DEFORMATION OF ANTIRUST ALUMINIUM BATTERY SHELL DURING DRAWING

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ABSTRACT: Drawing deeply is an important sheet metal forming process in many industrial fields. For the purpose of optimize the design of drawing dies for the battery shell, the work carried on the simulation to forming process of the battery shell with finite-element software MSC.SuperForm, has studied the ironing drawing forming and influence of the main parameters to the forces, and avoided the slight tension fracture flaw, furthermore, made up the insufficiency of drawing die empirical design. The unit drawing strength is stable when friction coefficient f=0.80, which verified the instruction function of numerical simulation results in the multi-pass drawing and the technological design. The experimental results showed that the sidewall corner base and the punch-nose angle contacting place material are thick smallest to the strain algebraic value. Additionally, wall thickness attenuation quantity is biggest, and the drawing base semi-finished materials thin are more serious, the present examine implied that the proposed approach is a valuable.

KEY WORDS: Battery shell, Ironing drawing, Tension fracture flaw, FEM.

1. INTRODUCTION

In recent years, the electronic communication product rapidly expand, it is well known that rectangular shell parts are widely used in our daily lives, especially applied to all kings of the battery cover, which is a main component of portable intelligence terminal products. With the development of these mobile communication products is required to be much lighter and thinner, it makes the new demands on the formation technology and method of the battery covers. That causes the drawing craft and the quality control of box bulkhead takes in the current ramming forming domain research hot spot [1]. As well-known, both facts include the fillet part the drawing, and has on the straight edge curving and the drawing, makes the parameter of drawing mould in the determination to be quite difficult. When multiple drawing to a great extent is decided in each drawing distorts whether evenly, wealthy quantity assignment to be whether reasonable, depends on the empirical design, cannot often achieve expectation effect, but the mature emulation technique may reduce the experimental mould number of times and causes the mould and technological design qualified [2] under the controlled condition.

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However, with the optimization design of numerical simulation method, few detailed experimental observations of material processing performancehave been reported[3-6].

Especially, the study aimed at the quality problem of the scratch, fracture and instable product during the process of multi-pass drawing of the battery shells. As a vital metal processing, sheet forming is comprehensively applied in industry field. There are three main defects includes wrinkle and cracking and spring back in metal shaping, however, the wrinkle among them is the hardest controlled in recent years [7-9]. After all, it is an actual problem and a long-term hotspot in academe as well, so that studies mainly focused on the mould design. For instance, the smaller die radius may increase drawing force, reduce the die life, and will have a useless influence on the forming of sheet metal with the same blank-holder force and friction coefficient and punch speed. Therefore, the excessive die fillet can cause the wrinkling and influence metal forming [10-13]. Many investigations show that we had better adopt the larger value within the permitted range of the die fillet. On the other hand, the practice illustrates that it is helpful for forming parts with blank holder device [14-15]. Because it is useful for the improvement of the sheet forming performance with an isotropic thick plastic strain ratio index increased, at the same time, it may reduce wrinkling trend and make complete forming in the security area.

Therefore the blank holder force as an important factor in the process of sheet metal deep drawing process parameters is mainly used to produce friction and increase the tensile stress in sheet metal and control the flow of sheet metal. Based on the above issues, the lab applies finite element simulation method to simulate the process of production, the purpose is to avoid these defects, which can show that finite-element method may save much time and cost, and it is a useful tool for engineering analysis. The abstract will contain an introduction in which the main aspects according with the paper theme are described, as well as the objectives and the way in which they are approached.

2. EXPERIMENTAL MODEL

The numerical simulation of forming process of the box part is carried out using the explicit non-linear finite-element, and the mode is established to simulate the drawing process based on the characteristics of the part. Particularly, stress field and strain field and the variation of thickness at different depth of drawing are analyzed, also the vectograph of node displacement is gotten, and reasonable technology parameters are acquired by simulating with different velocity of punch and coefficient of friction.

Al5052 fasten metal alloy for AL-Mg, is a kind of antirust aluminium to apply most widely. The Chemistry composition of the metal alloy well contains Mg element and Fe element etc.The Mg element (the content is lower than 2%) in which has the actions of solid solution strengthening and recrystallization grain refinement, The Fe element also can refine grain, and prevent hot wear phenomenon for dies due to draw deeply. So it selects 5052 antirust aluminium for battery shell to conduct the experimental study, its mechanics properties parameter such as (Table 1**)** show. As a result of the material's strength and degree of hardness are very low, but the plasticity and toughness are extremely high, namely can realize this components multiple drawing forming, when may reduces cost for the initial debugging [16]. Because the workpiece requests highly high, the material is thin, and the components are small (Fig. 1), is unable while going along drawing to form. Because the high and thickness compares of components is bigger than eight, moreover wall thickness is non-uniform, does not suit uses the multi-while going along drawing forming directly. According to the components size characteristic, as shown in (Fig.2) the technical process, the multi-while going along drawing, then thins the drawing (thins when drawing plunger size constancy again first, and forming process drawing thins again first).

Table 1. Characteristics of 5052 antirust aluminium

Yong's modulus,Y	70000MPa
Poissons'ratio	0.33
Hardenability,n	0.189
Tensile strength,σ_b	170~240 MPa
Conditional yield strength,$\sigma_{0.2}$	≥70 MPa
Elongation	12~16%

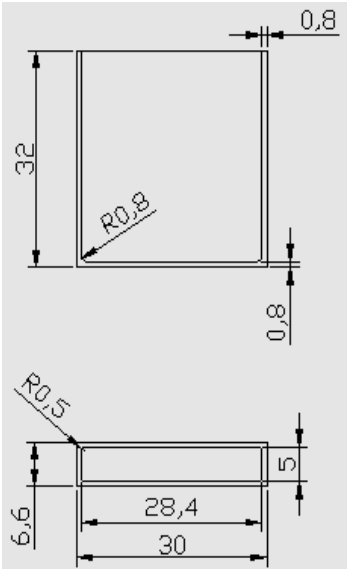


Fig.1 Dimension of parts

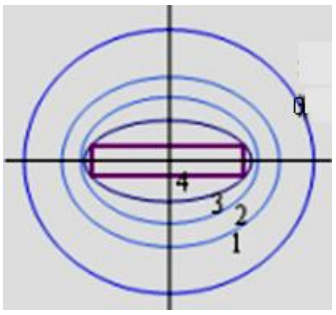


Fig.2 Drawing flow chart

3. RESULT AND DISCUSSION

In the drawing process, the plunger action transmits through the sidewall semi-finished materials for flange's in edge (lower die entrance), therefore has the drawing stress in the flange part's radial direction, tangential has the elastic strain, under the two's combined action, the flange deformation range's semi-finished materials has the

plastic deformation, and is pulled unceasingly like the lower die. Because the presses the circle function, has the compressed stress in the flange area semi-finished materials' thickness direction, but because with the absolute value is bigger than far, also only then can guarantee that like the cylinder drawing forming continues to carry on.

3.1 Simulation processes

In view of the fact that the length limits, only introduced that the sheet multi-while going along drawing the first result, passes through the continuous analogue first while going along components the shape. As shown in (Fig.3), and the stress restores resembles is quite serious, the convex-concave friction coefficient is unreasonable, the length of stride is too small (its step-value is 250). After optimizes through to the non-flange cylinder entire drawing process analog computation, has obtained the cylinder interior stress field distributed situation, obtains more reasonable forming process 10th, 110, 210, 310, 463 step time equivalent stress distribution (Fig.4).

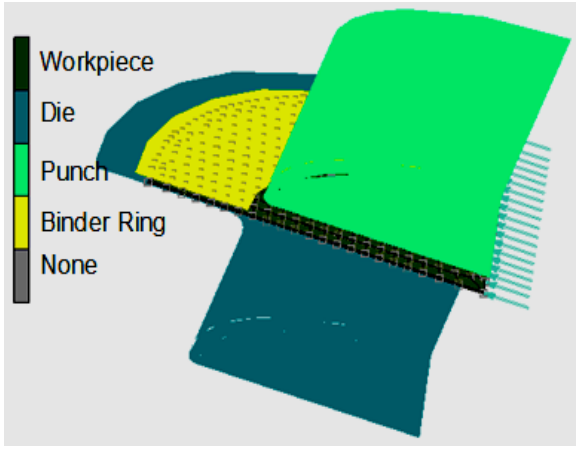
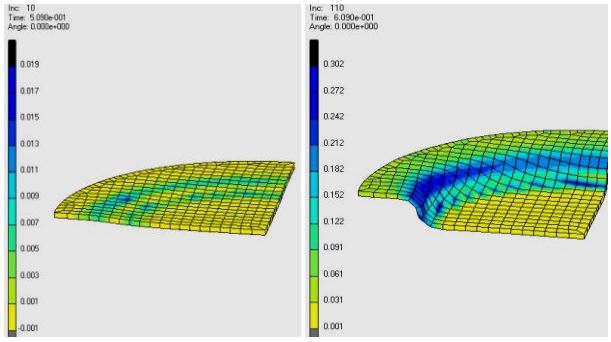
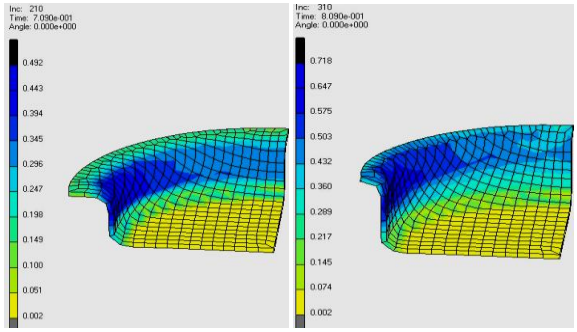


Fig.3 Drawing geometry structure and model



a b



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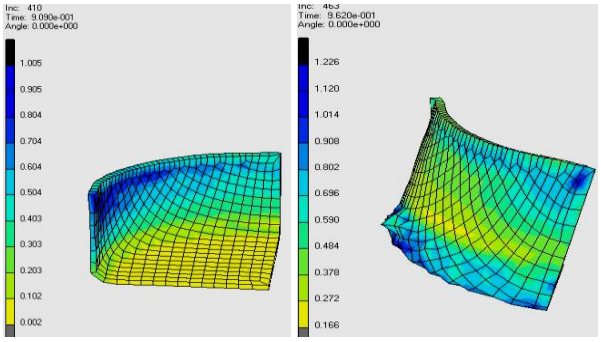
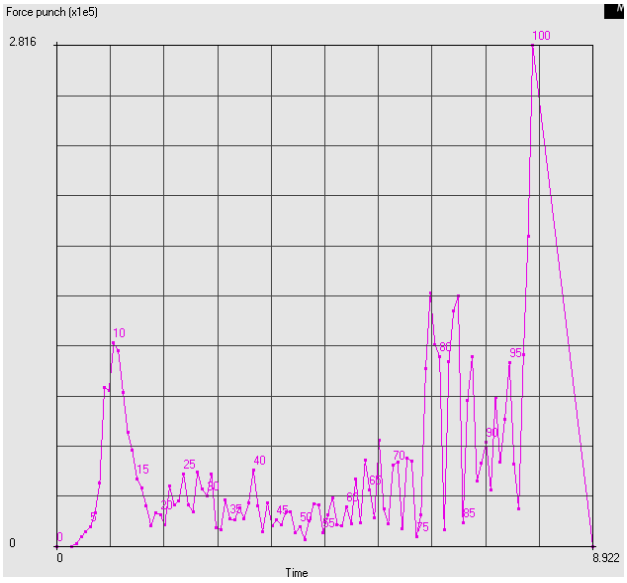


e f

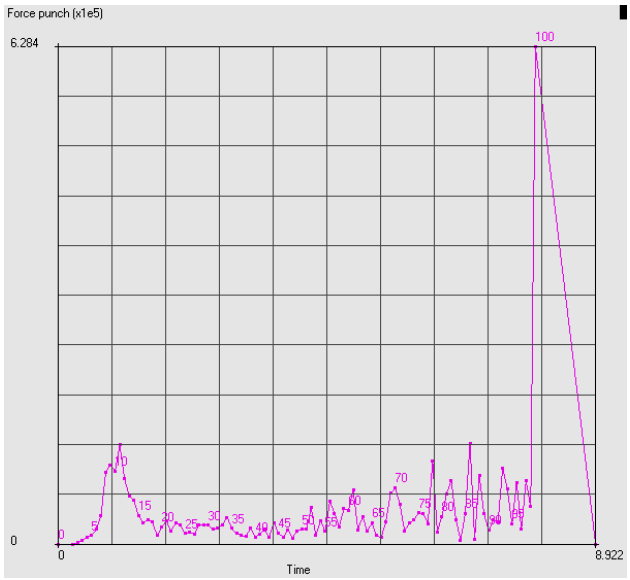
Figure 4 a,b,c,d,e,f

First while going along drawing each step equivalent stress (each small chart respectively is the 10th, 110, 210, 310, 410, 463 step situation)

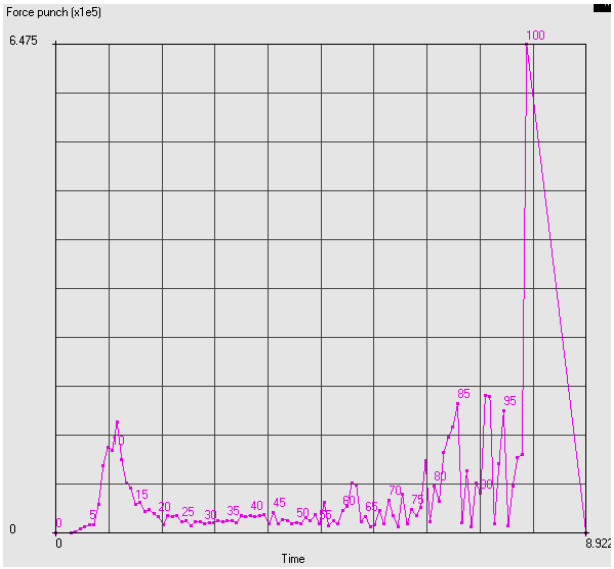
3.2 Parameters to drawing strength's influence



a



b



c

Fig5. a,b,c Change curve of drawing strength under different friction coefficient

As shown in Fig.5, die radius of curvature is 2mm, die radius is 3mm, when the dying speed is 10mm/s, had demonstrated the friction coefficient is a) 0.78, b) 0.8, c) when 0.82 dies the drawing strength traveling schedule curve.

Regarding the bulkhead drawing of high side box, it is generally through increases the friction coefficient to obtain the driving influence which the flow of metal needs. The contact friction is bigger, the high side box bulkhead base thins the tendency to be smaller, the flange material thickens the tendency to be bigger. The contact friction is smaller, the high side box bulkhead base thins the tendency to be bigger, the flange material thickens the tendency to be smaller. But the friction coefficient is oversized, will cause the metal drawing distortion degree to increase, even different will cause the creasing flaw because of the metal flow speed; The friction coefficient is too small, then cannot provide enough big drawing strength, even presents the metal lateral drawing distortion degree to reduce, but cannot realize continues to distort. When friction coefficient f=0.80, the unit drawing strength is stable, is advantageous and can improve the product quality in the distortion uniformization.

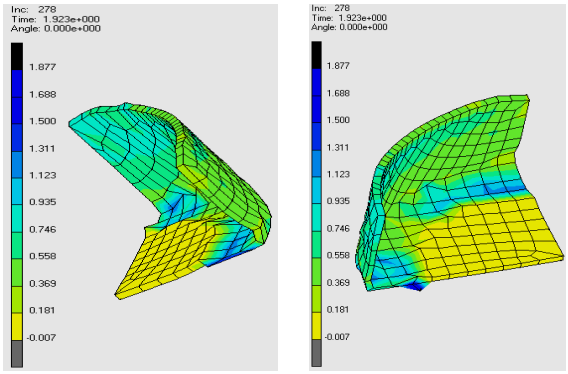


Fig6. Flaw analysis

3.3 Forming flaw

Plate drawing forming process's main flaw question is the corrugation and the tension fracture. When the tube blank material flows through the lower die fillet part has, the inflection to distort curving is very intense, after this part of materials enter the sidewall, its bearing capacity is lower than t he punch-nose angle part, easy to cause the lower die fillet part is before the base occurs bursts.

(Fig.6), the flaw is simulates in the process and obvious on account of the drawing is mainly oversized,. Because the flange partial material resistance to deformation is oversized, causes the tube wall to pass on the strength which surpasses the ultimate strength, such punch-nose angle place easy to burst. Obviously the punch radius is bigger, the plunger bottom surface and the semifinished materials contacted area reduces, the drawing base semifinished materials thin are more serious. In addition, the work may through enhance the material the performance, the improvement mold structure and the lubrication condition solution, and finaly got test product of the last process through adjusting the experiment parameter.

4. CONCLUSION

In summary, the work investigated the bulkhead drawing of high side box forming

process technological parameter to its formed quality influence, and mainly obtained the following conclusion.

(1) Calculates the instruction finite element analysis through the experience, completes the sheet by the best technological parameter the entire drawing forming process, witch can reflect that the thin wall of box bulkhead the distortion situation and carries on the qualitative analysis. (2) The sidewall corner based and the punch-nose angle contacting place material is thick smallest to the strain algebraic value, and wall thickness attenuation quantity is biggest, therefore bursts mainly occurs in the sidewall corner base and punch-nose angle contacting place.

CONFLICT OF INTEREST STATEMENT

We declare that we have no financial and personal relationships with other people or organizations that can inappropriately influence our work, there is no professional or other personal interest of any nature or kind in any product, service and/or company that could be construed as influencing the position presented in, or the review of, the manuscript entitled, "The authors declare that there is no conflict of interests regarding the publication of this paper".

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