Used in suction dredgers for dredging navigable channels or sand quarries

What Matters When it Comes to Submersible Motors

Image 1) Suction dredger removing sediment from the riverbed. Image: ©Shutterstock.com/Nordroden

The manufacture of specialised motors is a broad field – one type that BEN Buchele frequently produces is the submersible motor, which is used to power pumps on suction dredgers, for example. In this article, the electric motor specialist explains what matters most when designing submersible motors.

Whether for dredging the navigable channel of the Main-Danube Canal, for dredging work in canals in the Netherlands, or for the wet extraction of quartz sand at a quartz sand plant – various customer projects have required submersible motors with specific design requirements. The motors serve as drives for suction dredgers mounted on a ship's pontoon. They power an underwater pump on the lowerable suction structure, which is used to extract sediment and sand deposits so that waterways have the necessary width and depth to accommodate ship traffic – or so that quartz sand can be mined in a natural basin.

As with all electric motors, the key parameters – such as power, speed and operating mode (always S1 operation in the projects mentioned) – are first determined. However, other factors also come into play when it comes to underwater use. Since the motors operate completely submerged in water for all of the projects, specifications regarding water depth, temperature range, and immersion duration were critical. The motor's design also varies depending on whether the environment involves saltwater or freshwater – or even more aggressive liquids, such as in a submersible motor for a pump in a wastewater treatment plant. The housing, paint finish, and seals must be correspondingly resistant.

Sealing is the Be-all and End-all

The main challenge with a submersible motor lies in sealing it; the deeper the motor is used, the more reliable the seal needs to be. Absolutely no water must penetrate the interior of the motor. As a rule, protection level IP68 is assumed. For less demanding applications, IP67 would also suffice (immersion depth approx. 1 m, for an immersion duration of approx. 2 minutes); however, BEN Buchele's submersible motors are designed to IP68 for longer operations at greater depths. The motors are usually cylindrical with components that are as round as possible, as these are easier to seal. The standard terminal box at the rear of the motor is also cylindrical in shape and is secured with a particularly high number of screws to ensure a truly tight seal.

Case Study: Main-Danube Canal

Initially, cable connections were requested for the motors used to dredge the navigable channel of the Main-Danube Canal, for the connection to the pump. However, external cables are always problematic when it comes to submersible motors, as movement in the cables can create gaps, which in turn can allow water to enter. In addition, due to the required motor power – 550 kilowatts – the size and weight were enormous: a size 400 unit weighing approximately 3 tonnes. Given these dimensions, the cable diameter – and consequently the weight of the cables – would also be extremely large (cables 30 metres long were required). As this did not appear to be a viable option, the company proposed a plug-in solution as an alternative. Despite being significantly more expensive, it worked best for the customer from a logistical point of view. To this end, a plug connection was provided on the terminal box, which was fully wired so that the customer received a plug-and-play-capable, securely sealed connection solution.

Risk of Condensation Drain Holes

This dredging project also highlighted what can happen if openings are not properly sealed. Every submersible motor from BEN Buchele comes fitted with an anti-condensation heater as standard. This ensures that no moisture builds up inside the sealed compartment once the motor has been switched off – moisture that could otherwise accumulate and lead to condensation. Motors without an anti-condensation heater have condensation drain holes through which moisture can escape. Despite the presence of an anti-condensation heater, the customer insisted on additional drain holes; however, they forgot to install the sealing screws, allowing water to penetrate due to the 45-degree installation angle and rendering the motor inoperable. For this reason, the electric motor manufacturer recommends keeping openings in submersible motors to a minimum and ensuring they are sufficiently watertight.

Cable connections were requested for the quartz sand mining project, in which quartz sand is extracted via a suction pipe into a natural sedimentation basin. To prevent water from entering the motor here, strain relief was provided for the cables. This consisted of a bracket that initially guided the first 30 cm of the cables rigidly, so that they could not bend around the seal and screw connection and thus create a gap. Notably, the motor was significantly smaller than in the Main-Danube project and therefore required smaller and lighter cables.

The selection of cable quality is also important – depending on the immersion depth and duration, special submersible cables with robust insulation must be used so that the cables do not become saturated with water even during continuous underwater operation. When choosing a cable, the depth of immersion and therefore the water pressure are the primary factors.

Water Detector as a Safety Feature

A simple yet effective component that the electric motor specialist includes in all projects is a water detector that signals water ingress despite all precautions taken. In itself, it isn’t a highly technical system, but rather a two-bolt terminal block that is connected to the bearing shield on the drive side at the lowest point of the motor – depending on the installation position. If water accumulates between the two bolts, a contact is made, triggering, for example, an audible alarm, a warning light, or an emergency stop.

Logistical Challenges

Image 2) Logistical challenge: Extra-large machines had to be purchased to manufacture the three-tonne motors, and as there was no suitable immersion tank, the leak test was carried out using leak detection spray. Image: ©BEN Buchele Elektromotorenwerke GmbH

The challenging aspect of many submersible motor projects is not so much the design, the special requirements regarding connections and cables, or the sealing, but rather the logistics involved. A size-400 motor weighing three tonnes is not exactly easy to manoeuvre. This starts with the manufacture of certain large steel components, for which extra-large machines need to be purchased in certain cases. Transporting the motors was also a challenge – the weight was too much for the building's lift to handle, so the motors had to be manufactured entirely on the ground floor and all stages of the process had to be moved there. In addition, there was no immersion tank in the required size available for the necessary leak test. Normally, motors are suspended in an immersion tank, pressurised from the outside in, and then monitored to see if any air bubbles escape. Instead, the oversized submersible motors were suspended in the courtyard, pressurised with compressed air and then sprayed with a leak detection spray. Any bubbles that formed in these areas would also indicate a leak – however, the motors passed the leak test with flying colours.

No Detail Left Untouched

As with all custom motor manufacturing, it is important to define all specifications early on. Typical design-specific parameters, such as power or speed, water depth, and temperatures (South Seas or Arctic), are common, but even seemingly minor details like the selection of connections matter. If cables can be used, is a plug connection more flexible? Does the plug-and-play option justify the higher investment costs? Together with its customers, BEN Buchele takes a holistic view of the entire application and also provides advice on the finer details in order to avoid additional costs arising from subsequent modifications.