Design and Elimination of Heat Check Marking in Chip Stripper for Rim Manufacturing Process

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***Abstract*— Increasing cost of consumable materials has put an enormous pressure on the pricing as well as the profitability of an organization. Therefore without any compromise on quality, the variable cost has to be reduced. This demands novel thinking and creativity for constant improvement in manufacture, resulting in good profits. In this work, rim process is to reduce the rework and scrap losses, and in spinning operation has to reduce material cost and we saved the material and man work in this operation. Increasing cost of consumable materials has put an enormous pressure on the pricing as well as the profitability of an organization. Therefore without any compromise on quality, the variable cost has to be reduced. This demands novel thinking and creativity for constant improvement in manufacture, resulting in good profits. The results of the heat check marking were successfully finished. This paper provides designing and manufacturing skill and opportunity to know the fundamental concept of design. The results of the heat check marking were successfully finished. So, the material cost is reduced and also the space occupied. The basic idea of this paper of rim process is to reduce the rework and scrap losses. When we use the Sheet metal subjected to shear stress developed between a punch and a die is called shearing. In general, an increase in temperature brings out a decrease in strength, an increase in ductility, and a decrease in the rate of strain hardening – all effects that would tend to promote ease of deformation.**

Keywords- Profit, quality, Manufacturing, RIM, Heat check marking, Stripper, Spinning

I. INTRODUCTION

The Rim is the “outer edge of a wheel, holding the tire”. It makes up the outer circular design of the wheel on which the inside edge of the tire is mounted on vehicles such as automobiles. For example, on a bicycle wheel the rim is a large hoop attached to the outer ends of the spokes of the wheel that holds the tire and tube.

Figure 1. Rim Model

A. Problem Definition

TABLE I Types of Root Causes

S l. n o	Problem related to man/machine/material/method	Description of the cause	Consider /not consider for further analysis	Reason for eliminating the cause
1	Machine	Ram excess play	Considered	Slide clearance to be checked
2	Method	Heat check mark in component	Considered	Heat check mark found in stripper
3	Method	Heat check mark in stripper	Considered	Frequent change of stripper
4	Material	Stripper hardness	Considered	To be check the material hardness

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Sl.no	Cause	Validation	Inference			SELECT
		Checked in the line and the observation are as follows	Low	Medium	High	
1	Stripper hardness	Hardness of the stripper 58/60 RC	yes			Not significant
		Hardness of the stripper measure – 60 RC				
2	Ram excess play	Jib clearance SPEC value 0.006" to 0.008"	yes			Not significant
		Actual value 0.008"				
3	Rework high	Rework data taken and found more heat check mark rework		yes		significant
		Heat check mark rework average 12548ppm.				
4	Frequent change of stripper	Found frequent change monthly 12 times changed		yes		significant

II. Interaction between the Machine, the Tool and the Work Piece

A typical system for a metal-forming process is presented here through forging. The platens are manipulated by a hydraulic cylinder. The force applied to the workpiece through the piston and platens is contained by the frame. The resultant force on the system is zero. However, the frame must be strong enough to contain the forming forces.

While the largest forging press during World War II was a 5,000 ton press available only in Germany in limited numbers, there are throughout the world today a few production presses of 50,000 to 80,000 tons. These presses are huge and expensive. The power supply needed for a press this size is an impressive system by itself. Not so long ago, the control and manipulation of the workpiece and tools were manual. Today's modern presses are automated. The following description is the state of the art in several of the most advanced designs. The shape of the product, together with other information about the feed stock is given as the input to an online computer that activates the press and its accessories. The entire workpiece, tooling, and press manipulations schedules are calculated by the computer. Workpiece after workpiece is automatically fed to the press from its storage. An assortment of tools is stored on a rack at the press, and automatic selection of the desired tools at the proper portion of the cycle is affected. The tools and workpiece are manipulated in synchronization to shape the workpiece to the proper design by repeated forging actions. When forming of one workpiece is completed, the workpiece is removed to make room for the next one.

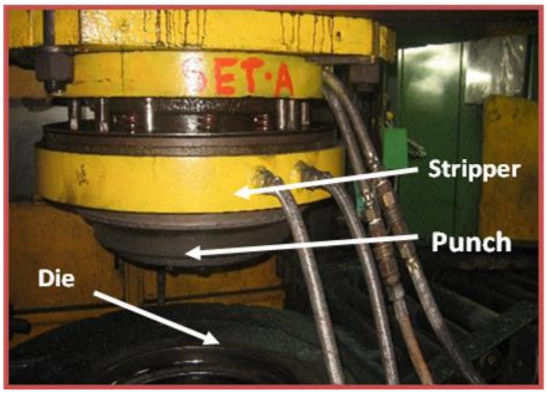

Figure 2. Stripper Tool

Almost all of the disciplines of engineering at their most advanced stage interact in providing the present-day metal-forming system. Starting with the workpiece, knowledge of metallurgy and mechanics combine to provide an insight to its behavior. Sliding occurs on the interface between the workpiece and the tool, friction is manifested, and lubrication is exercised. Thus, tribology (i.e., the study of friction and wear) is necessary. The tools are made from hard metals and nonmetals as well, and therefore the latest advances in material science are immediately applied. Furthermore, to optimize tool wear, the latest in surface treatments, by coating, ion implantation, and laser beam surface hardening, are all practiced. In the design of the machine tool itself, all disciplines combine. To mention a few, the frame is made of any material from cast iron to plastic, which will reduce weight and noise. Hydraulics and electronics with robotics combine to provide motion inspection and vibration control.

B. Punching

Punching is performed by placing the sheet of metal stock between a punch and a die mounted in a press. The punch and die are made of hardened steel and are the same shape. The punch just barely fits into the die. The press pushes the punch against and into the die with enough force to cut a hole in the stock. In some cases the punch and die "nest" together to create a depression in the stock. In progressive stamping a coil of stock is feed into a long die/punch set with many stages. Multiple simple shaped holes may be produced in one stage but complex holes are created in multiple stages. The final stage the part is punched free from the "web". A typical CNC punch has a choice of up to 60 tools in a "turret" that can be rotated to bring any tool to the punching position. A simple shape (e.g. a square, circle, or hexagon) is cut directly from the sheet. A complex shape can be cut out by making many square or rounded cuts around the perimeter. A punch is less flexible than a laser for cutting compound shapes, but faster for repetitive shapes (for example, the grille of an air-conditioning unit). A CNC punch can take 600 strokes per minute. A typical component (such as the side of a computer case) can be cut to high precision from a blank sheet in less than 15 seconds by either a press or a laser CNC machine.

C. Heat Energy Rate Forming

Up to this point, the processes described were achieved through static loading, as in the forging of a disk between two platens of a press. We now examine how the same result (upsetting) can be achieved by a high-energy rate-forming (HERF) process. (The process is also called high-velocity or HVF). If, hypothetically, the disk is thrown with a high speed at the bottom platen, the entire kinetic energy of the rushing disk will be absorbed at the moment of impact with the platen. If the projectile achieves bullet speeds, it may, on impact, penetrate the platen, like an armor-piercing bullet, weld to the platen, deform, or undergo two of the above simultaneously. It represents the most common design for the use of explosives in a HERF process. A blank made of a plate or sheet metal is placed over a die cavity of the desired shape. A vacuum must be formed in the cavity below the blank by evacuating the air. The tank above the bank is filled with water. An explosive charge is placed just below the surface of the water, directly above the center of the blank. When the explosive charge is detonated, a shock wave moves through the water. Water is a very effective shock-wave-transmitting medium through which the impact of the explosion is transmitted from the source to the work piece target. The effectiveness of the energy transfer is demonstrated by observing uses in other fields. For example, sonar under water is most efficient and sensitive. The destructive force of the shock wave has been used for centuries (now illegally) by fishermen to destroy (or to stun) all life in a vast sea or pond space. Submarine warfare demonstrates the sharpness by which the shock wave from a bomb hits the submarine, as if it had been hit directly by a hammer. On reaching the blank, the shock wave hits it so hard that the blank rushes downward and conforms to the cavity. Once the shock wave has hit the blank and set it in motion, the rest of the operation is performed by the inertia of the Schematic of explosive forming.

D. Furnace For Heat Treatment

The car bottom furnace is used for large parts that are to be heat treated and particularly for annealing and normalizing. Such furnace get their name from their design, which employs a flatbed car on rail road like wheels that is pushed into either a gas-fired or electrically heated, well-insulated, room like furnace. They vary in size from about 320 to 8000 ft² (30 to 740 m²). The bell top furnace is made so that once parts are loaded on a platform the furnace can be lifted up and placed over the parts. The box furnace, in which steel pellets are loaded into a furnace by a forklift truck, is a variation of the car bottom furnace. Small versions of the box furnace are called a muffle furnace and can sit on a bench. Continuous furnace employs a set of roller, skids, or a walking beam on which the castings are moved systematically through the furnace. One type utilizes a carousel arrangement. Continuous furnaces are seldom used for normalizing. Because the size of the part regulates the time spent in the furnace, such furnace are often single purpose units. For small parts the fluidized bed is increasing used. It consists of a container filled with pellets of alumina or sand, which are heated by a high-velocity, air-gas flame that not only heats the bed but also “fluidizes” the particles. The particles became almost airborne, and parts immersed in the pellets are surrounded by the pellets much as if they were in a liquid. If a stoichiometric mixture of air and gas is used, an almost inert atmosphere is present in the container. Some furnaces are electrically heated and an inert gas is forced upward to fluidize the pellets. When parts are vaccum heat treated, a furnace is heated by electrical means or hot gases are circulated around it. The parts are placed inside and a vacuum is pulled.

Figure 3. Heat Treatment of Stripper

III. PROCESS

Induction heating is a non-contact process which uses the principle of electromagnetic induction to produce heat in a work piece. By placing a conductive material into a strong alternating magnetic field, electrical current is made to flow in the material, thereby causing Joule heating. In magnetic materials, further heat is generated below the Curie point due to hysteresis losses. The generated current flows predominantly in the surface layer, the depth of this layer being dictated by the frequency of the alternating field and the permeability of the material.

E. Heat Check Marking in Chip Stripper

The increasing demand on die cast products continues to place greater emphasis on the continuous development of steel grades for die casting dies. These grades call for higher strength combined with higher ductility and better toughness both at ambient and elevated temperatures. The latest trends in product design are also placing greater emphasis on larger components, thinner wall thickness, more complicated shapes and tighter tolerances. All these factors lead to higher levels of thermal & mechanical stresses on the die casting dies. These stresses are manifest in the form of Heat Check marks, Chipping or Gross Cracking.

While, heat checking is still the major failure mode, gross cracking is fast increasing in incidence due to the more complicated shapes of the cast parts.

1. Heat check mark in stripper
2. Heat check mark in component (More Rework)
3. No. of recondition more (Recondition period 3500 comp.)
4. Stripper life low (Max. life 25mm thick. reduced)
5. Recondition cost high
6. Operator fatigue high

F. Stripper Consumption high in Flange Forming

1. Heat check mark in component
2. Frequently changing the stripper
3. Stripper having heat check mark while running
4. Heat translating from Lip area to Solid area
5. Stripper entry space not suitable for heat transfer
6. Existing Stripper design
7. Stripper design changed to with stand the heat transaction at Flange entry face.
8. To increase the lip area thickness,
9. Tool angle changed from 90° to 89°.then by trial & error modified to 91° 30'.

So, we decided to change the tool angle by reverse engineering.

IV. DESIGN CALCULATION

Stripper data =7/CN 1178
Rim size = 22.5"×8.25" 11"R22.5"
Material=first class steel.
Hot work tool steels=T35 cr45MoW1V30
Specific compression loading, σ=3150 N/mm²
Work done = 35KN

G. Flange Forming Operation

Method of operation: Hot upsetting and drop forging
Type of punch: Hydraulic presses-400T HMT press
CNC punch take 600 strokes/min
During the time taken of heat treatment for the press=15 sec.
Temperature for heat treatment on the rim=1250°c
Tensile strength of work material=800N/mm²
Deformation rate, w=50%/sec
Dynamic deformation strength=48N/mm²
Upsetting die =450 mm
Upsetting path, h=13 mm
B/s=6.3
Ls/Bm=2.5
Deformation resistance=240 N/mm²
Upsetting force= 4450 tones
Work done=35×10³ mm tones.
Flange at the entry face of the stripper angle =91.30°
Initially,
In which the flange at the entry face of the stripper angle = 90°
When the heat transaction is not completed and rework takes place. So the stripper will be changed.
Flange at the entry face of the stripper angle =91.30°
Bending stress, $\sigma_{-1b} = 0.46\sigma_u$ (reversed cycle)

$$\sigma_{-1b} = 0.46\times600$$
$$\sigma_{-1b} = 276 N/mm^2$$

Bending stress, $\sigma_{-1b} = 0.6\sigma_u < \sigma_y$ (repeated cycle)

$$\sigma_{-1b} = 0.6\times600$$
$$\sigma_{-1b} = 360 N/mm^2 \leq \sigma_y$$

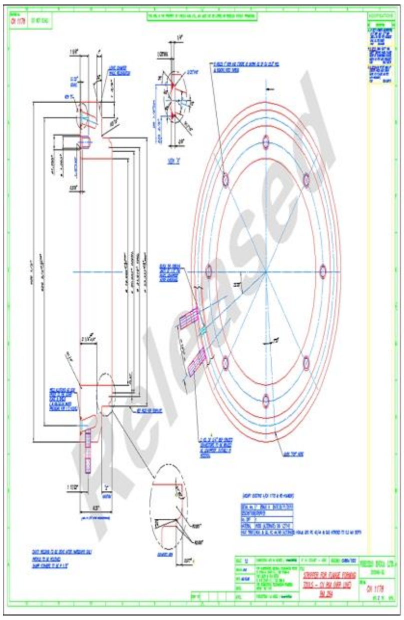

Figure 4. Model Diagram of Stripper

V. DEVELOPING SOLUTION

1. Stripper design changed to withstand the heat transaction at flange entry face.
2. To increase the lip area thickness, tool angle changed from 90° to 89°.
3. But the result found very less 1450 no's in place of our regular process 3500 nos.

TABLE III
TRIAL PROCESS AND RESULTS

Trial no	Process/machine/details of the trial	Quality accepted	Final results
1	Stripper entry face-89°	1450 nos. processed after that heat check mark observed.	Trial not satisfied
2	Stripper entry face-90° 30'	4450 nos.processed successfully. After that heat check mark is observed.	Trial improved.
3	Stripper entry face-91°	6050 nos. processed successfully. After that heat check mark is observed.	Trial improved.
4	Stripper entry face-91°30'	8150 nos. processed successfully. After that heat check mark is observed.	Trial improved.

1. Trial conducted up to 92° in stripper entry face.
2. Result found flange profile is not ok.
3. Therefore we stopped the entry face angle is 91°30'.
4. Strippers recondition to be done after every 8150 nos. component.

VI. CONCLUSION

In this work, rim process is to reduce the rework and scrap losses and we saved the material and man work in this operation. Increasing cost of consumable materials has put an enormous pressure on the pricing as well as the profitability of an organization. Therefore without any compromise on quality, the variable cost has to be reduced. This demands novel thinking and creativity for constant improvement in manufacture, resulting in good profits. The results of the heat check marking were successfully finished. This paper provides us designing and manufacturing skill and opportunity to know the fundamental concept of design.

REFERENCES

[1] M. Sabri, M. Rezal, A. Mu'az, K. Shahril, J. Ihsan, "Deformation Behaviour analysis of Car Wheel Rim under Different Loading Using Finite Element Method", international Journal of Engineering and Technology, pp- 181- 184, Volume 5, No.3, March, 2015

[2] T. Siva Prasad, T. Krishnaiah, J. Md. Iliyas, M. Jayapal Reddy "A Review on Modeling and Analysis of Car Wheel Rim using CATIA & ANSYS" at International Journal of Innovative Science and Modern Engineering (IJISME) ISSN: 2319-6386, Volume-2, Issue-6, May 2014

[3] "Fatigue Analysis of Aluminum Alloy Wheel Under Radial Load" by N. Satyanarayana & Ch. Sambaiah at International Journal of Mechanical and Industrial Engineering (IJMIE), ISSN No. 2231 –6477, Vol-2, Issue-1, 2012.

[4] "Design and Weight Optimization of Aluminum Alloy Wheel" by Sourav Das, (CAE Analyst) Altair Engineering India Pvt Ltd, Bangalore at International Journal of Scientific and Research Publications, Volume 4, Issue 6, June 2014 ISSN 2250-3153

[5] "Design and Analysis of Spiral Wheel Rim for Four Wheeler" by S.Ganesh and Dr. P. Periyasamy at the International Journal of Engineering and Science (IJES), Volume-3, Issue-4, Pages-29-37, 2014, ISSN (e): 2319 – 1813 ISSN (p): 2319 – 1805.

[6] "Fatigue life analysis of Aluminium wheels by Simulation of Rotary Fatigue Test" by Liangmo Wang, Strojiniski vestnik- Journal of Mechanical Engineering 57 (2011)1, 31-39.

[7] The Aluminium Automotive Manual", Version 2011 European aluminium association

[8] WenRu Wei, Liang Yu, Yanli Jiang, JunChuan Tan and Ru HongQiang (2011), "Fatigue Life Analysis of Aluminum HS6061- T6 Rims Using Finite Element Method", International Conference on Remote Sensing, Environment and Transportation Engineering, pp. 5970-5973.