Why Bigger is Not Always Better

Hydraulic orbital motors are common actuators found on a variety of hydraulics systems, from conveyers in factories, to wheel drives on mobile equipment. When orbital motors wear out over time their efficiency drops. The tell-tale symptoms of lost of power, speed reduction, and leaking seals manifest. The first thought is that this motor must not be large enough. When this happens the end-user will call into their hydraulic supplier with an unintentionally abstruse request, “I would like the same motor but bigger”. Frequently, these customers are asking for a replacement to an existing orbital motor with the same mounting, shaft size, and porting but with a larger displacement. They believe changing to a larger displacement is fairly easy and will fix their lack of power and speed issues. Hydraulic suppliers find after they have replaced a customer’s motor, the customer will return it with the same problem(s). As sure as the sun rises in the east and sets in the west, end-users tend to believe they thoroughly checked the rest of the hydraulic system, added new oil and changed all the filters. Immediately after the new motor is installed, it is still having the same problem. It is running even slower than before. The end-user calls the hydraulic supplier and arranges to return the motor. They want to purchase an even larger displacement motor. However, to do so, without entirely understanding the application can further lead to inadvertent complications in their system.

First, the hydraulic supplier should consider what type of problems are prompting the customer’s request for a larger motor. What is the application/function of the motor; for example: a winch, an auger, or spreader on a salt truck? Is the salt spreading motor running too slow? Is the skid steer slowing down to almost a halt when carrying a load bucket? Has the application changed from a small crab pod, to a larger crab pod increasing the power requirement for the motor driving a winch on crabber boat? Has the customer inspected other components within the hydraulic circuit to make certain the valves and pump are in good working condition and set to the correct settings? What is the available flow rate and pressure of the current system design? In most cases, the motor was sized correctly when the equipment was designed and built. Originally, the motor probably achieved its purpose without any issues and as time passed its seals began to dry, the gerollers or gerotors wore, and the internal leakage of the motor increased. The customer may have tried to buy a larger displacement motor believing this would fix their problem. If this is the case, then the customer may only need a new motor with the same specs. If the application has changed and the work required needs added power or additional speed then the hydraulic supplier will need to provide design modification advice based upon the information the customer can provide.

$$\textbf{RPM} = \frac{231 \text{ X GPM}}{\text{CID}}$$

(Cubic inch displacement)

Consider the formula for Fluid Motor Speed (above). If we assume that the system in our example, has a supply of 10 GPM and the original motor has a displacement of 6.2 in^3 then it would be running at approximately 372 RPM. By changing to the larger displacement motor, 12.2 in^3 in this case, the speed drops to 189 RPM. This is roughly half of the original speed. This application will now take twice as long to do the same amount of work. Twice the displacement reduces the RPM by half; it takes twice the fluid to make one revolution.

So, if the speed output has decreased, then what is gained by switching to the larger displacement motor? Torque! The torque produced has increased relative to the displacement size.

Torque in Inch Pounds = $\frac{\text{PSI X CID}}{6.28}$

Consider the formula for Fluid Motor Torque (above). Let us assume that our system pressure is 1000 PSI and using the original motor from our example, the 6.2 in^3 size is producing 987 inch-pounds of torque. When we change to the larger displacement of 12.2 in^3 the amount of torque produced jumps to 1942 inch-pounds of torque. While switching to the larger displacement motor caused havoc to our system speed, it has doubled the amount of torque produced.

The end-user used flawed logic and decides to return the motor they have ordered. They decide to order a replacement that is smaller than the original motor. This smaller size motor will provide the increased speed they are looking for but there is still a caveat. The increased speed is great, but now the amount of torque supplied by the motor has been reduced to the point that it struggles to do the work. Desperate for a resolution, they return the smaller motor and purchase a motor that is an exact replacement (mount, shaft, displacement and porting) of the original. The replacement motor works better than the original worn out motor. The speed is on track for the application and there is enough torque. This one is just right.

The example is based on many real-life conversations. Does this mean that we cannot change the size of a hydraulic motor? Of course not, motors are upsized, downsized and replaced with different variations every day. Choosing a larger or smaller motor will not always give you better results. There was thought and engineering that went into the selection of the original motor. Most displacement size changes are small; a few cc which is not noticeable to the performance of the motor. Changes involving large amounts of displacement require a closer examination of the overall system before implementing. If you are in doubt, contact your hydraulic supplier, they are more than happy to discuss your application with you.

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