RECENT DEVELOPMENTS OF PRECISION FORGING IN JAPAN

Kozo Osakada
Graduate School of Engineering Science, Osaka University,
1-3 Machikaneyama, Toyonaka 560-8531, Japan

Summary
The characteristic feature of precision forging is reviewed first, and then the results of the development of precision forging in Japan since 1960 together with some recent examples of product are introduced. New forging methods such as enclosed die forging, divided flow method, extrusion against pressure supported tool, forging of sheet metal, forging utilizing friction and controlling of elastic deformation of die are explained. Some topics related with the newly developed servo-controlled mechanical presses are also presented.

1. Introduction

Since the forging pressure is quite high in precision forging, many forming stages are used to make a product. **Fig.1** shows an example of the precision forging process in which various forging methods such as rod extrusion, can extrusion, upsetting, etc. are combined. Since the long production sequence increases the cost of production and decreases the flexibility, it is desirable to reduce the number of the stages.

Precision forging can be employed when its production cost is lower than other manufacturing methods, especially machining.

Fig.2 is an example of cost reduction in manufacturing of transmission and synchronous gears achieved through integrating two parts by precision forging. Reduction of the total cost is effectively achieved by reducing the machining cost through integration of plural components although the forging cost increases [1].

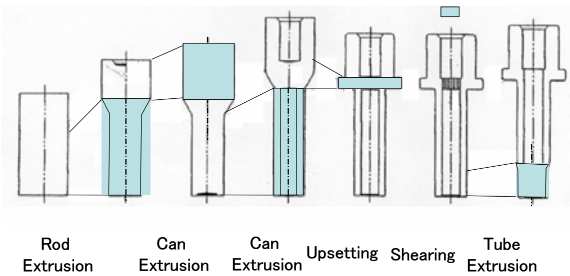

Fig.1 Precision Forging Process

Another important feature of precision forging is that the manufacturing cost decreases gradually with the volume of production, whereas machining requires new machine tools when the volume is increased [1].

2. History of Precision forging in Japan

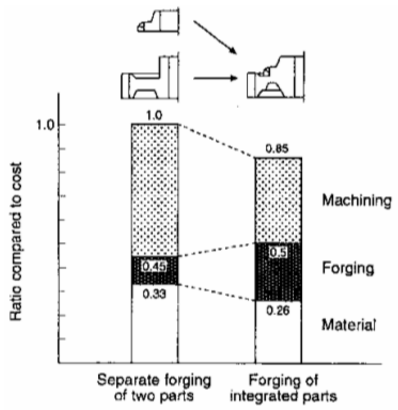

Fig.2 Forging cost of integrated transmission and synchronous gears [1]

The cold forging technology was introduced into Japan in the late 1950s and applied to production of automobile parts. In the 1970s, the level of the Japanese cold forging technology caught up the advanced countries and new forging technologies were developed. Warm forging is the most significant result of development in the 1970s. Presently hot precision forging is also widely used with similar forging process as in cold and warm forging on the horizontal mechanical presses, called hot formers.

Fig.3 shows the changes of the weight of cold forged parts mounted on a car from 1960 to 1995 and the typical products at the time [2]. The weight of cold forged products increased steadily until 1980. In the 1960s, small axi-symmetric products like hub bolt were

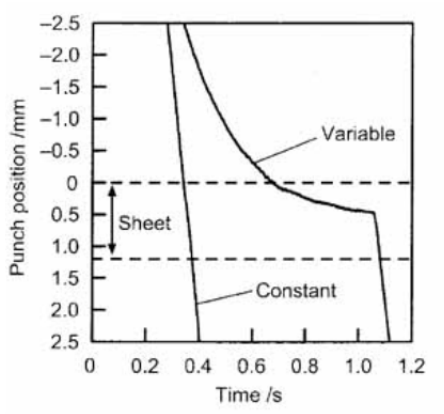

Fig.22 Motions of punch in shearing [15]

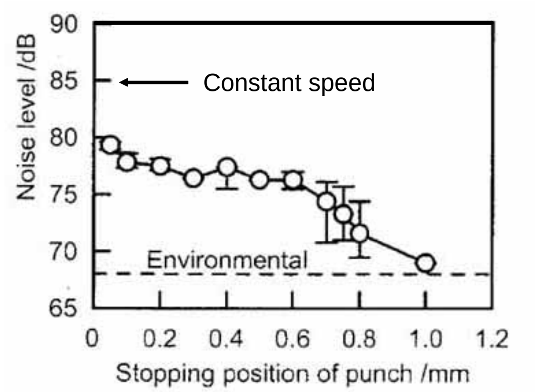

Fig.23 Reduction of noise level by two stage shearing [15]

in the two step shearing is between 69 and 80 dB depending on the intermediate stopping position.. The noise level is significantly lowered because the vibration of the press becomes smaller as a result of reduction of maximum load just before breakthrough.

6. Concluding Remarks

1) Various new precision forging methods, especially for gears, have been proposed.
2) Flexible mechanical servo presses will be used to realize new forging processes.
3) Simulation can be used effectively to develop new processes but data of flow stress, friction and material properties are lacking.
4) Tool coatings such as DLC are important targets of development.
5) Combination with other methods such as machining and joining will increase.
6) Precision forging of Al, Mg and Ti alloys will increase.

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