Air Filled vs. Oil Filled Motors in Submersible Pumps
Submitted by Dan Porter

Long, trouble free life is an important consideration in specifying and installing a submersible pump system. The most important pump component is the motor. There are two types of motors: air filled and oil filled. Pump manufacturers have developed oil filled motors in an effort to reduce costs. Here are a few reasons the air filled motor is superior to the oil filled motor.

- **Service Factor Rating**
  Due to the fact the pump is submerged in water, manufacturers of oil filled motors use fewer copper windings than would be considered acceptable for a given horsepower rating. In order to compensate, the motor cavity is filled with oil to aid cooling. This allows the motor to run in a condition where the service factor can be as high as 1.8. Compared to typical motor service factors of 1.15 or 1.2. Thus, they draw more amps than one would expect.

- **Higher Efficiency**
  1. The oil filled motor has a significant hydraulic drag resulting from the rotor spinning in an oil bath. The extra power required to spin in oil can be likened to walking in water compared to air.
  2. The hydraulic drag requires the gap between the rotor and the stator to be larger in an oil filled motor. Because the motor operating principle is based on the magnetic field generated between the rotor and stator, a larger gap automatically results in lower efficiency.

- **Lower Efficiency**
  Lower Efficiency generates more heat. Oil acts as a layer of insulation, retarding the dissipation of heat. These factors result in a higher winding temperature and in turn a shorter winding & motor life.

- **Class F vs Class B Insulation**
  Most oil filled motor windings only have Class B insulation. Class B insulation is rated at 130C. Class F insulation temperature is rated at 155C. Oil filled motors run hotter than air filled motors, yet many have a lower maximum allowed operating temperature than air filled motors. Weil submersible pumps all have air filled motors & Class F insulation, as standard. This is why an oil filled motor is not rated for “continuous” operation.

- **Longer Bearing Life Means Longer Motor Life**
  Air filled motors have longer bearing life than oil filled motors. The metal surfaces in the bearing (the balls and raceways) must not come in contact with each other while running. To prevent contact, a lubricant is used to maintain a film between the two surfaces. The higher viscosity grease used in the sealed bearings in air filled motors will maintain the lubricant layer between the surfaces better than the thin, lower viscosity, dielectric transformer oil used in the oil filled motors. Usually the transformer oil does an acceptable job of lubrication at lower temperatures, but becomes marginal as the bearing temperature approaches 100C. Many motors operate near 100C. Lubrication and cleanliness is critical in assuring long bearing life. The air filled motor design maintains a clean lubricant as the bearings are sealed. The bearings used in the oil filled motor design are open, potentially allowing the contaminated circulating oil to pass through the bearings and between the bearing surfaces resulting in failure. In addition, an oil leak will result in premature motor failure. The upper bearing will fail immediately after the oil drops below the bearing. The oil filled motor design relies on the oil to dissipate heat. As the oil level drops, the motor will overheat. When the motor cycles, the hot oil does not cool quickly. The continuing contact of the hot oil with the windings keeps the windings hot and the purpose of cooling is now reversed. This expedites the deterioration of the coating on the wires of the windings.

- **Lower Maintenance Costs**
  Maintenance on air filled motors is easier than an oil filled motors. In an oil motor, the oil must be drained and properly disposed of, it may not be discharged into the sewer. After reassembly, the oil filled motor must be thoroughly cleaned, including all interior components to eliminate potential contamination. Oil filled motors should require monitoring to assure the proper oil level is always maintained.

The bottom line is air filled motors on submersible pumps offer far fewer potential concerns for the specifying Engineer or the Installing Contractor. Is your project “Worth Weil”? Contact B.J. Mulcahy Co. for all your submersible AND vertical sump and sewage pump needs.
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