TO DEVELOPE TECHNIQUES TO CONTROL THE DISTORTION IN WASHER

ANURODH KHIRE[1], LAUKIK RAUT[2], SANDESH POTNIS[3]

[1]*Student, Department of Mechanical Engineering, G. H. Raisoni College of Engineering, Maharashtra, India*

[2]*Assistant Professor, Department of Mechanical Engineering, G. H. Raisoni College of Engineering, Maharashtra, India*

[3]*General Manager, NRB INDUSTRIAL BEARINGS LTD, Maharashtra, India*

ABSTRACT: -

The Moto of this paper is to show how to control the distortion occurring in steel washer. Distortion can be defined as deviation from the natural, normal, or original contour, shape or size due to application or removal of forces [1]. Distortion can be reduced but never be completely eliminated. It aims at reducing the bend occurring in the washers due to addition of external forces at time of punching operation. Many bearings contains washer as a major component which is required to have very less distortion. Distortion in washer can prove very fatal for the life and working of bearing. Usually thrust bearings are made up of the washers containing needles and virol as main elements. This paper showcase the techniques developed to control the distortion so as to minimize the bad effects on the bearings. Distortion is usually caused in the washers having larger internal and external diameters .Proper strip holding devices and lubrication if required should be used to reduce the bend in washers.

KEYWORDS:-*washer, distortion, pitting marks, fastener, cryogenic, etc*

INTRODUCTION

A **washer** is a thin plate (typically disk-shaped) with a hole (typically in the middle) that is normally used to distribute the load of a threaded fastener, such as a screwor nut . Other uses are as a spacer, spring (Belleville washer, wave washer), wear pad, preload indicating device, locking device, and to reduce vibration (rubber washer). Washers often have an outer diameter (OD) about twice their inner diameter (ID), but this can vary quite widely. The washers are made from a flat strip and processes carried out are blanking, piercing and forming. The washers have to go through two stages which are soft stage and hard stage. The stage before heat treatment is soft stage and after heat treatment is hard stage.

LITERATURE REVIEW

Distortion can be defined as deviation from the natural, normal, or original contour, shape or size due to application or removal of forces [1]. It can also be defined as the act of twisting or altering something out of its true, natural, or original state. In the case of washer the distortion is considered as in term of bending. It is also called as warpage in other terms.

Bearings are highly engineered, precision-made components that enable machinery to move at extremely high speeds and carry remarkable loads with ease and efficiency .Bearings must be able to offer high precision,

reliability and durability, as well as the ability to rotate at high speeds with minimal noise and vibration. Bearings are found in applications ranging from automobiles, airplanes, computers, construction equipment, machine tools, DVD players, refrigerators and ceiling fans. If something twists, turns or moves, it probably has a bearing in it. [10]

Bearing Types and Application

There are many distinct bearing types, each with particular characteristics which are suited to specific applications. Here are the four most common types of bearings:

1. Ball Bearings**:**

–Rolling function is provided by a ball
–Low friction, high speed, light to medium loading
–Light and general machine applications

Commonly found in fans, roller blades, wheel bearings, and under hood applications on cars etc.

2. Cylindrical & Needle Roller Bearings**:**

-Where the rolling function is provided by a cylinder of some kind. May also be referred to as needle roller bearings (where length is much greater than diameter)

-Low friction, medium to heavy radial loading

-Commonly found in general machine applications including gearboxes and transmissions, machine tool and construction equipment.

3. Tapered Roller Bearings**:**

-A tapered version of a roller bearing is used for combined axial and radial loads, such as in wheel applications on trucks

-Commonly found in heavy industrial, truck and wheel applications with combined radial and axial loads. Some examples are manual transmissions, gearboxes, power generation and other process equipment.

4. Spherical Roller Bearings**:**

A roller bearing that has a barrel shaped roller.
- Medium friction, medium to heavy loads and misalignment capabilities
- Generally used for very high load applications with misaligned shafts to housings.

Commonly found in gearboxes, conveyors, pulp and paper machines and other process equipment.

Washer

A **washer** is a thin plate (typically disk-shaped) with a hole (typically in the middle) that is normally used to distribute the load of a threaded fastener, such as a screw or nut. Other uses are as a spacer, spring (Belleville, wave washer), wear pad, preload indicating device, locking device, and to reduce vibration (rubber washer), Bearings**.** Washers often have an outer diameter (OD) about twice their inner diameter (ID), but this can vary quite widely.

Washers are usually metal or plastic. High-quality bolted joints require hardened steel washers to prevent the loss of pre-load due to Brinelling after the torque is applied.

Rubber or fibre gaskets used in taps (or faucets, or valves) to stop the flow of water are sometimes referred to colloquially as washers; but, while they may look similar, washers and gaskets are usually designed for different functions and made differently.

Washers are also important for preventing galvanic corrosion, particularly by insulating steel screws from aluminium surfaces.

Types of washer

1. Flat washers
2. Fender washer
3. Lock washer
4. High collar lock washer
5. Lock washer with external tooth
6. Lock washer with internal tooth
7. Square dock washer
8. Thrust washer [11]

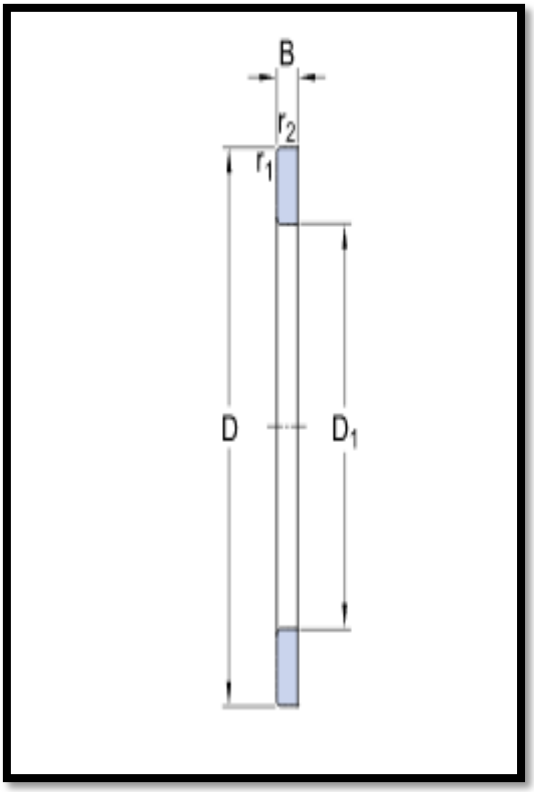

Fig 1:- General drawing of washer[12]

PROCESS FLOW CHART

The following processes are done on washer to make it completely ready for use with required hardness and surface finish. The following process flow chart is for 500 washers.

This process flow can vary according to size and type of washers. The time cycle is varied according to required hardness and material structure.

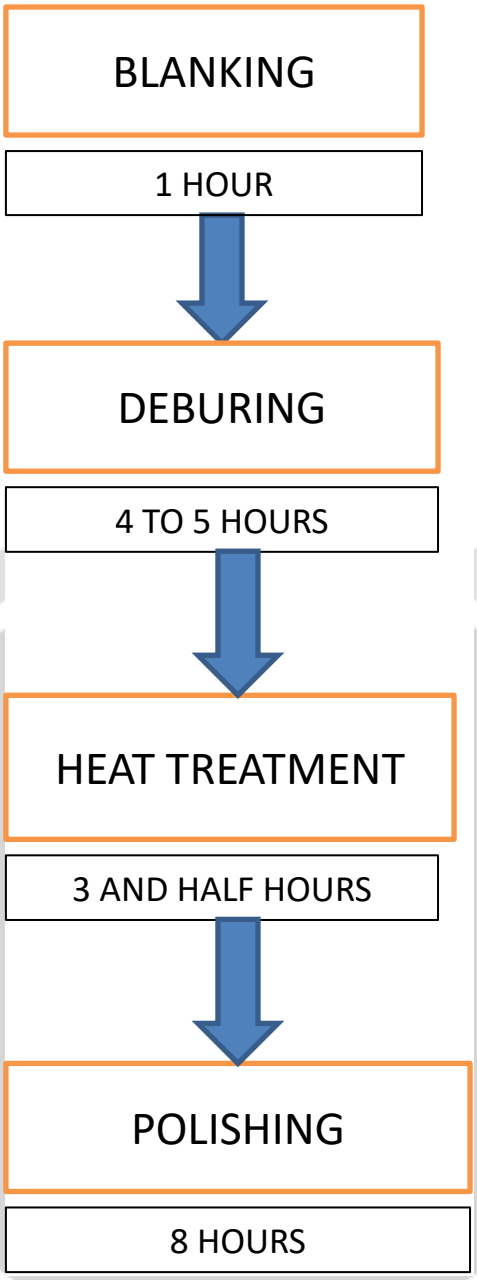

Fig 2:- process flow chart of washers

PROCESS DETAILS

I) BLANKING PROCESS: - Blanking process is the process for removing the washer from strip. It is done with help of press machine in which die punch set is employed to carry out process. The blanking process removes the washer from strip by cutting the OD and piercing process cuts the ID. Forming process gives the required shape to the washer. This all three process are done at a time.

II) DEBURRING PROCESS: - Burrs are sharp edges resulting from cutting and stamping operations. Although usually small in size, burrs can cause assembly problems, interfere with fluid flow, and are a common cause of worker injury. Burrs can also cause increased stresses and subsequent fatigue failure of the part. Burr removal, or "deburring," is a standard practice associated with virtually every segment of the manufacturing process. The vast majority of deburring is performed using mechanical deburring processes, but thermal deburring and electro-chemical deburring processes are also used [2].

III) HEAT TREATMENT PROCESS*:* - Heat treatment process is done to bring the hardness in the washer. Surface hardness is required in the washer to withstand the forces and stresses upcoming on it whether in bearing or other applications. Different processes are carried out under heat treatment process like heating, quenching and press tempering. Tempering is a low temperature heat treatment process normally performed after neutral hardening, double hardening, atmospheric carburising, carbonitriding or induction hardening in order to reach a desired hardness/toughness ratio [3].

IV) POLISHING PROCESS: - Polishing is one finishing loose abrasive process, used to generate surfaces with very high tolerances in geometry, surface integrity, and roughness characteristics. It is still one of the most important finishing methods. Polishing particles remove small elements of a surface and make them smooth. This smoothness is obtained by rubbing the surface with the polishing particles with a rotating disk. Polishing is the best method today to obtain the finest surface. Polishing uses a larger number of multi point or random cutting edges for effective material removal. Abrasive finishing processes are accepted in a wide range of material applications and industries [4].

PROBLEM IDENTIFICATION

The problem identified was the bending of washer straight from blanking process. The washer was getting bend after the process. As discussed earlier at the time of punching the stress is induced in the washer thus causing it to bend. So it was necessary to control the bend from blanking process itself. The heat treatment process also induces some stresses into the washer thus causing it to bend. Various stress removal process are carried out to overcome the distortion. Other process deburring and polishing does not cause any bend. In addition to distortion the other problems observed were pitting marks and rusty surface on the surface of washers. Pitting marks are the marks which are impressed on washer surface due to material removal because of rust.

Bend washer is straightly rejected for using in bearings. This is also Cause Company more loss as single washer is also costly. To avoid this loss reducing the distortion was necessary.

Other than the above mentioned problems, the bend washer which are sold for nut-bolt tightening purpose cannot fully tighten the bolts due to bend structure. They cannot bear the load and vibrations to ultimate level thus cause vibrations and related problems.

Problems occurring due to use of bend washer in bearings:-

1. Bearing will generate noise while working.
2. There will be rotation problem. Bearing will not rotate properly and thus will cause vibrations.
3. There will be irregular contact between bearing and surface.
4. Needle and washer will not get in regular contact.
5. There will be increased gap between washer and cage.
6. Bearing will not rest parallel to the surface.
7. Needle and cage will get damaged.
8. Ultimately, the life of bearing will be reduced.

Fig 3:- Parts of thrust bearing

PROBLEM SOLVING

The setup of machine is such like there is a strip holder and then flattener or straightner and then the press machine. The changes that we made are in the flattener. The main function of flattener or straightner is to flatten the strip so as to reduce the bend from strip. The flattener contains multiple rollers within it which presses the strip while rolling. The rollers are both upside and downside and the strip moves within them. The pressure of rollers is controlled by tightening the bolts which are available on the top of machine. On the amount of tightening of bolts the rollers press the strip and results in straightening of strips.

We made the changes in the pressure of flattener as to reduce the bend from the strip. The pressure is not indicated on the machine on any dial. It is just controlled. The changes made in pressure are shown by the amount of tightening of bolts. The initial stage and final stage of the position of bolts are shown in the drawing below. The lengths of bolts before tightening and after tightening are indicated.

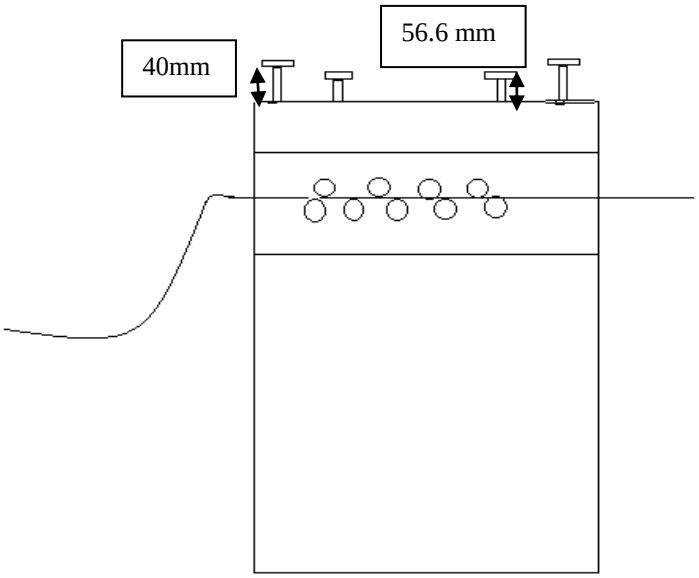

Fig 4:- height of bolts before tightening or initial position of bolts

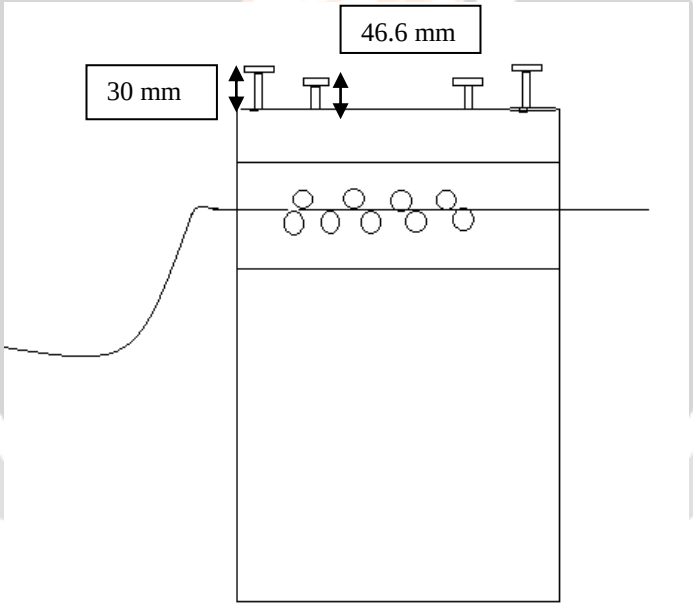

Fig 5:- length of bolts after tightening or post tightening position of bolts

After the above shown changes were made, the distortion from soft area was fully eliminated. The bend in the washer was removed to great extent. The bend was checked by passing the washers through a go/no-go bridge. The conditions for checking was that the washers must pass through bridge very smoothly and after the changes were made in flattener the observation seen were up to the expectations.

The next step taken to reduce the distortion was that pressing the washers on 20 ton press in soft stage itself. A batch of 500 washers was pressed under the 20 ton press and the result we got was that the bend was reduced up to 50 to 70 microns. The washers were pressed one by one under specific pressure and dual time and the bend was reduced up to great extent.

The readings of washer before and after pressing

Table 1:- Before press readings of washer

SR. NO.	BEND (IN μ)
1	90
2	100
3	40
4	110
5	60
6	30
7	90
8	60
9	40
10	40

Table 2:- Post pressing readings of washer

SR. NO.	BEND (IN μ)
1	50
2	84
3	50
4	20
5	22
6	20
7	24
8	30
9	20
10	28

Another way of reducing the distortion in washer is by treating the punch-die set with cryogenic treatment. Cryogenics is the study and use of materials at very low temperature. The National Institute of Standards and Technology has suggested that the term cryogenics be applied to all temperatures below -150° C (-238° F or 123° above absolute zero on the Kelvin scale). Cryogenic temperatures are achieved either by the rapid evaporation of volatile liquids or by the expansion of gases confined initially at pressures of 150 to 200 atmospheres Cryogenic treatment of tooling steels is a proven technology to increase wear resistance and extend intervals between component replacements for blades, bits, and machining mills.[13]

The idea of cryogenic treatment came as to improve the life of die punch set. In many cases due to wrong setting of die and punch it may break the die and may cost to great extent. After treating it with cryogenic treatment it gets hardened and its life increases by 10 times. It also reduces the burr creation on the washer. Cryogenic treatment of tooling steels is a proven technology to increase wear resistance and extend intervals between component replacements for dies, punches, drill bits, end mill cutters, bearings, cams, crankshafts, blocks, pistons, blades etc. Controlled Cryogenic Process is commonly appended in-between conventional

hardening and tempering treatments for tool/die steels. The execution of the deep cryogenic treatment on quenched and tempered high speed steel tools increases hardness, reduces tool consumption and down time for the equipment set up, thus leading to cost reductions of about 50%.[14]

Benefits of Cryogenic Treatment on Punch –Die Set:-

Researcher has shown many benefits, following are the main benefits of cryogenically treated material:

1. Significantly enhances abrasive wear resistance.
2. Improves corrosion resistance.
3. Increases dimensional stability before extensive machining.
4. This process is irreversible, with beneficial properties retained even after resurfacing.
5. Closes and refines metal grain structures.
6. Transforms retained austenite into the harder, more desirable martensite.
7. Reduces retained stresses, as well as wear and surface stresses.
8. Cuts operating costs and downtime by reducing the need for tool replacement or regrinding and maintenance.
9. Effective for items ranging in size from tiny drills to dies weighing hundreds of pounds.

As the process is costly and time consuming. Only those companies can carry it who has sub-zero furnace in their plant. Otherwise you have to pay to other laboratories who carry out this process. Also it has to be carried out with great care and precision. The temperature under which process has to be carried out is very difficult to maintain.

CONCLUSION

As per the above readings and the techniques applied the conclusion came as these techniques used worked efficiently and controlled the distortion of washer to great extent. These techniques were applied on two to three sizes and types of washer and results came were extremely satisfying.

These techniques were very low time consuming and did not stopped work while taking trials. Also these techniques were cost efficient.

REFERENCES

1. http://www.businessdictionary.com/definition/distortion.html
2. https://www.google.com/patents/US3623278
3. DEBURRING PROCESS Filed Dec. 3, 1969 INVENTOR HERMAN J. SCHWARTZ ATTORNEY United States Patent O DEBURRING PROCESS Herman J. Schwartz, Chicago, Ill., assignor to Teletype Corporation, Skokie, Il]. Filet! Dec. 3, 1969, 5er. No. 881,799 Int. Cl. B24b 1/00 U.S. Cl. 51-317
4. http://www.bodycote.com/en/services/heat-treatment/harden-and-temper/tempering.aspx
5. http://www.eng.utoledo.edu/pmmc/polishing.pdf
6. Sameet Dandawate, Laukik P. Raut, “Implementing ‘5-S Methodology’ as Tool for Improving Efficiency & Performance of Delivery and Production Operations at Bajaj Steels”, IJSRD - International Journal for Scientific Research & Development| Vol. 3, Issue 03, 2015 | ISSN (online): 2321-0613

7. Rajat P. Kale, Laukik P. Raut, "Kaizen & Its Applications – A Japanese Terminology Referred to Continuous Improvement", IJSRD - International Journal for Scientific Research & Development| Vol. 3, Issue 02, 2015 | ISSN (online): 2321-0613
8. Rajat B. Wakode, Laukik P. Raut," Overview on Kanban Methodology and its Implementation", IJSRD - International Journal for Scientific Research & Development| Vol. 3, Issue 02, 2015 | ISSN (online): 2321-0613
9. Pratik P. Kulkarni, Laukik P. Raut, "Just In Time Manufacturing: A conceptual survey & IT's Application in 'Bajaj Steels Ltd.' Nagpur", International Journal of Research in Advent Technology, Vol.3, No.2, February 2015 E-ISSN: 2321-9637
10. https://www.americanbearings.org/?page=what_are_bearings
11. https://www.boltdepot.com/Washers.aspx
12. http://www.skf.com/us/products/bearings-units-housings/roller-bearings/needle-roller-thrust-bearings/bearing-washers/index.html?designation=GS%2089438