

Forming Of Complicated Shape by Using Viscous Pressure -A Review

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Abstract: Viscous pressure forming (VPF) offers a multipurpose approach to low volume stamping of difficult-to-form sheet metal alloys. The process imposes the use of a highly viscous pressurised medium as a forming tool. Compared with solid metal punch forming, the necking in the sheet metal can hold up in the VPF process. The viscosity of the viscous medium keeps constant in Viscous Pressure forming. In the VPF process using a viscous material can also be used in the Hydroforming process and offers the advantages of improved sealing to reduce leakage. The viscosity maintained most important role in the viscous pressure forming process. This paper represents the structure of a flexible tool system for internal maximum-pressure metal forming, together with the forming capability that it opens up and looks into the results of studies that shows the applicability of the system. Conventional sheet Hydroforming uses water with additives as a pressure medium. At the present time, Hydroforming technology is used widely for forming light in weight or complicated components in the automobile industry and aerospace industry, etc. Latest developments and the character of Hydroforming, especially sheet Hydroforming, also known by the name of internal high pressure forming And we can improve process capability of existing process by using VPF.

Keywords: Viscous pressure forming, sheet metal forming, viscosity, complicated shape, etc.

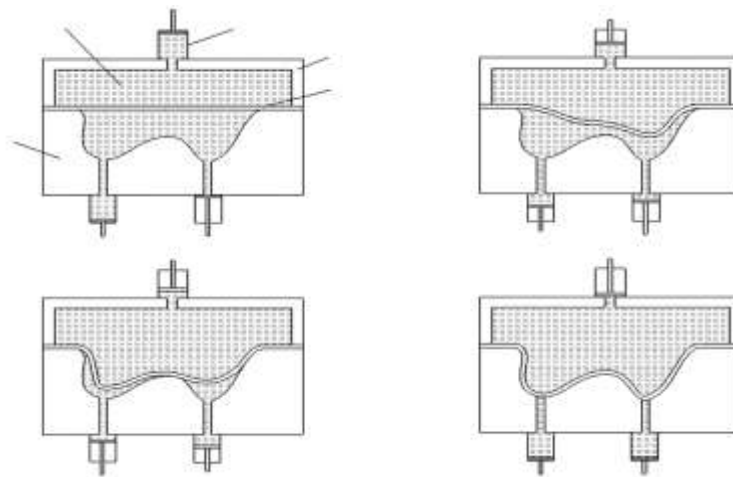
I. Introduction

The viscous pressure forming (VPF) process is used to form sheet metal components by means of a pressure applying viscous medium to determine the capabilities of the VPF process [1]. Viscous pressure forming (VPF) technology is a new process that uses a viscous fluid medium as the soft die in which the pressure can be varied along the sheet–medium interface [3]. This technology is intended to form difficult-to-formed and unsymmetrical components. A recently developed process called viscous pressure forming (VPF) offers a simple and versatile approach to low volume stamping of difficult form sheet metal alloys. The process entails the use of a highly viscous but flowable semi-solid medium typically applied to both sides of the sheet. During the forming operation, the medium is pumped under pressure into the cavity on one side of the sheet to be formed and controllably released through a single or multiple ports from the other side (Fig. 1). In the VPF process, viscous medium is used as a forming tool. The friction at sheet medium interface does not significantly affect the deformation of the sheet [2]. Viscous pressure forming process offers a simple and versatile approach to low volume stamping of difficult-to-form sheet metal alloys, such as aluminum alloys, high-strength low-alloy steel, titanium alloys, composite materials and laminated sheets. In its simplest version, it can be thought of as Hydroforming where a semisolid, flowable and highly viscous macromolecule polymer is used as a pressure-carrying medium. The viscous medium is usually used on both sides of the workpiece. During the viscous-pressure forming process, the viscous material is pumped under pressure into a medium chamber on one side of the workpiece, while the medium in the other side of the sheet is ejected through single or multiple ports. Thus, the viscous pressure forming operation is a combination of the bulk deformation of the viscous medium and sheet metal forming processes. The sheet metal formability is improved in the process by controlling the parameters of the pressure of the viscous medium and the blank-holder clamping force. The viscosity of the medium has an important effect on the forming process. With the presence of the viscous medium on both sides of the sheet metal, a more uniform stretch can be achieved. This process is mostly used in the defence industry to form complicated shape parts in difficult-to-form materials. Unlike the conventional sheet metal forming, the

viscous medium can fill complex-shaped surfaces very well, and parts with good surface quality and high dimensional accuracy can be formed using this method.

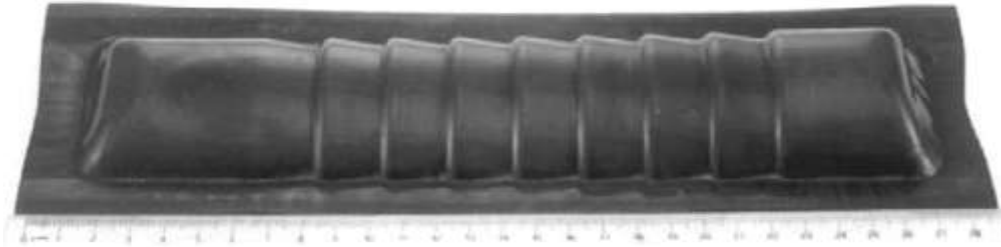
II. Methodology

The viscous pressure forming sequence is illustrated in Figure below. Firstly the sheet metal is laid over the mouth of the die and the chamber is closed followed by the engagement of the blank binder as shown in Figure 1. The viscous medium is pumped into the cavity on both sides of the sheet until it is full and overflowing into the diffuse cavities. With the constant volume achieved, the isostatic pressure is now raised to the set level. In order to create a pressure differential, some of the viscous medium is removed from the die cavity below the sheet through the outflow control valve and the more viscous medium is added at the top cavity. The pressure differential distribution over the whole sheet surface is maintained and controlled to the desired level (Fig. 1). This whole process continues while at the same time the blank-holder pressure is regulated in such a way that the sheet material is forced against the die. . The pressure must be sufficient to enable the sheet to deform plastically and follow the detail of the die form (Fig. 1).



Once this is achieved, pressure is removed and the chamber is opened with the formed part completed (Fig. 1.). It is clear from this process that the viscous medium acted as deformable punch when acting only on one side of the sheet metal. When applied on both sides of the sheet metal, it acts as a deformable punch and back pressure. Viscous pressure forming is different from other current flexible-die forming techniques, which use rubber or fluid (water, oil, gas) as the soft-die. The main difference is that this process uses a viscous medium that shows strong strain rate sensitivity to the condition of loading pressure, and so the forming pressure could be varied along the sheet–medium interface. This causes the sheet metal to be formed in a preferred manner due to the viscosity of the medium. The viscosity of the medium greatly affects the forming process. Lower viscosity resulted in the process becoming more akin to Hydroforming, while the higher viscosity resulted in the process becoming more like the rigid punch forming. As the friction between the viscous medium and the sheet is low, the interface shear stress is small, thus the effect of the deformation of the sheet is low. Therefore, localized stretching can be prevented or delayed with a more uniform stretch as a result. Due to the controlling of the value and the distribution of viscous medium pressure and blank-holder pressure in viscous-pressure forming, the workpiece can be formed in a definite sequence. Nonuniform pressure distribution in the workpiece can be achieved by controlling the position of the inlet and outlet ports of the viscous medium and the blank-holder pressure. This pressure non-uniformity is advantageous for forming of complex-shaped parts. The shape of the part formed using viscous pressure forming depends on the direction of the flow of the medium; as such the flow can be controlled by specific location of the outlet ports. The sheet metal is pushed to the location of the outlet ports, for example by specifying the outlet port at the corner of the die, and more pressure can be focused on the sheet metal in the direction of the outlet port at the corner of the die. The force applied to the blank-holder is also important as low force of the blank-holder allows the sheet metal to be drawn in, reducing the yielding of the sheet metal at that particular instance. This ensures a more uniform thickness of the formed sheet metal product. A thin-walled corrugated component formed by viscous pressure forming technique is shown in Figure 2

Figure. 1



Corrugated surface shape of a nickel-base Superalloy specimen formed by viscous pressure forming process (Wang et al., 2004)

Figure 2

III. Literature Review

Z.J. Wang et al. He was concluded that the melt indexes of three kinds of viscous medium were obtained by experiment. analyzing the mechanical properties of the viscous medium[5].

Zhong-Jin Wang(2004) et al. In this paper he was studied small radius corrugated and non-uniform depth thin-walled super alloy sheet parts are manufactured by pressure forming (VPF).[6]

J. Liu(2010) et al. As a result of the relatively low flowability of viscous medium compared with fluid, the deformation sequence of the workpiece can be controlled and regulated through controlling the loading mode of viscous medium. In the present study, viscous pressure bulge (VPB) tests with three kinds of loading location of viscous medium[7]

J. Liu, M. Ahmetoglu*, T. Altan It has been found that the formability of the sheet stretched with VPF is higher than that of the sheet stretched with a hemispherical solid metal punch (limiting dome height LDH test).[8]

Mustafa Ahmetoglu, Jiang Hua, Srikanth Kulukuru This paper describes the application of VPF to the forming of a non-symmetric part from steel, aluminum and a nickel alloy.[9]

Junhua Liu, et al. he was studied that the use of highly viscous medium typically applied to both side of the sheet in its simplest implementation ,the viscous medium is pumped on the pressure into the cavity on one side of the sheet to be formed and controllably released through a singal of multiple ports from the other side .[8]

Leonid B. Shulkina, Ronald A. Posterarob, Mustafa this paper describes the VPF process may have a cost advantage over deep drawing and hydroforming for prototyping and niche product shops due to lower cost of the tooling, easier and safer handling of viscous medium, and quieter operation.[10]

Gerhard Gutscher,et al. the use of viscous material instead of fluid as a pressure medium has made the VPB test simple and easy to evaluate the formability of sheet metals. The use of a viscous material as a pressure medium, however, has a disadvantage. At high deformation velocities, the viscous material is strain rate dependent.[11]

Tie-jun GAO, Qing LIU this paper describes Viscous medium can maintain great rate sensitive at high temperature, and generates non-uniform pressure field which is helpful to enhance the deformation of material.[12]

Mustafa Ahmetoglu ,et al. It was shown that it is possible to form simple parts with a simple tool design and using the viscous pressure forming actions. In these experiments, process parameters (such as clamping load, forming speed and sheet metal blank material) were varied and their effect on medium pressure, part geometry and thickness has been evaluated.[13]

IV. Conclusion

From the above study VPF is especially suitable for the forming of difficult to form materials and complex shapes under the action of the viscous pressure, sheet metal formability can be improved. Vpf process is an effective way to produce forming of sheets with good accuracy and small thickness thinning. Since viscous medium is semisolid at room temperature, can be maintained in the die cavity.due to the high viscosity of viscous mediam may promote metal flows towards the deformation region.

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