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4m-Analyses on the Brake Oil Filling Machine

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Abstract: My project is about brake oil filling machine, after a through analysis on the brake oil filling machine. I came up with the following results which are discussed elaborately in the following chapters. The implementation of these ideas would vastly help in overcoming the companies' problems. The use of sensor fitted torque wrenches would ensure torque and perfection of work. thus this technique would help in ensuring 100% perfection to overcome the problem of under tightening or not torque checked with ease in parts of brake lines. The preventive maintenance would sort out problems related with the brake oil filling machine. Some proper oil storage techniques followed by leading oil production companies would vastly help the company to bring down problems related with the air entering the storage drums. Proper oil storage would completely stop air interruption in the system. the implementation of the above suggestions would be a part of the company to achieve its motto of "drive defects to zero".

Key words: In parts of brake lines · Brake oil filling machine · entering the storage drums · Bring down problems related

INTRODUCTION

Hyundai Motors Limited: Established in 1967, Hyundai Motor Co. has grown into the Hyundai-Kia Automotive Group which was ranked as the world's sixth largest automaker in 2005 and includes over two dozen auto-related subsidiaries and affiliates. Employing over 68,000 people worldwide, Hyundai Motor posted US$58.1 billion in sales in 2005 (on a consolidated basis). Hyundai vehicles are sold in 193 countries through some 5000 dealerships and showrooms.

Brake Oil Filling Machine

General Description: The brake oil filling machine comprises of an evacuation system to evacuate the internal volume of the braking system into which oil is to be filled, a leak measurement system for measurement of any leakage in the component an oil filling system to fill brake oil and a control system to manage the whole process [1]. A filler adaptor/connector is fitted to the component and the cycle is started. First operation is evacuation of the internal volume of the component. After evacuation process the component is subjected to leak test. If a leak is detected then an alarm output is generated and further operation is halted otherwise the evacuation system is isolated by closing a solenoid valve and oil filling system fills the component. After a set quantity of oil fill this process stops. Then the adaptor is removed from the component and fitted to a vacuum reservoir to suck out line leftover oil to prevent oil loss and also to protect the leak measurement system [2-4].

The evacuation and leak measurement system comprises of a motor driven vacuum pump, a reservoir and Maxeff make type DP3 leak detector. The oil filling system comprises of a gear pump, a relief valve, a hydraulic piston cylinder, four numbers solenoid valves, one oil filter and two numbers proximity sensors. It also includes two numbers additional solenoid valves and a reservoir for recovery of line oil and for protection of leak detector. The controller is a Micro PLC programmed to manage the entire operation. The complete pneumatic and hydraulic circuit is as per the enclosed diagram

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Working: The brake oil filling machine does the following process.

- Vaccum test
- Leak test
- Oil filling
- Oil top up
- Complete

- The machine follows the above process as a procedure, during which the vaccum test is a process where the machine test the whole system for vaccum. The company follows a standard of maintaining a vaccum pressure of 1.1 to 1.6 torr.
- Then the machine tests the system for any leak. The leak is of two type's small leak and large leak. Normally a small leak occurs when the joints are not being torque checked and a large leak occurs when the mountings are improper.
- Then it fills the oil for the required quantity under pressure.
- This is the process in which the machine checks the oil level and top up is done if needed or else the extra amount of oil filled is sucked out and brought to the required level. Then alarm sounds which signifies the completion of the whole process. The whole process time comes around 65 seconds and the car moves to the next section.

Brake System: Normal brake system of an automobile is a hydraulic system, air assisted hydraulic system, pneumatic system or a conventional mechanical system. A Brake system in Hyundai i10 is some what different from the normal ones as it has a vaccum assisted hydraulic brake system [5-7].

The brake system consists of the following parts.

- Brake booster assembly.
- ABS- unit.
- Brake pedal.
- Oil reservoir.
- Hydraulic master cylinder.

Problems Faced by the Company: The company faces various problems during the process of brake oil filling. as a brake oil filling section comes under safety, the company ensures perfect process. The problems are as following

- Vaccum error – This is the major problem that every automobile industry comes across. Vacuum error is nothing but an error detected by the brake oil filling machine as a leak in the system. As brake oil filling machine has its own constrain to have a vaccum pressure of 1.1 to 1.6 Torr. (TORR is the unit measurement of vacuum pressure).
- Communicational error-this is the secondary problem in a brake oil filling machine where the machine has to be brought into an interface with the car. As the machine consist of a diagnostic connector which as to be properly inserted in the car HCU unit.

Failure Mode Effect Analysis:

- Customers are placing increased demands on companies for high quality, reliable products. The increasing capabilities and functionality of many products are making it more difficult for manufacturers to maintain the quality and reliability. Traditionally, reliability has been achieved through extensive testing and use of techniques such as probabilistic reliability modeling. These are techniques done in the late stages of development. The challenge is to design in quality and reliability early in the development cycle.
- Failure Modes and Effects Analysis (FMEA) is methodology for analyzing potential reliability problems early in the development cycle where it is easier to take actions to overcome these issues, thereby enhancing reliability through design. FMEA is used to identify potential failure modes, determine their effect on the operation of the product and identify actions to mitigate the failures. A crucial step is anticipating what might go wrong with a product. While anticipating every failure mode is not possible, the development team should formulate as extensive a list of potential failure modes as possible. The early and consistent use of FMEAs in the design process allows the engineer to design out failures and produce reliable, safe and customer pleasing products. FMEAs also capture historical information for use in future product improvement.

Types of FMEA's: There are several types of FMEAs, some are used much more often than others. FMEAs should always be done whenever failures would mean potential harm or injury to the user of the end item being designed. The types of FMEA are:

- System - focuses on global system functions
- Design - focuses on components and subsystems
- Process - focuses on manufacturing and assembly processes
- Service - focuses on service functions
- Software - focuses on software functions

FMEA Usage: Historically, engineers have done a good job of evaluating the functions and the form of products and processes in the design phase. They have not always done so well at designing in reliability and quality. Often the engineer uses safety factors as a way of making sure that the design will work and protected the user against product or process failure. As described in a recent article: "A large safety factor does not necessarily translate into a reliable product. Instead, it often leads to an over designed product with reliability problems." Failure Analysis Beats Murphy's Law FMEA's provide the engineer with a tool that can assist in providing reliable, safe and customer pleasing products and processes. Since FMEA help the engineer identify potential product or process failures, they can use it to:

- Develop product or process requirements that minimize the likelihood of those failures.
- Evaluate the requirements obtained from the customer or other participants in the design process to ensure that those requirements do not introduce potential failures.
- Identify design characteristics that contribute to failures and design them out of the system or at least minimize the resulting effects.
- Develop methods and procedures to develop and test the product/process to ensure that the failures have been successfully eliminated.
- Track and manage potential risks in the design. Tracking the risks contributes to the development of corporate memory and the success of future products as well.
- Ensure that any failures that could occur will not injure or seriously impact the customer of the product/process.

Benefits of FMEA: FMEA is designed to assist the engineer improve the quality and reliability of design. Properly used the FMEA provides the engineer several benefits. Among others, these benefits include:

- Improve product/process reliability and quality
- Increase customer satisfaction
- Early identification and elimination of potential product/process failure modes
- Prioritize product/process deficiencies
- Capture engineering/organization knowledge
- Emphasizes problem prevention
- Documents risk and actions taken to reduce risk
- Provide focus for improved testing and development
- Minimizes late changes and associated cost
- Catalyst for teamwork and idea exchange between functions

Brake System:

- The modern automotive brake system has been refined for over 100 years and has become extremely dependable and efficient.
- The typical brake system consists of disk brakes in front and either disk or drum brakes in the rear connected by a system of tubes and hoses that link the brake at each wheel to the master cylinder. Other systems that are connected with the brake system include the parking brakes, power brake booster and the anti-lock system.
- When you step on the brake pedal, you are actually pushing against a plunger in the master cylinder which forces hydraulic oil (brake fluid) through a series of tubes and hoses to the braking unit at each wheel. Since hydraulic fluid (or any fluid for that matter) cannot be compressed, pushing fluid through a pipe is just like pushing a steel bar through a pipe. Unlike a steel bar, however, fluid can be directed through many twists and turns on its way to its destination, arriving with the exact same motion and pressure that it started with. It is very important that the fluid is pure liquid and that there is no air bubbles in it. Air can compress which causes sponginess to the pedal and severely reduced braking efficiency. If air is suspected, then the system must be bled to remove the air. There are "bleeder screws" at each wheel cylinder and caliper for this purpose.
- On a disk brake, the fluid from the master cylinder is forced into a caliper where it presses against a piston. The piston in-turn squeezes two brake pads against the disk (rotor) which is attached to the wheel, forcing it to slow down or stop.
- This process is similar to a bicycle brake where two rubber pads rub against the wheel rim creating friction.

- With drum brakes, fluid is forced into the wheel cylinder which pushes the brake shoes out so that the friction linings are pressed against the drum which is attached to the wheel, causing the wheel to stop.
- In either case, the friction surfaces of the pads on a disk brake system or the shoes on a drum brake convert the forward motion of the vehicle into heat. Heat is what causes the friction surfaces (linings) of the pads and shoes to eventually wear out and require replacement. Let's take a closer look at each of the components in a brake system and see where other problems can occur.

Master Cylinder:

- The master cylinder is located in the engine compartment on the firewall, directly in front of the driver's seat. A typical master cylinder is actually two completely separate master cylinders in one housing, each handling two wheels. This way if one side fails, you will still be able to stop the car. The brake warning light on the dash will light if either side fails, alerting you to the problem. Master cylinders have become very reliable and rarely malfunction; however, the most common problem that they experience is an internal leak. This will cause the brake pedal to slowly sink to the floor when your foot applies steady pressure. Letting go of the pedal and immediately stepping on it again brings the pedal back to normal height.

Brake Fluid:

- Brake fluid is special oil that has specific properties. It is designed to withstand cold temperatures without thickening as well as very high temperatures without boiling. (If the brake fluid should boil, it will cause you to have a spongy pedal and the car will be hard to stop.) Brake fluid must meet standards that are set by the Department of Transportation (DOT). The current standard is DOT-3 which has a boiling point of 460º F. But check your owner's manual to see what your vehicle manufacturer recommends.
- The brake fluid reservoir is on top of the master cylinder. Most cars today have a transparent reservoir so that you can see the level without opening the cover. The brake fluid level will drop slightly as the brake pads wear. This is a normal condition and no cause for concern. If the level drops noticeably over a short period of time or goes down to about two thirds full, have your brakes checked as soon as possible. Keep the reservoir covered except for the amount of time you need to fill it and never leave a can of brake fluid uncovered. Brake fluid must maintain a very high boiling point. Exposure to air will cause the fluid to absorb moisture which will lower that boiling point. Never put anything other than approved brake fluids. Any other type of oil or other fluid will react with the brake fluid and very quickly destroy the rubber seals in the brake system causing brake failure.

Brake Lines:

- The brake fluid travels from the master cylinder to the wheels through a series of steel tubes and reinforced rubber hoses. Rubber hoses are only used in places that require flexibility, such as at the front wheels, which move up and down as well as steer. The rest of the system uses non-corrosive seamless steel tubing with special fittings at all attachment points. If a steel line requires a repair, the best procedure is to replace the complete line. If this is not practical, a line can be repaired using special splice fittings that are made for brake system repair. You must never use brass "compression" fittings or copper tubing to repair a brake system. They are dangerous and illegal.

Proportioning Valve:

- The Combination valve is simply a proportioning valve and a pressure differential valve that is combined into one unit.
- These valves are mounted between the master cylinder and the rear wheels. They are designed to adjust the pressure between the fronts and rear brakes depending on how hard you are stopping. The shorter you stop, the more of the vehicle's weight is transferred to the front wheels, in some cases, causing the rear to lift and the front to dive. These valves are designed to direct more pressure to the front and less pressure to the rear the harder you stop. This minimizes the chance of premature lockup at the rear wheels.

Pressure Differential Valve:

- This valve is usually mounted just below the master cylinder and is responsible for turning the brake warning light on when it detects a malfunction. It measures the pressure from the two sections of the

master cylinder and compares them. Since it is mounted ahead of the proportioning or equalizer valve, the two pressures it detects should be equal. If it detects a difference, it means that there is probably a brake fluid leak somewhere in the system.

Electronic Brake Force Distribution:

- Newer cars use the antilock brake hardware and the onboard computer to replace these proportioning valve systems with a system called Electronic Brake force Distribution (EBD) in order to distribute the exact amount of pressure at each wheel to insure a balanced brake system.

Disk Brakes:

- The disk brake is the best brake we have found so far. Disk brakes are used to stop everything from cars to locomotives and jumbo jets. Disk brakes wear longer, are less affected by water, are self adjusting, self cleaning, less prone to grabbing or pulling and stop better than any other system around. The main components of a disk brake are the Brake Pads, Rotor, Caliper and Caliper Support.

Brake Pads:

- There are two brake pads on each caliper. They are constructed of a metal "shoe" with the lining riveted or bonded to it. The pads are mounted in the caliper, one on each side of the rotor. Brake linings used to be made primarily of asbestos because of its heat absorbing properties and quiet operation; however, due to health risks, asbestos has been

Brake Shoes: Like the disk pads, brake shoes consist of a steel shoe with the friction material or lining riveted or bonded to it. Also like disk pads, the linings eventually wear out and must be Replaced. If the linings are allowed to wear through to the bare metal shoe, they will cause severe damage to the brake drum.

Backing Plate: The backing plate is what holds everything together. It attaches to the axle and forms a solid surface for the wheel cylinder, brake shoes and assorted hardware. It rarely causes any problems.

Brake Drum: Brake drums are made of iron and have a machined surface on the inside where the shoes make contact. Just as with disk rotors, brake drums will show signs of wear as the brake linings seat themselves against the machined surface of the drum. When new shoes are installed, the brake drum should be machined smooth. Brake drums have a maximum diameter specification that is stamped on the outside of the drum. When a drum is machined, it must never exceed that measurement. If the surface cannot be machined within that limit, the drum must be replaced.

Wheel Cylinder: The wheel cylinder consists of a cylinder that has two pistons, one on each side. Each piston has a rubber seal and a shaft that connects the piston with a brake shoe. When brake pressure is applied, the pistons are forced out pushing the shoes into contact with the drum. Wheel cylinders must be rebuilt or replaced if they show signs of leaking.

Return Springs: Return springs pull the brake shoes back to their rest position after the pressure is released from the wheel cylinder. If the springs are weak and do not return the shoes all the way, it will cause premature lining wear because the linings will remain in contact with the drum. A good technician will examine the springs during a brake job and recommend their replacement if they show signs of fatigue. On certain vehicles, the technician may recommend replacing them even if they look good as inexpensive insurance.

Self Adjusting System: The parts of a self adjusting system should be clean and move freely to insure that the brakes maintain their adjustment over the life of the linings. If the self adjusters stop working, you will notice that you will have to step down further and further on the brake pedal before you feel the brakes begin to engage. Disk brakes are self adjusting by nature and do not require any type of mechanism. When a technician performs a brake job, aside from checking the return springs, he will also clean and lubricates the self adjusting parts where necessary.

Material: The material used is also considered one of the major constrains in the analysis of brake oil filling machine. The material includes 1.oil used 2.components like brake booster, brake tube, master cylinder etc.

Oil Storage:

- Proper oil storage techniques to be followed. As improper storage can lead to accumulation of moisture (air bubbles) inside the barrel. Which leads to our major problem vaccum error? As this is fully a vacuum system proper installation of system,

storage, filling, should be carried out. As recommended by leading oil manufacturers the barrel position for the storage of oil is given below.

In this vertical position of the barrel there is a major possibility of air entering into the barrel even when it is fully loaded. {The white line indicates the gap inside the barrel even when it is fully loaded.}

- In this horizontal position when the barrel cap is closed there is a possibility of air entering the barrel.(the white line indicates the gap inside the barrel even when it is fully loaded)
- In this position when the barrel cap is at the bottom there is no possibility of air entering in, as the oil would occupy the space beneath the barrel cap. This is a standing procedure followed by oil manufacturers.

Oil Grade: The grade of oil used is of a major concern in the analysis of brake oil filling machine. Even though the oil is from a reputed company, it is better for the consumers to have a quality test on the oil. The oil specified by the manufacturer may not satisfy needs of the consumer. Thus it is good to have a test on

- Viscosity
- Lubricity,
- Heat dissipation capabilities,
- Density and other major characteristics of a good hydraulic fluid.

Hydraulic Fluids: Are a large group of fluids used as the motive medium in hydraulic machinery. Fluid types include synthetic compounds, mineral oil, water and water-based mixtures. The fluids are found in machinery and equipment ranging from brakes, power steering systems and transmissions to backhoes, excavators, garbage trucks and industrial shredders. Hydraulic systems are very common in aircraft flight control systems.

Hydraulic systems like the ones mentioned above will work most efficiently if the hydraulic fluid used has low compressibility.

Brake fluid is a subtype of hydraulic fluid with high boiling point and low freezing point. It is intentionally hygroscopic, so that it will absorb water which could otherwise cause corrosion of brake system components.

CONCLUSION

The 4m-analyses on the brake oil filling machine results us to follow the below. The ensuring of torque by applying the above technique, the preventive maintenance of the brake oil filling machine and proper oil storage techniques.

By doing the above changes in the company, the company can ensure 100% efficiency in the production field over all such constrains to produce quality cars there by ensuring safety. Thus my idea would definitely help the company to its motto of “drive defects to zero”.

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