufficient strength and toughness to withstand the stresses that are imposed during forging. There have also been some cost effective applications of other materials such as ceramics, carbides and super alloys although these applications are limited due to design restrictions and costs.Hot working die steels used at temperatures between 310 °C and 650 °C contain additions of chromium, tungsten, vanadium and molybdenum to provide deep hardening characteristics and resistance to abrasion and thermal softening at high temperatures. Molybdenum increases resistance to thermal softening, vanadium improves wear and thermal fatigue characteristics. Tungsten alloy steels are not resistant to thermal shock and must not be cooled intermittently with water.*

I. INTRODUCTION

In this review paper, some of the commercially available die materials were compared based on their hardness data available in material data sheets. These materials are used for hot and warm forging in mechanical presses. This paper also includes the results of a study by ERC/NSM, in which wear and plastic deformation on warm forging dies was successfully estimated by using Finite Element Analysis. Some of the studies on ceramic die materials presented in literature were reviewed. Surface treatment techniques such as nitriding and weld overlays, as well as ceramic coatings, are also discussed. In hot and warm forging, mainly hot work die steels are used due to their ability to retain their hardness at elevated temperatures with sufficient strength and toughness to withstand the stresses that are imposed during forging. There have also been some cost effective applications of other materials such as ceramics, carbides and super alloys although these applications are limited due to design restrictions and costs. Hot working die steels used at temperatures between 310 °C and 650 °C contain additions of chromium, tungsten, vanadium and molybdenum to provide deep hardening characteristics and resistance to abrasion and thermal softening at high temperatures. Molybdenum increases resistance to thermal softening, vanadium improves wear and thermal fatigue characteristics. Tungsten alloy steels are not resistant to thermal shock and must not be cooled intermittently with water.

II. FAILURE REVIEW

Depending on the conditions of the process and the characteristics of the material and surface conditions, one could encounter various modes of tool failure. These are:

- Wear (abrasive, adhesive and oxidation)
- Thermal fatigue or heat checking
- Mechanical fatigue
- Plastic deformation

Of these, wear (abrasive and adhesive) and mechanical failures are the most common forms of failure Figure 4(a). Of the two mode of wear, abrasive wear is the more common form of wear. Adhesive wear is not very common in hot and warm forging of steels because of the presence of lubricant film and/or scales and oxide layer. It does become a mode of die wear when the lubricant film is non-existent either because there is no lubricant application or when excessive sliding and deformation thins the lubricant film. Good tooling design and material selection can overcome gross cracking and mechanical fatigue. Thermal fatigue, in almost all cases, serves as a catalyst to accelerate abrasive wear.

The main physical phenomenon that control the abrasive wear in a metallic surface sliding past another surface are relative sliding distance, normal pressure and hardness of the surface.