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Study of Bimetallic Sheets through Deep Drawing

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ABSTRACT

Sheet-metal forming processes are technologically among the most important metalworking processes. Products made by sheet-forming process include a very large variety of different geometrical shapes and sizes, like simple bend to double curvatures even with deep recesses and intricate shapes.The object of this study is to define the forming conditions of a bimetal material composed of two dissimilar sheet metals. The ever increasing industrial demand for more sophisticated composites, which, in addition to the required physical and mechanical properties, would also show a reasonable degree of homogeneity, calls often for the use of unconventional methods of manufacture. Deep drawing of sheet metal is an important manufacturing technique. In deep drawing process, a blank of sheet metal is clamped against a die by a blank holder. A punch is then moved against the blank, which is thus drawn into the die. The ratio of drawing depends on the force on the blank holder and the friction conditions at the interface between the blank and the blank holder and die. The force and the friction at the blank-die-blank holder interface limit the slip at the interface and increase the radial stretching of the blank. In many investigations that are based on the use of mechanical energy considerations logarithmic stress distributions are assumed in the flange. This is provided by the simplifying assumptions of lack of friction, constant sheet contact thickness, trescas yield criterion, isotropic material properties, rigid-plastic material behaviour without work hardening. Hydro forming technology is very useful for the light weight material include low carbon/mild steel for chassis and side rails, aluminum, and its alloy for automotive body, stainless steel for exhaust system part. There are many process parameters like as hydraulic pressure, blank-holding force, die radius, material properties, and coefficient of friction affect the sheet hydro forming process. This paper presents on sheet metal forming process for bimetallic sheets and studied.

Key words: Bimetal sheets, laminated sheets, deep drawing, sheet metal forming

1. INTRODUCTION

Deep Drawing process is a one of the fundamental forming method with potential applications in forming of cups, hollows and boxes and has an edge over other micro manufacturing methods. There are numerous process parameters and other factors that affect product quality produced by deep drawing. Deep-drawing operations are performed to produce a light weight, high strength, low density, and corrosion resistible product(1-5). These requirements will increase tendency of wrinkling and other forms of failure in the product. Parameters like as blank-holder pressure, punch radius, die radius, material properties, and coefficient of friction affect deep drawing process. A thorough knowledge of the overall process is required to produce a product with minimum defects. Typical examples are automobile bodies, aircraft panels, appliance bodies, kitchen utensils and beverage cans. Sheet-metal forming processes are widely used in the manufacturing industry. Greater productivity and low production cost can be expected for commercial scale production of sheet metal forming processes. As mentioned that the flat sheet of metal is formed into a 3-D product by deep drawing process. The basic tools of the deep drawing process are blank, punch, die and blank holder or pressure plate. Deep drawing is affected by various factors such as material properties, tool geometry, lubrication etc. Owing to these factors, failures may occur during the process(6-10). Tearing, necking, wrinkling, earing and poor surface appearance are the main failure types that can be seen in deep drawing. Tearing and necking are caused by the tensile stresses and hence named as tensile instabilities. Another failure is wrinkling, caused by compressive stresses unlike to tearing and necking. When the radial drawing stress exceeds a certain value compressive stress in the circumferential direction becomes too high, plastic buckling occurs. The four major defects which can occur during deep drawing are fracture, wrinkling, earing and spring back .The phenomenon of wrinkling (flange instability) is specific to the process of deep-drawing (11-12). Instability in the work piece, also called wrinkling of the walls. In deep drawing process the main objectives are to obtain defect less or minimum defects in the product. Prediction of wrinkling is a very important process for a deep-drawing operation since wrinkled parts are treated as scrap. In certain applications the bimetal strip is utilized in the level structure. In others, it is wrapped into a loop for conservativeness. The more prominent length of the curled form gives improved affectability. Expanding request to join different materials like aluminum to steel, aluminum to copper, and titanium to steel so as to refine their properties has been transformed into a main impetus for the upgrade of current joining methods(13-16). Examinations are drawn through the investigations on different bimetallic sheets Like Al/cu, Steel/Al metal, and Cu/St/Cu multilayer's. In deep drawing process is enhanced with fluids are introduced. One of the fluid assisted deep drawing process is known as hydrodynamic deep drawing process. The Hydro-Mechanical Deep Drawing (HMDD) process has become an emerging technology to reduce the sheet forming steps and production of the advanced light-weight materials with complex shapes. The HMDD process overcomes to some limitations of conventional deep drawing and thereby makes possible production of deeper cups (high drawing ratio) with a more uniform cup wall thickness, higher dimensional accuracy and better surface quality and forming of complex-shaped sheet metal parts. Normally, the HMDD process includes two steps: pre-bulging step, that in which blank is bulged by initial pressure and drawing step with applied controlled pressure. In this step, a punch draws the blank into a chamber that has been filled by a controlled fluid medium generally oil as the die(17-20). The earliest studies on analytical models of bimetallic sheets were carried and which presented continuum mechanic model to investigate yielding and plastic deformation of clad sheets on the basis of hills theory. The many works have been presented on forming processes of the two-layer sheets using the conventional technologies such as tension, deep drawing, bending, etc. Dissimilar clad metal sheets produced by roll bonding have found many applications in electrical-mechanical industries because of their higher comprehensive properties. Al/Cu bimetal, this material possesses higher magnetic shielding, corrosion-resistance and heat conductivity with a relatively low production and investment cost. This kind of bimetal material is used for electrical parts, such as battery and condenser casings, and crystal vibrators. The mechanical and metallurgical properties of the materials have a great effect on their applications.

2. HYDRO-DEEP DRAWING OF BIMETAL SHEETS

Deep drawing of sheet metal is a significant assembling system. In Deep drawing process, a clear of sheet metal is braced against a kick the bucket by a blank holder. A punch is then moved against the blank, which is accordingly brought into the die. The proportion of drawing relies upon the power on the blank holder and the rubbing conditions at the interface between the blank and the blank holder and bites the dust(6). The power and the contact at the blank kick the bucket blank holder interface limit the slip at the interface and increment the outspread extending of the blank. The utilization of hydro-mechanical deep drawing (HMDD) process on overlaid sheets joins focal points of both procedure and material to improve the shaping state of poor formable light-weight metals, for example, aluminum combinations. The HMDD use of overlaid structures and segments made of sheet metals with jumble materials has been grown essentially due to making different consolidated mechanical, physical, and compound properties by the base materials(9). Overlaid metal sheets can be created utilizing diverse joining strategies, for example, dangerous welding, move holding and glue holding. Hydro-mechanical deep drawing (HMDD) process as shown in Fig.1

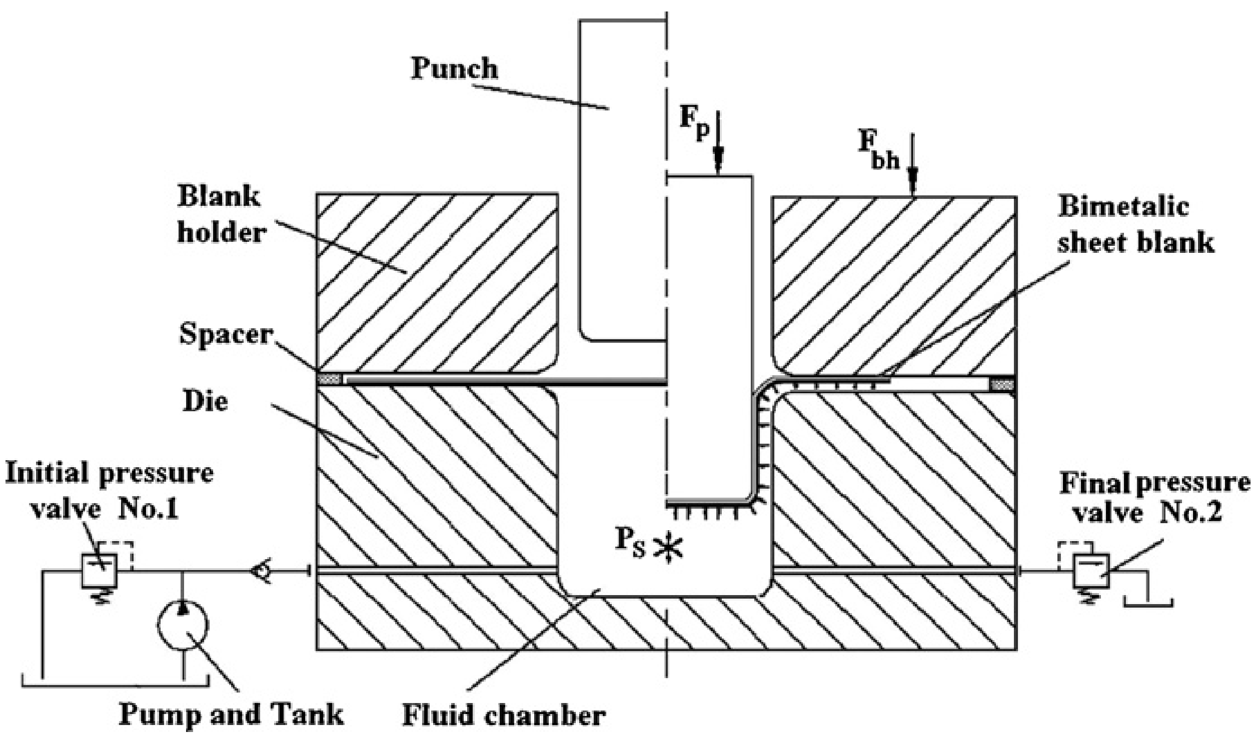

Fig 1.Hydro-deep drawing process of bimetal sheet

Among, two-layer composite sheets manufactured by roll bonding composed of one layer with appropriate strength and a good corrosion resistance, wear resistance, or electrical conductivity of the other layer, have found wide applications in chemical, electrical, ship, food and building industries.

The experimental works on Aluminum (1050-H0)/Carbon steel (St13) two-layer sheets for verificationofanalyticalresultsandthepredictionofactualworkingpressurewindow.HMDD process with proper fluid pressure improves formability and LDR in forming of bimetallic sheets than conventional deep drawing. Applying hydraulic pressure under blank during forming moves failure region from the punch corner zone toward the die corner zone based on applied pressure value. At a specified lay-up and thickness combination, by increasing the drawing ratio the critical pressure decreases and consequently the upper limit of safe working zone for the fluid pressure becomes narrower and also applying fluid pressure increases limiting drawing ratio for formed cup than conventional deep drawing[14], which results in a nose-like curve for the process window. The process window and the safe working zone for the fluid pres-sure in the AS lay-up is wider as compared to the SA lay-up.

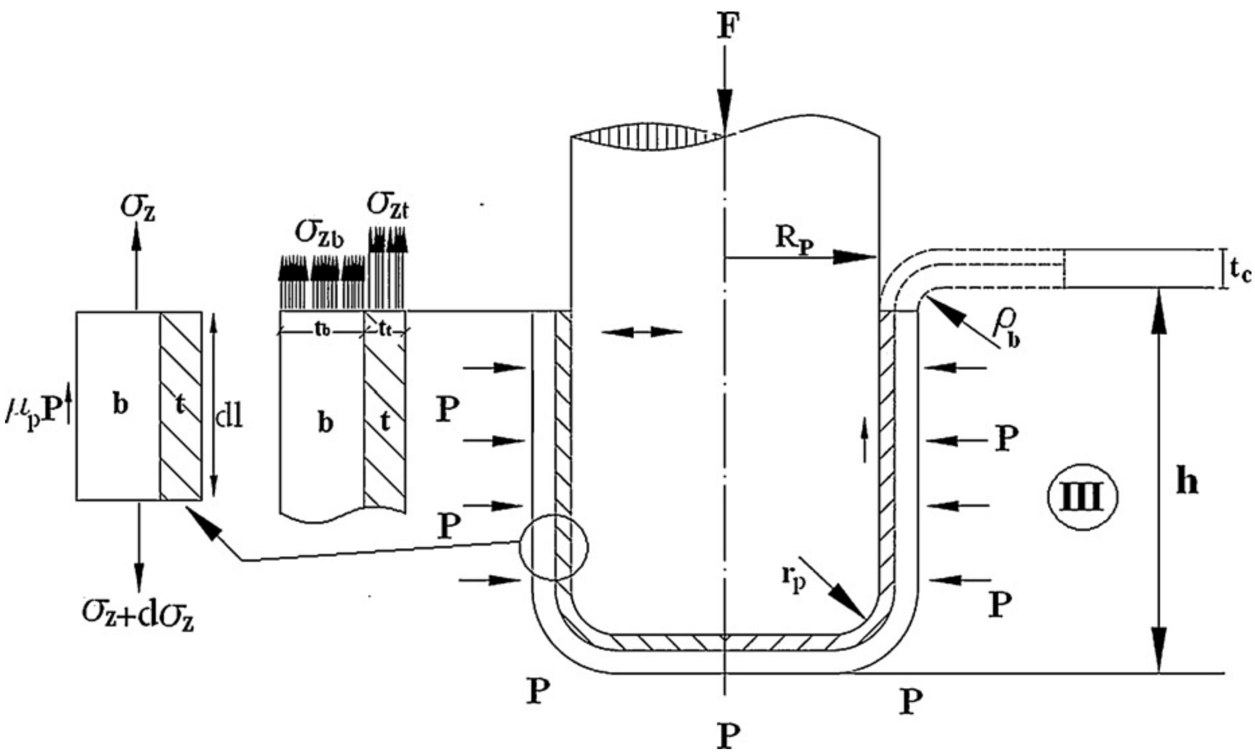

Fig 2. Bimetallic sheet in wall region equilibrium structure

Fig.2 represents equilibrium diagram of bimetallic sheet in wall region. Higher drawing proportions and LDRs can be accomplished by actualizing the A Slay-up than the SA lay-up. Deep drawing procedure of round and hollow components is ideal model analyses for the forecast: circulation of anxiety or frictional conduct and frictional powers for stepping draw pieces(14). The frictional powers at the bite the dust range, sorts of grease up and also the powers for twisting ought to be resolved, precisely. The bimetal materials for draw pieces ought to be precise explored. The examinations did in research centers give significant information for ideal parameters of profound drawing process. Especially for draw pieces with bimetal material, which it tends to be utilized in auto body parts like: curved guard and components of case. On the deep drawing process of steel-brass bimetal sheets to measure blank holder force, stress-strain curve, blank diameter and blank stacking sequence. The stacking sequence is followed by two cases BS (brass and steel) and SB (steel and brass). In first case BS, the stain less steel is contacted with punch and in SB brass is contacted with punch. Graph between load and stroke for bimetallic sheet in two directions that is BS and SB. In stacking sequence SB>BS is observed. Again contact layer between the sheets are fitted by dry, grease, bonded conditions. In this dry condition obtaining the maximum load for maximum displacement and it is shown that Dry>grease>adhesive. Fig 3.Shows the influence of contact condition of two layers in drawing process .

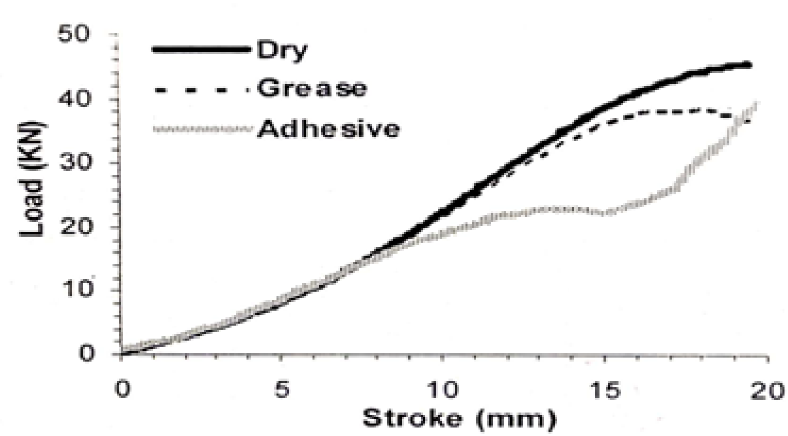

Fig 3. Contact condition effect on two layers in drawing process

Changing the blank holder force keeping maximum and minimum and measuring the errors like wrinkling and tearing on cups. While increasing the blank diameter 7.50 cm to 10 cm the load versus stoke diagram indicates the maximum punch force occurs when the outer diameter of the drawn component reaches 0.77 of the initial blank diameter. The Characterization of Directional Elasto plastic Properties of Al/Cu Bimetallic Sheet considering the material Al/Cu Bimetallic Sheet with varying composition of Cu percentage of 0,25,40,45 and 50 to measure the parameters of Elastic module[17], modulus of rigidity in changing the position with rolling direction and transverse direction is obtained in flexural mode and torsion mode. Measurement of resonance frequency, incremental friction, strain energy, elastic limit, and tensile strength was obtained by changing position of bimetal with 0 degree and 90 degree.

3. RESULTS & DISCUSSION

Deep drawing of sheet metal is an important manufacturing technique. In deep drawing process, a blank of sheet metal is clamped against a die by a blank holder. A punch is then moved against the blank, which is thus drawn into the die. The ratio of drawing depends on the force on the blank holder and the friction conditions at the interface between the blank and the blank holder and die. The force and the friction at the blank-die-blank holder interface limit the slip at the interface and increase the radial stretching of the blank.In many investigations that are based on the use of mechanical energy considerations logarithmic stress distributions are assumed in the flange. This is provided by the simplifying assumptions of lack of friction, constant sheet thickness, Tresca yield criterion, isotropic material properties, rigid-plastic material behaviour without work hardening. The significant results in investigations of mechanical and technological parameters of a sheet metal shaping have been done. For more complex, three dimensional shapes, the interface conditions need to be controlled within a narrow range in order to obtain a good product. During the drawing process the response is primarily determined by the membrane behaviour of the sheet. For axi- symmetric problems, the bending stiffness of the metal yields only a small correction to the pure membrane solution. In contrast, the interaction between the die, blank and blank holder is critical. Process parameters include blank holder force, coefficient of friction, drawing ratio, material properties. Geometrical parameters include blank diameter, cup diameter, blank thickness, and corner radii of cup. Machine parameters include die radius and punch radius. To achieve a successful deep drawing process, a study of the stress-strain and anisotropy behavior of the sheet metal to be used is inevitable. Before one begins to study the stress-strain and anisotropy behavior in sheet metals, a proper knowledge of the stresses that occur during the forming process needs to be established. Two-layer metallic sheets have mechanical (vehicle, aviation, electrical, and concoction enterprises) and residential applications because of their focal points, for example, improving the formability of low formable segment, expanding wear protections, and diminishing spring back. Sheet metal formability is obliged by plastic shakiness and limited necking. The strains of the metallic sheets at the break and acquired a chart that is called forming limit diagram. The consequences of anova software affirm that the created observational models for the yield reactions show an incredible fit, and give the anticipated estimations of these reaction factors that are near the exploratory qualities, at acceptable level.

4. CONCLUSIONS

The sheet metal forming process for bimetal sheets are depending on factors of deep drawing process are Process parameters,geometrical parameters and machine parameters.The investigated formability of stainless steel-aluminum clad sheets by press forming tests. It is found that higher strength component has more effect on drawing ratio during the deep drawing process of bimetallic sheets. Also, they claim the formability of both stretching and deep drawing was higher when the aluminum was set on the outer side of cup. The analytical study of bimetal deep drawing for calculated drawing load for cylindrical parts by considering dynamic stresses and inertia forces into plasticity formulation. Distribution stress and strain in bimetallic sheet deep drawing depending on layers thickness ratio and layers yields strength ratio. Obtained a successful deep drawing process it is essential to control the slip between the blank and its holder and die. If the slip is restrained too much the material will undergo severe stretching, thus potentially causing necking and rupture. If the blank can slide too easily the material will be drawn completely and high compressive circumferential stresses will develop causing wrinkling in the product. For simple shapes, like the cylindrical cup here, a wide range of interface conditions will give satisfactory results. In bimetal sheets, the forming powers increment about 8% by expanding the instrument measurement about 20% and the progression down about 45% by utilizing the winding apparatus way and about 6% by utilizing Al as the top layer. Formability of two-layer metallic sheet is compelled by plastic unsteadiness and restricted necking. Shaping farthest point chart is an acknowledged proportion of sheet metal formability. The formability of two-layer sheets relies upon the material properties of their parts such as strain solidifying example, strain rate affectability coefficient, solidness coefficient, and grain size. Right now, impacts of the referenced parameters on the forming limit diagram of two-layer sheets are examined with a hypothetical model which has been checked with a trial approach. The outcomes show that the shaping furthest reaches of two-layer sheet lies between the framing furthest reaches of its parts relies upon their material properties. The forming limit diagrams give materials limits of safe conditions and also for selection of material for processing. Furthermore, the thickness variety is progressively uniform contrasted with the progression device way, which improves the state of flexibility and furthermore utilizing copper as the top layer improves the formability of the substrate about 3% on the grounds that most anxieties go to the underside layer aluminum of bimetal sheets.

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