

CRANE

PUMPS & SYSTEMS

BARNES[®]

SH Series

TECH NOTES

#4

Oil-Filled versus Air-Filled Motors

The benefits of Oil-filled versus Air-filled motors have been debated for decades. Most Consulting Engineers recognize that both approaches work and do not specify that level of motor specification unless using a pump manufacturer's proprietary spec. It's interesting that, in the evolution of submersible pump design, most European manufacturers have utilized air-filled motors, while most US manufacturers have chosen oil-filled motors. And one European manufacturer normally uses air-filled motors but offers oil-filled motors as an option for higher loads!

Let's review the differences:

- Oil-filled motor bearings are lubricated by the dielectric oil; air-filled motors use permanently sealed grease-lubricated bearings.
- Oil-filled motors ease the impact of winding hot-spots by more effectively dissipating the heat than air-filled motors.
- Oil-filled motors, due to improved cooling, provide greater output power, or service factor, than air-filled motors using the same stator winding.
- Since air is lower viscosity than oil, rotors in oil-filled motors experience higher friction loss, a factor in very large motors.

For the range of motors being made available for the SH Solids Handling Pumps, we believe the first three items above far outweigh the fourth, especially with regard to bearing lubrication.

In an Application Handbook published by bearing manufacturer SKF titled, "Bearings in Centrifugal Pumps", they state that, with regard to grease lubricated bearings, "The re-greasing interval is reduced in half if the shaft orientation is vertical." Since the bearings in an air-filled motor are permanently sealed and mounted in a vertical configuration, the conclusion is that those bearings have half the life of oil-lubed bearings mounted on a horizontal shaft.

The reason is that, when oil in the grease separates from its binder in a horizontally mounted bearing, much of the oil is retained in the raceway, but the oil leaks out when the bearing is mounted vertically as in a submersible pump. Indeed, we have heard from a number of repair shops of a small puddle of oil being discovered in the bottom of the motor housing when an air-filled pump is being repaired due to bearing failure.

Compare that to an oil-filled pump, where the same oil that cools the motor surrounds the bearings and provides a continuous lubrication of nearly ideal viscosity.

SH Series Bearing Life

While we are on the subject of bearing life, the SH Series pumps are designed for a life of 50,000 hours at minimum flow. Minimum flow is defined as 2 ft/sec at the discharge, which is the minimum recommended velocity to be able to move solids in a full horizontal pipe; 80 GPM in a 4" pump. This contrasts with some manufacturers who claim 50,000 hours without specifying minimum or maximum flows. But the actual minimum flow in a lift station installation will be higher, depending on the size of the vertical riser pipe, in order to achieve the necessary 3-5 fps of fluid velocity needed to move solids up the riser and through the check valves.

The leading Submersible Non-Clog pump manufacturer states their bearings are rated for 50,000 hours and are, "...as trouble-free as a bolt." Their Installation & Operation Manual, on the other hand, states: "The time between Major Service (they define this as including bearing replacement) could vary considerably depending on operating conditions ... a minimum of 20,000 hours could be anticipated."

The issue is one of allowable radial thrust, the force acting against the impeller as a result of operating away from the pump's Best Efficiency Point, BEP. Radial thrust, which is at its highest value at zero flow (also known as shut-off), is what loads the bearings and causes the shaft deflection that shortens mechanical seal life. One can easily claim high bearing life assuming operation near the BEP of the pump but in reality the operating point in a lift station varies continually as the liquid level changes.

The Barnes SH bearing rating is calculated per ISO 281. The old way of calculating bearing life, B-10, only compares the maximum speed and load capacity of the bearing with the intended maximum load and speed of the specific application. ISO 281 uses this calculation plus it also considers lubricant viscosity, operating temperature and cleanliness in the ultimate rating. ISO 281 is a much better way of evaluating bearing life.

