Friction Testing Methods for Cold Forging

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In our history, cold forging of steels became practical by the zinc phosphate coating. Since then the lubrication coating on the billet surface has been always the center of attention in cold forging and new lubricants to replace the zinc phosphate coating have been developed to reduce the environmental impact. To improve the performance of the lubrication coatings for cold forging, many testing methods have been proposed. In this paper, the features of main testing methods are reviewed.

Keywords: tribology, cold forging, lubrication coating, testing method

1. Introduction

Cold forging has been used widely to produce small parts with high precision. The tribological conditions in cold forging are extremely severe due to large surface expansion and high contact pressure combined with high interface temperature. The role of the lubrication coating on the billet surface is to prevent direct contact between the tool surface and the billet, and to provide a low friction to ensure smooth sliding between them. To improve the performance of lubricants for cold forging, many testing methods have been proposed. In this paper, the features of main testing methods are reviewed.

2. Testing Methods

Hansen et al. [1] presented a twist-compression test to evaluate the lubricating performance under high pressure by using backward can-extrusion. After can-extrusion is performed to the pre-determined height, the punch load is kept constant and the die and workpiece, together with the lower support, are rotated whilst the punch is kept stationary.

Kitamura et al. [2] proposed backward can-extrusion test. In this test, the cup depth is increased until galling generation. Kada et al. [3] improved this test by using a divided punch, the tip of the punch is left at the extrusion end when the main body of the punch is returned after extrusion, thus the galling situation on the inner surface of the cup is perfectly maintained. In this method, galling generation on the inner surface of the cup is judged by the rapid increase in the extrusion load in the extrusion load-stroke diagram. Nakamura et al. [4] proposed a method by combined forward rod and backward can extrusion. In this method, the friction coefficient or the friction factor can be estimated using a theoretical calibration.

Omori et al. [5] proposed a ball penetration test. In this test, a steel bearing ball is forced to penetrate into the cylindrical workpiece. Saiki et al. [6] investigated the influences of surface expansion ratio, sliding speed and temperature on the lubricating performance of the zinc phosphate coating by rod drawing with localized teeth deformation test. Isogawa et al. [7] proposed a spike test. In this test, the spike height and forging load are measured.

Wang et al. [8] developed an upsetting-extrusion test to investigate the performance of the lubrication coating on the side surface of a billet in the multi-stage cold forging.

Wang et al. [9] proposed an upsetting-ball ironing test to evaluate lubricants in the multi-stage cold forging. In this test, the lubrication coating on the side surface of the billet is first subjected to free expansion by upsetting and then squeezed in ironing with bearing balls.

Wang et al. [10] designed a side compression test. In this test, the flow stress of wire material, the friction coefficient and the sticking capability of the lubrication coating on the wire surface are evaluated with a single test.

3. References

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