SUBMERSIBLE MOTOR ENGINEERING

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GENERAL INFORMATION ON SUBMERSIBLE ELECTRIC MOTORS

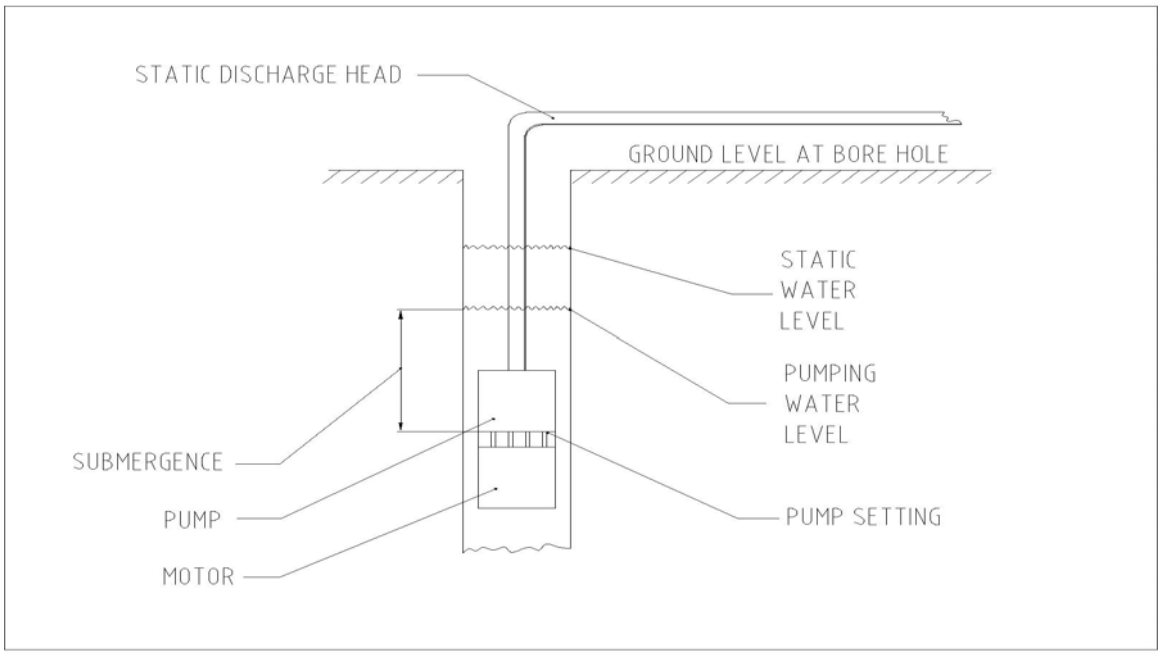
Submersible electric motors are generally long and thin and designed to operate in a borehole coupled to a submersible multistage pump. In recent years the motors have been used in a number of different applications.

Typical applications are:

- Submersible pumps for water supply – drinking water and industrial water.
- Booster pumps for high rise buildings.
- Mine dewatering.
- Dewatering for Civil Engineering Projects.
- Irrigation.
- Fire fighting and sprinkler systems.
- Air conditioning systems.
- Offshore oil rigs – sea water lift pumps for re-injection and cooling, ballast pumps, and fire pumps.
- Water treatment plants.
- Fountains.

These motors, with multistage pumps attached, are designed to be lowered into a small diameter borehole to pump ground water. Typical bore holes have 4”, 6”, 8”, 10”, 12” and 14” internal diameters usually this is a steel or plastic pipe which is pushed into a hole after it is drilled to form the well liner or well casing.

The motors are actually smaller than their dimensional name implies. The Inch dimension actually refers to the ID of the hole not the motor diameter. The motors need to be smaller than the hole to allow water to pass between the motor and the well liner and into the pump.



There are three different types of submersible motor:-

Canned Type

Water filled Type

Oil filled Type

Comparison of Features

Type of Motor	Type of Winding	Rewind-able	Size	Reliability	Acceptable for pumping drinking water	Temp Rating of the Winding	Ambient Temp of Water being pumped
Canned Or Encapsul-ated	Normal Enamel Wire – PEI2	No	4” 6” 8”	Good	Yes	90ºc Max	35 deg.C.
Water Filled	PVC Covered or PE / nylon	Yes	6” 8” 10” 12” 14” 16” 18” 22” 26”	Good	Yes	90ºc Max	35 deg.C.
Oil Filled	Normal Enamel wire	Yes	4” to 16”	Not so Good	Probably not	120º Max	35 deg.C.

These parameters will vary between different manufactures.

Note: Oil filled motors can be filled with a Vegetable oil, which is safe for human consumption, however most water Authorities do not want to take the risk of consumers complaining of oil in their water, which could happen if and when the oil leaks from the motor.

Costs vs Reliability

Canned type motors are slightly more expensive than oil filled or water filled motors. Oil filled motors in the smaller sizes are less expensive than water filled motors.

Canned and water filled motors tend to be more reliable than the oil filled motors, because of the complexity of ensuring that the oil can expand and contract without escaping from the motor.

Cooling and Good Water Flow

These motors rely on good water flow past the motor. Water flow velocity must be between 0.5 ft/sec. to 10 ft/sec. (15cm/sec to 300 cm/sec). If the flow is less than this the motors will probably overheat and burn out. Surprisingly if the flow is more than this, motors will also overheat because the high velocity does not allow efficient heat transfer from the motor to the water.

These motors are designed for high power outputs in small sizes in comparison with normal air cooled motors. Because water is a very efficient cooling medium, compared with air, the current density in the stator winding is much higher than an air cooled motor. This is acceptable provided the external body of the motor is efficiently cooled be the external water. If there is no external water flow or if the external water ambient temperature is too high the motor will overheat. If the internal water reaches boiling point it will form steam which will force a way out of the motor past the seals. If enough steam escapes the top bearing will run dry and fail, or the winding wire will melt and cause a catastrophic failure in the winding.

Oil also a reasonable conductor for heat compared to air but not as good as water.

Oil cooled motors are more tolerant to overheating, but in general the oils used in these motors can only operate up to 90ºC before they start to carburize and degenerate – the oil turns black and has a burnt smell when the motor is opened.

Oil cooled motors have to be designed to allow the oil to expand as it heats up. Typically the internal oil will expand by at least 10% and the bellows have to be able to expand to accommodate this as the motor heats up and contract again when the motor cools down.

Water does not expand very much as it heats up so it is easier to design the bellows to allow for the expansion and contraction. Internal water will probably escape from the motor and / or external water will enter the motor eventually, however this should not be a problem for the water cooled motor unless sand or foreign matter manages to enter the motor, as this will probably lead to increased wear on the bearings and eventual mechanical failure.