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Study and Implementation to Reduce the Internal Failures in Power Steering Valve

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Abstract: Nowadays, automobile industries are playing a vital role in all over the world. The economic recession has an impact on automobile industry which affects the domestic and global auto ancillary components. This has created pressure on manufacturing units to improve the productivity, quality i.e., reducing seven wastes (MUDA). Rane TRW is one of the quality conscious auto ancillary manufacturing groups with ever ending target to produce products with good quality and low cost. This forces to improve the production rate with the above target by adapting the modern technologies. Considering these aspects the researcher is trying and suggesting the division of production line which is producing Valve in Valve Plant. By improving the quality and to reduce the internal failure cost and machining time in production of valves Quality Circle (QC) method is used in power steering valve.

Key words: Auto ancillary components · MUDA · Quality Circle

INTRODUCTION

In recent days, power steering is mostly used to drive the vehicle easy and more comfortable with low effort. Power steering helps the drivers to steer vehicles by augmenting steering effort of the steering wheel. Hydraulic or electric actuators add controlled energy to the steering mechanism, so the driver needs to provide only modest effort regardless of conditions. Power steering helps considerably when a vehicle is stopped or moving slowly.

In power steering, valve is one of the main part of the steering. Valve is used to flow the hydraulic oil very easily to drive the steering at certain pressure and temperature.

In India, valve is manufacturing by three Automobile companies (Rane TRW, Sona and ZF). Rane TRW is one of the leading valve manufacturing company which they are giving high profit than other companies i.e., 60,000 valves is producing every month.

Introduction to Rane Trw Steering Systems Ltd: Rane TRW steering systems ltd., is established in 1988 in collaboration with TRW U.S.A. Rane TRW steering systems ltd., is manufacturing power steering gear, power steering valve and power steering pump for automobile assembly line.

According to manual steering is concerned, steering effort is achieved through gears only. Already Driver is to concentrate on clutch, brake and accelerator. So it is difficult for the driver to drive the vehicle as additional effort is to be given to steer the vehicle in manual steering vehicles. Power steering is one which gives easy steering effect which is affected by hydraulic fluid. The hydraulic is pumped by power steering pump and controlled by rotary valv [1].

Rane Trw supplying power steering valves to the companies that are Indica Vista , Indigo, Indica V2, Winger, Ace Aria, Safari, Sumo, Grande, Xenon, Xylo, Bolero, Santro, Figo, Fiesta, Ikon, Docia Duster, Logon, Sports Car, Corsa, City, Rhino, Palio.

Introduction to Power Steering

Purpose of Steering System: The purpose of steering system in automobile vehicle is to direct the vehicle in desired direction.

Working of Turning of Wheel: In an automobile vehicle Front wheels are mounted on stub axle and stub axle is mounted on front axle with king pin. When the vehicle is steered the drop arm fitted to the steering gear will rotate. As drag link connected to the drop arm it will move. Further king pin arm which is connected to the drag link

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will rotate which will enhance the front wheel to rotate about king pin axis so that vehicle will turn in the desired direction.

Power steering system component:

- Reservoir (or) Oil tank
- Hydraulic power steering pump.
- Fully integral power steering gear.
- Hoses &pipes.

Components of Power Steering Valve

Input Shaft: Input Shaft is one part of the power steering valve. It is the main part to flow. It acts as a cam. It is to control the direction of hydraulic oil and to turn the wheel by using rack and pinion shaft [2].

Torsion Bar: The torsion bar is a thin rod of metal that twists when torque is applied to it. The amount of torque in the torsion bar is equal to the amount of torque the driver is using to turn the wheel.

Valve Sleeve: It is connected with input shaft and used to control the direction of hydraulic oil and turn the wheel by using rack and pinion shaft.

Pinion Shaft: It is also one part of the power steering. It is used to transmit the rotating motion into linear motion.

Operation

Grade Matching Operation: In this operation checking oil flow grade and leak of input shaft & valve sleeve. Its indicate only in grade format.

Bell Matching Grade Range:

Grade	Range
Low	-100 to above 100
Pink	-70 to -99
Blue	-30 to -70
Green	-30 to 30
Amber	30 to 70
White	70 to 99
High	100 and above

Air Leak: After assembly of the valve, check air leak in the valve. It indicates vacuum, low, high.

Balancing Operation: It is the process of rotating the valve by setting and clamping it in neutral position.

Testing: It is the process of checking following factors either by Clock Wise & Counter clock wise:

- Hysteresis test
- Valve characteristic test
- Leak test
- Internal Leak
- Torque Test

Project Work

Cause and Effect Diagram for Rejection the Rejection of Valve Based on Torque

Identification

How to Approach this Problem?: In this Problem have two types of rejection one is Low torque another one is High torque. The Low torque is occur when small gap between input shaft and valve sleeve (or) when small pocket width of the input shaft and valve sleeve. The High torque is occur when high gap between input shaft and valve sleeve (or) when high pocket width of input shaft and valve sleeve.

But this problem result can change when oil temperature and oil flow of machine. i.e., the result of the valve is change when oil temperature and oil flow of the machine. The oil temperature and oil flow are more affect in border limit grade.

Method Based Rejection: Initially check the correlation between bel matching and testing machine but it's not coincides at different temperature (or) oil flow in bel matching and testing machine. i.e., the oil temperature and oil flow of the bel matching should be equal to oil temperature and oil flow of the testing machine otherwise does not coincides.

Machine Based Rejection: Valves are test in seven testing Machines (Ventura-1, Ventura-2, Ventura-3, Valtek-1, Valtek-2, Twins and Broens). Check all Testing Machines coincides or not by checking manual oil temperature readings in different testing machine. From this data all machines are working as correct or not [3].

By the collecting information, Ventura-3 Testing machine has master value of oil temperature is vary from actual reading. The machine has master value is 43°C till after 15 minutes. So take more accurate machine ventura-2 for checking oil temperature and flow parameters.

In Ventura-2 Testing Machine oil temperature not maintain constant level i.e., Machine was runs between 50°C to 60°C. The Main Property of oil is Viscosity, flash point and fire point. The Viscosity can change by change in oil temperature. So its affect flow parameters. i.e., when the temperature of the oil reaches 60°C, the resistance of flow is high so it affects flow. When the temperature of the oil reaches 50°C, the resistance of flow is low so it affects flow. Therefore oil temperature of testing machine should be maintaining constant level by use of oil chiller machine.

In Ventura-2 Testing Machine oil flow can change manually. Each model valve has certain flow value but it's not set accurately in testing machine. The valve result is change when the flow of testing machine set not correctly. If oil flow of the machine set correctly gets correct result.

Machine Tolerance: Every Machine can be manufacture under the tolerance limit. The tolerance of the machine has varied the gap between input shaft and valve sleeve.

Tschudin 3 in 1-2(N) ± 0.002
Micrometric Grinding ±0.002
Tschudin 3 in 1-1(O) ±0.002
Valve sleeve hobbling (ID) ±0.025

Man Based Rejection: Due to employee laziness & not involvement in work missing of pre-matching. If utilize use of bell matching machine 50% Rejection can be control.

Material Based Rejection: If Pocket Width of the input shaft and valve sleeve are either high or low it will cause high torque or low torque. The Pocket width of the Valve sleeve is not vary it's only vary rare times due to fatigue stress [4].

The outer diameter of the input shaft also causes torque. By using in-process gauge the outer diameter maintain accuracy.

Inner Diameter of the valve sleeve also causes torque. This Problem occur when wear occur in brush i.e., the wear brush can remove metal low it cause low torque otherwise the new brush remove high metal from valve sleeve inner its cause high torque. Wear of the brush reduce by using abrasive brush. It makes good surface finish and low wear in brush.

Three grinding Machines are used for cam edge across flat. (TSCHUDIN 3 IN 1-2(N), TSCHUDIN 1 IN 1-1(O), Micromatic Grinding).

From the collection of data,

- TSCHUDIN 3 IN 1-2(N) is high repeatability and accuracy.
- TSCHUDIN 1 IN 1-1(O) is poor repeatability and accuracy most of the rejections occur from this machine.
- Micromatic Grinding is high repeatability and accuracy compare with TSCHUDIN 1 IN 1-1(O)

To check what are the factors affect accuracy and repeatability:

In this machine has backlash problem so only poor repeatability.

Backlash is defined as the loss of motion when the machine's axis, either rotational or linear, reverses, it can have a major influence on the precision of the component being made.

With cam lobes needing to be ground to accuracies of +/- 6 microns or better, the backlash in the machine is therefore of critical importance. The result of loose or worn components in the cross-slides-bolts, ball screws, end supports and keyways, to name but a few - a typical cross-slide lead screw might have anything between 0.003 and 0.005 in (0.076-0.127 mm) of axial play or backlash in the mechanism. And without any measures to counter it, the effect can be alarming.

In explanation, as the lead screw is rotated, one side of the screw will push the saddle nut (which is attached to the machine saddle) across the machine bed. At the completion of the stroke, as the direction of rotation reverses the lead screw must rotate through a finite angle before the opposite side of the screw can begin to move the saddle in its reverse direction.

The degree of this backlash is therefore down to the fit of the lead screw inside the saddle nut. This is true for any machine tool incorporating lead screw technology moving the tool post or grinding head in or out against a rotating work piece.

The methods that are to minimize this lead screw backlash have been used for many years. The Methods include the use of an additional anti-backlash nut on the same screw. This abuts against the opposite side of the thread to that used to move the saddle. Effectively jamming the lead screw between two nuts, this is highly effective at minimizing backlash but creates substantial and unwanted friction in the mechanism.

The approach most commonly used in all but the very latest in CNC machines, however, is the ball screw. Replacing the simple lead screw profile with one rolled or finely ground to accept ball bearings running between it and a similar thread form in the saddle nut almost totally eliminate this backlash, which is further reduced using a spring-loading mechanism. This mechanism is still used in many of the best cam grinding machines but with the high forces involved it is susceptible to wear and will need checking regularly [5].

CONCLUSION

From this research the researcher has gained knowledge on manufacturing and assembly of power steering valve. In this study, we observe that the rejection of valve in valve plant is mostly occur on the parameter torque i.e., low torque and high torque. On focusing this solutions can be found, implementing the solutions in the machines and changing the way of methods in the production will be able to control and reduce the valve rejection.

If the solutions getting standardizes, productivity of the valve may increases, direct cost such as labor cost, machine cost may reduces. By maintaining the solutions effectively, the company will attain the superior quality with low cost, low rejection and increases the productivity of the valves.

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