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When a hydraulic issue occurs, the pump is one of the first components changed out, but it should be the last. A pump is one of the most time-consuming and expensive parts to replace, and it should never be changed before several tests are conducted. In this article, we'll discuss some of the simplest tests and checks to perform first before you consider part replacement. Visual Tests Before any physical tests are administered, there are several, basic visual tests that you can conduct to ascertain the state of your pump. Check that the electric motor is running. Although this is a simple concept, before you begin replacing parts, it's critical that you make sure the electric motor is running. This can often be one of the easiest aspects to overlook, but it is necessary to confirm before moving forward. Check that the pump shaft is rotating. Even though coupling guards and C-face mounts can make this difficult to confirm, it is important to establish if your pump shaft is rotating. If it isn't, this could be an indication of a more severe issue, and this should be investigated immediately. Check the oil level. This one tends to be the more obvious check, as it is often one of the only factors inspected before the pump is changed. The oil level should be three inches above the pump suction. Otherwise, a vortex can form in the reservoir, allowing air into the pump. If the oil level is low, determine where the leak is in the system. Although this can be a difficult process, it is necessary to ensure your machines are performing properly. Leaks can be difficult to find. Sound Checks What does the pump sound like when it is operating normally? Vane pumps generally are quieter than piston and gear pumps. If the pump has a high-pitched whining sound, it's most likely cavitating. If it has a knocking sound, like marbles rattling around, then aeration is the likely cause. Cavitation Cavitation is the formation and collapse of air cavities in the liquid. When the pump cannot get the total volume of oil it needs, cavitation occurs. Hydraulic oil contains approximately nine percent dissolved air. When the pump does not receive adequate oil volume at its suction port, high vacuum pressure occurs. This dissolved air is pulled out of the oil on the suction side and then collapses or implodes on the pressure side. The implosions produce a very steady, high-pitched sound. As the air bubbles collapse, the inside of the pump is damaged. While cavitation is a devastating development, with proper preventative maintenance practices and a quality monitoring system, early detection and deterrence remain attainable goals. UE Systems UltraTrak 8505 CD pump cavitation sensor is a Smart Analog Sensor designed and optimized to detect cavitation on pumps earlier by measuring the ultrasound produced as cavitation starts to develop early-onset bubbles in the pump. By continuously monitoring the impact caused by cavitation, the system provides a simple, single value to trend and alert when cavitation is occurring. 3 Reasons Why a Pump Cavitates: 1. Oil viscosity too high. 2. Low oil temperature increases the oil viscosity, making it harder for the oil to reach the pump. Most hydraulic systems should not be started with the oil any colder than 40F and should not be put under load until the oil is at least 70F. Many reservoirs do not have heaters, particularly in the South. Even when heaters are available, they are often disconnected. While the damage may not be immediate, if a pump is continually started up when the oil is too cold, the pump will fail prematurely. Figure 1 Reason Two The suction filter or strainer is contaminated. A strainer is typically 74 or 149 microns in size and is used to keep large particles out of the pump. The strainer may be located inside or outside the reservoir. Strainers located inside the reservoir are out of sight and out of mind. Many times, maintenance personnel are not even aware that there is a strainer in the reservoir. The suction strainer should be removed from the line or reservoir and cleaned a minimum of once a year. Years ago, a plant sought out help to troubleshoot a system that had already had five pumps changed within a single week. Upon closer inspection, it was discovered that the breather cap was missing, allowing dirty air to flow directly into the reservoir. A check of the hydraulic schematic showed a strainer in the suction line inside the tank. When the strainer was removed, a shop rag was found wrapped around the screen mesh. Apparently, someone had used the rag to plug the breather cap opening, and it had then fallen into the tank. Contamination can come from a variety of different sources, so it pays to be vigilant and responsible with our practices and reliability measures. Reason Three The electric motor is driving the hydraulic pump at a speed that is higher than the pumps rating. All pumps have a recommended maximum drive speed. If the speed is too high, a higher volume of oil will be needed at the suction port. Due to the size of the suction port, adequate oil cannot fill the suction cavity in the pump, resulting in cavitation. Although this rarely happens, some pumps are rated at a maximum drive speed of 1,200 revolutions per minute (RPM), while others have a maximum speed of 3,600 RPM. The drive speed should be checked any time a pump is replaced with a different brand or model. Every one of these devastating causes of cavitation threatens to cause major, irreversible damage to your equipment. Therefore, it's not only critical to have proper, proactive practices in place, but also a monitoring system that can continuously protect your valuable assets, such as UE Systems UltraTrak 8505 CD pump cavitation sensor. These sensors regularly monitor the health of your pumps and alert you immediately if cavitation symptoms are present, allowing you to take corrective action before it's too late. Figure 2. An arrow on the gear pumps housing indicates the direction of rotation. Aeration Aeration is sometimes known as pseudo cavitation because air is entering the pump suction cavity. However, the causes of aeration are entirely different than that of cavitation. While cavitation pulls air out of the oil, aeration is the result of outside air entering the pumps suction line. Several factors can cause aeration, including an air leak in the suction line. This could be in the form of a loose connection, a cracked line, or an improper fitting seal. One method of finding the leak is to squirt oil around the suction line fittings. The fluid will be momentarily drawn into the suction line, and the knocking sound inside the pump will stop for a short period of time once the airflow path is found. A bad shaft seal can also cause aeration if the system is supplied by one or more fixed displacement pumps. Oil that bypasses inside a fixed displacement pump is ported back to the suction port. If the shaft seal is worn or damaged, air can flow through the seal and into the pumps suction cavity. As mentioned previously, if the oil level is too low, oil can enter the suction line and flow into the pump. Therefore, always check the oil level with all cylinders in the retracted position. If a new pump is installed and pressure will not build, the shaft may be rotating in the wrong direction. Some gear pumps can be rotated in either direction, but most have an arrow on the housing indicating the direction of rotation, as depicted in Figure 2. Pump rotation should always be viewed from the shaft end. If the pump is rotated in the wrong direction, adequate fluid will not fill the suction port due to the pumps internal design. Figure 3. The compensator setting limits the maximum pressure at the outlet port of a variable displacement pump. Testing a Fixed Displacement Pump A fixed displacement pump delivers a constant volume of oil for a given shaft speed. A relief valve must be included downstream of the pump to limit the maximum pressure in the system. After the visual and sound checks are made, the next step is to determine whether you have a volume or pressure problem. If the pressure will not build to the desired level, isolate the pump and relief valve from the system. This can be done by closing a valve, plugging the line downstream, or blocking the relief valve. If the pressure builds when this is done, there is a component downstream of the isolation point that is bypassing. If the pressure does not build up, the pump or relief valve is bad. If the system is operating at a slower speed, a volume problem exists. Pumps wear over time, which results in less oil being delivered. While a flow meter can be installed in the pumps outlet line, this is not always practical, as the proper fittings and adapters may not be available. To determine if the pump is badly worn and bypassing, first check the current to the electric motor. If possible, this test should be made when the pump is new to establish a reference. Electric motor horsepower is relative to the hydraulic horsepower required by the system. This is shown in the following formula: electric motor horsepower (hp) = gallons per minute (GPM) x pounds per square inch (psi) x 0.00067. For example, if a 50-GPM pump is used and the maximum pressure is 1,500 psi, a 50-hp motor will be required. If the pump is delivering less oil than when it was new, the current to drive the pump will drop. A 230-volt, 50-hp motor has an average full load rating of 130 amps. If the amperage is considerably lower, the pump is most likely bypassing and should be changed. The temperature of the pump housing and suction line should also be checked. A severe increase in temperature indicates a badly worn pump. Figure 4. To isolate a fixed displacement pump and relief valve from the system, close a valve or plug the line downstream (left). If pressure builds, a component downstream of the isolation point is bypassing (right). Testing a Variable Displacement Pump The most common type of variable displacement pump is the pressure-compensating design. The compensator setting limits the maximum pressure at the pumps outlet port. The pump should be isolated as described for the fixed displacement pump. If pressure does not build up, the relief valve or pump compensator may be bad. Prior to checking either component, perform the necessary lockout procedures and verify that the pressure at the outlet port is zero psi. The relief valve and compensator can then be taken apart and checked for contamination, wear, and broken springs. If a volume problem exists in the system, perform the following tests: Check the tank line temperature of the relief valve with a temperature gun or infrared camera. The tank line should be near ambient temperature. If the line is hot, the relief valve is either stuck partially open or is set too low. Install a flow meter in the case drain line and check the flow rate. Most variable displacement pumps bypass one to three percent of the maximum pump volume through the case drain line. If the flow rate reaches 10 percent, the pump should be changed. Permanently installing a flow meter in the case drain line is an excellent reliability and troubleshooting tool. Check the current on the drive motor. Ensure the compensator is 200 psi above the maximum load pressure. If set too low, the compensator spool will shift and start reducing the pump volume when the system is calling for maximum volume. Performing these recommended tests should help you make good decisions about the condition of your pumps or the cause of pump failures. If you change a pump, have a reason for changing it. Don't just do it because you have a spare one in stock. Conduct a reliability assessment on each of your hydraulic systems so when an issue occurs, you will have current pressure and temperature readings to consult. About the Author getcalc.com's Pump Hydraulic Power Calculator is an online mechanical engineering tool to calculate the power transmitted to lift the fluid, in both US customary & metric (SI) units. Pump Hydraulic Power is a measure of power required to increase & maintain the constant velocity of fluid. Formula to calculate lifting power of fluid 2 types of powers are associated with a pump: the hydraulic power and the shaft power. In order to size properly the motor of the pump, it is necessary to know the power to be transmitted to the shaft. The shaft power is dependent on the hydraulic power, the power to be transmitted to the fluid, and the efficiency of the pump which takes into account all the losses that happen when converting the shaft power to the hydraulic power. The shaft power is also called the absorbed power. The pump efficiency is given by the manufacturer, as a function of the pump capacity and can be determined from the pump characteristic. Figure 1: pump shaft and hydraulic power The hydraulic pump power calculation is done thanks to the pump flow rate, the pump head and the density of the fluid being pumped. Pump power formula is the following: P_hydraulic = Q * H * 367 In case the density is changing significantly when the fluid goes through the pump, the density at the inlet is used. Equation 1: Pump Hydraulic Power equation With Q: pump capacity in m³/h H: pump head in m: volumetric mass density in kg/l Hydraulic Power in kW The expression above is specified not in SI units but to give directly the results in kW, please pay attention to the units. How to calculate the pump shaft power? The pump shaft power is also called the absorbed power. It is the power that needs to be actually applied at the coupling / shaft to get the considered flow and head. It includes some losses and is therefore higher than the hydraulic power. P_shaft = P_hydraulic / Efficiency Equation 2: Pump Shaft Power With P_shaft = pump shaft power in kW P_hydraulic = pump hydraulic power in kW η = pump efficiency The shaft power is used to calculate the motor required for a pump. To calculate the actual electrical power, additional losses (electrical motor efficiency for instance) but also some margins to start the pump from a standstill and to consider that the circuit characteristic may not be exactly the one calculated or that the pump will age, have to be considered. Suppliers will advise a certain overdesign for the actual installed power of a pump, typically 10-50% depending on the power and the technology of the pump. For centrifugal pumps, the following coefficients are common: Shaft power in kW Coefficient to consider for installed power 50 1.1 4. Step by step example of calculation of pump power A pump has to deliver 100 m³/h of water at 2 bar g and 20c, from a tank at atmospheric pressure. The pump is connected to a pipe of same diameter DN100 at the inlet and outlet of the pump. The pump efficiency is 75%. Step 1: calculate the pump head The pump is delivering fluid at 2 bar g from a tank at atmospheric pressure. The velocity of fluid at the inlet and outlet is the same as water is considered incompressible and the temperature increase very low. H = (p2 - p1) / (ρ * g) + (v2² - v1²) / (2 * g) H = (2 - 0) * 10.2 / 0.998 = 20.44 m STEP 2: Calculate the hydraulic power The hydraulic power is calculated thanks to P = Q * H * 367 In this case Hydraulic power = 100 * 9.98 * 20.44 / 367 = 5.56 kW STEP 3: calculate the shaft power The shaft power is calculated by dividing the hydraulic power by the pump efficiency. This gives 5.56 / 0.75 = 7.4 kW STEP 4: calculate the installed power The installed power is calculated by multiplying the shaft power by the coefficient advised in paragraph 3. In this example, the power is in between 5-50 kW, which means that the installed power should be 15 to 20% higher than the shaft power This gives an installed power = 7.4 * 1.2 = 8.88 kW 5. Pump power Excel calculator Please access here the pump power Free Excel calculation tool: tool access Warning: this calculator is provided to illustrate the concepts mentioned in this webpage, it is not intended for detail design. It is not a commercial product, no guarantee is given on the results. Please consult a reputable designer for all detail design you may need. 07 Oct 2024 Tags: Calculations Concepts General User Questions hydraulic power formula for pump Popularity: Hydraulic Power Formula for Pump Calculation This calculator provides the calculation of hydraulic power for pump applications. Explanation Calculation Example: The hydraulic power formula for pump calculation is P = (Q * ρ * g * H) / η, where P is the power of the pump, Q is the flow rate, ρ is the density of the fluid, g is the acceleration due to gravity, H is the head, and η is the efficiency of the pump. Q: What is the importance of hydraulic power in pump calculations? A: Hydraulic power is important in pump calculations as it determines the amount of power required to operate the pump. This information is crucial for selecting the right pump for the application. Q: How does hydraulic power affect the efficiency of a pump? A: Hydraulic power affects the efficiency of a pump by determining the amount of power lost due to friction and other inefficiencies. A higher hydraulic power will result in a lower efficiency. Variables Symbol Name Unit P Power W Q Flow Rate m³/s Density kg/m³ g Acceleration Due to Gravity m/s² Efficiency % Calculation Expression Power Formula: The hydraulic power formula for pump calculation is P = (Q * ρ * g * H) / Calculator Calculated values Considering these as variable values: P=746.0, Q=0.0631, ρ=1000.0, g=9.81, η=80.0. the calculated value(s) are given in table below Derived Variable Value Power Formula 7.7376375000000011 H Similar Calculators Explore Calculator Apps in this article discussed about pump basic formulas with examples like pump power calculation formula, specific speed of centrifugal pump and affinity laws for centrifugal and displacement pumps. Also provided online calculator for pump power calculation Pump Efficiency and Pump Power Calculation Formulas with Examples Efficiency and Input Power of the Pump The work performed by the pump is equal to the weight of liquid pumped in Unit time multiplied by total Head in meters. However the pump capacity in M3/hr and liquid specific gravity are used rather than weight of liquid pumped for work done by the pump. The input power P of a pump is the mechanical power in kW or Watt taken by the shaft or coupling. So the input power of the pump also called Break Horse Power (BHP). Pump input BHP is the power delivered to the pump shaft and is designated as brake horsepower. so pump input power also called as pump shaft power. Pump output power is called as Water Horse Power (WHP) or Hydraulic power and it is useful work delivered by the pump, and is usually expressed by the formula Hydraulic power Ph = Flow rate X Total developed head X Density X Gravitational constant Pump Efficiency is the ratio of pump input and output power. i.e Efficiency of the pump is the ratio water horse power to break horse power. Pump Efficiency = (Pump Output / Pump Input) 100 = (Water Horse Power / Break Horse Power) 100 = (Hydraulic Power / Pump Shaft Power) 100 Pump input power calculation formula or pump shaft power calculation formula Pump Input Power = P Formula 1 Here Q = Flow rate in m³/sec H = Total developed head in meters = Density in kg/m³ g = Gravitational constant = 9.81 m/sec² = Efficiency of the pump (between 0% to 100%) Formula 2 Here Q = Flow rate in m³/hr H = Total developed head in meters = Density in kg/dm³ (1 kg/m³ = 0.001 kg/dm³) = Efficiency between 0 and Understanding hydraulic horsepower is essential for engineers and operators who work with hydraulic systems to assess the efficiency and power requirements of the machinery. By using the hydraulic flow rate and pressure, you can calculate the hydraulic horsepower, which helps to ensure that the system operates efficiently within its power limits. Historical Background The concept of hydraulic horsepower dates back to the early development of hydraulic systems, particularly in industries such as manufacturing and construction. Hydraulic systems, which use fluid under pressure to perform work, require accurate power calculations to optimize performance and prevent failures. Hydraulic horsepower (HP) is a crucial metric that helps engineers understand the power needed to move fluid through the system, ensuring that pumps and motors are correctly sized. Calculation Formula The formula to calculate hydraulic horsepower is: (Hydraulic HP) = (Flow Rate) * (Flow Rate) * (Pressure) * (1714) \ Where: Flow Rate is in gallons per minute (GPM) or liters per minute (L/min) Pressure is in pounds per square inch (PSI) or bar 1714 is a constant used to convert the units to horsepower Example Calculation If the flow rate is 100 GPM and the pressure is 1500 PSI, the hydraulic horsepower is calculated as follows: (HP) = (Flow Rate) * (Flow Rate) * (Pressure) * (1714) = 87.45 \ Importance and Usage Scenarios Hydraulic horsepower is an important value for selecting the appropriate pump or motor for a system. Knowing the required horsepower allows engineers to specify equipment that will efficiently handle the expected load without excessive wear or energy consumption. This is especially important in industries such as manufacturing, construction, agriculture, and energy. Common FAQs What is hydraulic horsepower (HP)? Hydraulic horsepower is the power required to move fluid through a hydraulic system, calculated using the flow rate and pressure. What units should I use for flow rate and pressure? Flow rate can be measured in gallons per minute (GPM) or liters per minute (L/min), and pressure can be measured in pounds per square inch (PSI) or bar. The formula will work with these units. Why is the constant 1714 used in the calculation? The constant 1714 is used to convert the product of flow rate and pressure into horsepower, as these two values alone do not directly correspond to horsepower without the constant. This calculator makes it easy for professionals to determine the hydraulic horsepower for their systems, helping them to select the right equipment and ensure optimal system performance. The formulas for calculating hydraulic and shaft power of a pump are: 1. Hydraulic Power: (HP) = (Flow Rate (GPM) * Flow Rate (GPM) * Head (ft) * Specific Gravity) / (3960 * Efficiency) 2. Shaft Power: (HP) = (Flow Rate (GPM) * Head (ft) * Specific Gravity) / (3960 * Efficiency) \ Where: Flow Rate: The volumetric flow rate of the fluid (in gallons per minute, GPM) Head: The total dynamic head of the pump (in feet) Specific Gravity: The ratio of the density of the fluid to the density of water Efficiency: The pump efficiency (in percentage) Calculation Steps Calculate the hydraulic power using the flow rate, head, and specific gravity Calculate the shaft power by dividing the hydraulic power by the efficiency Example Calculation Let's calculate the hydraulic and shaft power for a pump with the following parameters: Flow Rate: 500 GPM Head: 100 ft Specific Gravity: 1.0 Efficiency: 75% Hydraulic Power = (500 * 100 * 1.0) / (3960 * 0.75) = 16.84 HP Shaft Power = 12.63 HP Visual Representation Hydraulic Power: 12.63 HP Shaft Power: 16.84 HP Efficiency: 75% This visual shows the hydraulic and shaft power of a pump based on our example calculation.

Hydraulic pump calculation. Pump power calculation example. Hydraulic pump pressure calculation. Pump hydraulic power formula. Hydraulic pump calculation formula. Power calculation of pump.