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Microscopic examination of the fracture surfaces of a cold working die due to premature failure

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ABSTRACT

The paper studies the fracture surfaces of a rotary cold working die that broke down during the setup process on the machine it was designed for. The die was manufactured using AISI D2 tool steel and was intended for cutting paper at room temperature. The tool failed during the setup process on the machine. Initially, historical data were collected: operating conditions, lifetime, restitution of sound operation, collection of recorded service history. This was followed by measurement of temperatures, hardness control, optical inspection and selection and preparation of samples. The cutting edges, fracture surfaces and the structure, not affected by the failure, were investigated by optical microscopy. The quality of the nitrated layers were inspected. Additional information concerning the fracture was obtained by examining the fracture surfaces using a scanning electron microscope. Local chemical analysis of the material was made using an EDX spectrometer. Fracture mechanism, the type of the fractures, and the principal causes that led to the premature failure of the die are discussed. Justification of these causes facilitates the prevention of future failures and sometimes contributes to an increased service life of the tools.

1. Introduction

Cold work tool steels constitute an important group of steels as they cover a huge field of application. AISI D2 is one of the most characteristic steels for cold working tools and is broadly used for cutting tools and forming dies. It is a high-carbon, high-chromium tool steel alloyed with molybdenum and vanadium and is characterized by high wear resistance, high compressive strength, good through-hardening properties, high stability in hardening and good resistance to tempering-back [1].

The operating capacity and the life of die tools in service are determined by their mechanical properties, hardness, impact toughness, cyclic endurance (resistance to low-cycle fatigue) and wear resistance. Tool steel producers are continuously searching for ways to predict and increase the lifetime of tools. Geiger and Falk [2] presented a methodology for the lifetime calculation of cold forging tools, which are characterized by high load levels and often fail by fatigue crack initiation in surface areas. Okolovich [3] studied the effect of the main alloying elements and carbon on the properties of cold working dies. He proved that the main way for increasing the endurance of such tolls is by raising the fatigue resistance; which depends on mechanical properties of the steel. Xinmin [4] proposed a new heat treating processes to increase service life of nut cold heading dies made of AISI D2 steel. Gagg and Lewis [5] have recently proved that the wear is an important parameter for

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