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An Expert System of Die Design for Multi Stage Deep Drawing Process

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Abstract

Deep drawing process is mainly used to produce automotive & aerospace components, house hold utensils, casings of electronic devices and many more. It is a plastic deformation process consists of tools viz. punch, die and blank holder. The workpiece is set on the die and hold with blank holder. Then, punch travel to deform the workpiece. The tooling of the process varies with different material and geometrical aspects. The die of the deep drawing process plays a vital role because the precision and accuracy of final product is depending upon the accuracy, surface quality and tolerance of the die. The die designing for any component is a combination of art, science and expertise. Of course, it is also tedious job and that requires highly skilled man power. Hence, an expert system has been developed to design die for multi stage deep drawing operations using VB.NET and AUTOCAD. Multi stage deep drawing process (MSDDP) is normally used for the components having high length to diameter ratio (LDR). This system is indigenous of its kind which requires few data i.e. work material type, physical properties & shape and size of final product. The system will predict and estimate number of draws, clearance and force required by punch & blank holder during each pass. The knowledge of die design experts (industries, academics and professionals) are fed in terms of rules. The system is quite capable to generate manufacturing drawing of die sets for all sequence of operations. Moreover, it is most suitable to make templates of products which are normally used during inspection and testing. This will reduce indirect costs and lead time. It also improves quality and productivity.

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1. Introduction

Generally, sheet metal forming process is done with the use of die, punch, blank/workpiece holder and draw bead. The operation is normally performed on hydraulic or mechanical press. Automobile and aerospace body panels, electronic equipments body, food containers, house hold utensils etc. are the typical examples which are manufactured by deep drawing (sheet metal forming operation). A workpiece (normally termed as blank) is set on the die, clamped with the use of blank holder and punch moves towards the blank to deform it. The deformation takes place in the contact zone of punch and blank (Fig. 1). Such a way, the finished components produced. Multi stage deep drawing process (MSDDP) generally used to produce components with high length to diameter ratio (LDR) (e.g. gas bottle containers of CO₂ and argon used during gas welding and cutting process). Expert system is a branch of artificial intelligence. An expert system (also termed as knowledge based system) is a combination of rules, facts, fuzzy set, and logic frames [1].

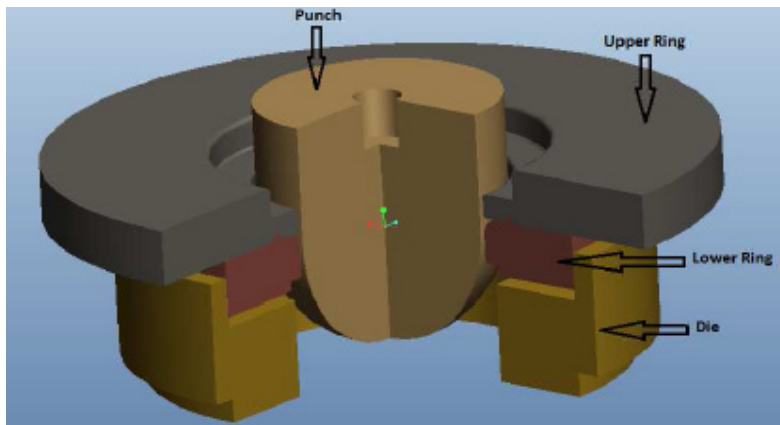


Fig. 1. Typical example of Deep Drawing Process [2]

Normally expert system is the collective bunch of computer program which contains skills/expertise (experience and/or analytical) of human experts. Logistics, medical, accountancy, fisheries etc. domains are already proven the importance of the knowledge and rule based systems. From last decade, few researchers started working on different manufacturing process like casting, welding, forming and machining using expert system. Ghatrehnab and Arezoo [3] had worked on progressive die and developed an automated nesting and piloting system using several algorithm. The work was emphasized on geometrical optimization using CAD. The cost estimation of forging die volume had discussed by Dale et al. [4]. A rule based approach had used which predicts forging die volume based on its geometry. The prediction of deep drawing phenomenon of tailor welded blanks had been carried out by Veerababu et al. [5]. The work was carried out using artificial neural network along with PAM STAMP and FE simulations. Jiang et al. [6] presented a neural network (NN) based fault diagnosis in the automobile engine using expert system. Mumtaz et al. [7] had emphasized on material selection to manufacturing by an expert system. Luis et al. [8] developed an expert system for setting parameters in machining processes which work with turning and milling processes. Tudor et al. [9] had demonstrated an automatic expert system for robot trajectory using fuzzy control in joint space. Horikoshi et al. [10] had developed Reynold's equation based die design for deep drawing using computer fluid dynamics with high-pressured water jet. In their experiment they have used water jet instead of oil or others lubrication.

However, certain issues in designing of multi stage deep drawing die are untouched. Further, this plays vital role for micro, small and medium scale enterprises. Because, die designing is the combination of knowledge, science and art. Also, the configurations of dies are varying with different work material and geometrical conditions. Therefore skilled manpower is required for the die designing. This limitation is addressed by developing the expert system for multistage deep drawing process.

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