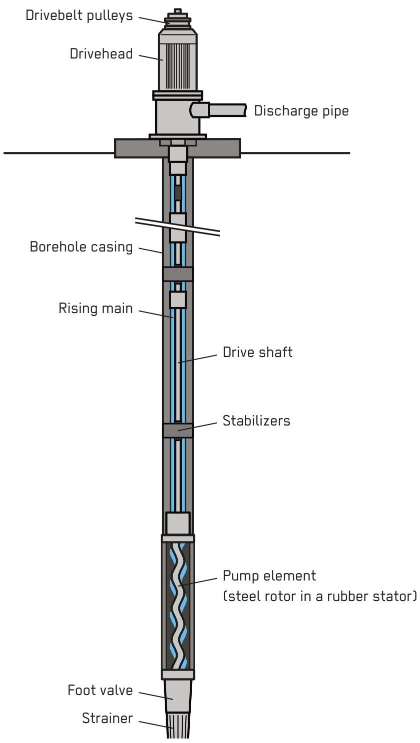
# Deep Well Progressive Cavity Pump

| Response Phase | Application Level | Management Level | Objectives / Key Features |
|---|---|---|---|
| * Acute Response<br>** Stabilisation<br>** Recovery | * Household<br>** Neighbourhood<br>City | * Household<br>** Shared<br>** Public | Positive displacement pump, shallow to deep lift pump, water column lifted with mechanical assistance |
| **Local Availability** | **Technical Complexity** | **Maturity Level** | |
| ** Medium | *** High | *** High | |




A Deep Well Progressive Cavity Pump is a positive displacement pump that displaces a fixed amount of water per cycle. Water is lifted from depths of up to 300 metres using a helical rotor rather than a reciprocating piston. These pumps are useful for all phases of an emergency.

Most Deep Well Progressive Cavity Pumps are mechanised, though handpump versions also exist. They function using rotary rather than reciprocating action. Different drive mechanisms exist that can be powered by hand, electricity (grid or solar) or diesel/petrol engines. In the past, the drive mechanism was situated at ground level and connected to a drive shaft (either through a V-belt or a geared drive head), but nowadays an electric motor is close-coupled to a short section of flexible drive shaft within the borehole. In both, the drive shaft connects to a single helix metal rotor that is in constant contact with and rotates within a double helix rubber stator.

**Design Considerations:** Deep Well Progressive Cavity Pumps can operate over a range of depths up to 300 metres, with flow rates up to 50,000 L/hour at low heads. In general, they are the pump of choice for higher head and lower flow requirements. They operate through the rotation of a helical rotor, which is shaped as a single helix that sits within a stationary double-helix rubber stator. Water occupies the cavity between the two, and when the rotor turns, this cavity moves ('progresses') upwards together with the water (hence the name of the pump), causing the water to be lifted in the rising main. This rotary design does not need a system of non-return valves, as is the case with reciprocating pumps, but a foot valve is still usually installed under the rotor to prevent backflow. The advantage of mechanised positive displacement pumps (of which progressive cavity is the main type) is that water flow does not vary significantly with differences in head. There are a few different considerations for operating this type of pump. These pumps can be set up in parallel, with both pumping into a pipe **(see A.8)**. Where the drive mechanism is at ground level with a vertical drive shaft in a borehole, the borehole also needs to be vertical to allow the drive shaft to hang vertically. Also the pumps should never be operated against a closed valve, as this can damage the pump and fittings. Progressive Cavity Pumps also exist as suction pumps (rather than only deep well), and in this case there is a maximum height to which water can rise in a pipe depending on atmospheric pressure, which itself varies with altitude **(see A.2)**. Another design consideration for motorised suction pumps is to ensure that enough pressure is maintained at the suction port to prevent cavitation. This is where air bubbles form in the water under low pressure, which then collapse, triggering shockwaves that can cause significant damage to the pump. To prevent this, the Net Positive Suction Head (NPSH) needs to be calculated using atmospheric pressure at the pump site, NPSH data from the pump manufacturer, friction loss in the inlet pipe and vapour pressure.

**Materials:** Materials needed include the rising main, drive shaft (stainless steel), motor, a helical rotor (usually chromium plated steel), a stator (rubber) and foot valve. This type of pump is produced at a few production sites in a few countries and exported.

**Applicability:** Deep Well Progressive Cavity Pumps can be a good choice for emergencies, when detailed pumping design is not usually possible in advance (compared to velocity pumps where good design is usually required). This means one choice of pump will serve different heads without too much variation in flow rate. These pumps are also more suitable for pumping water with solids or abrasive particles compared to other common types of borehole pump (e.g. velocity pumps) and are used for both drinking and non-drinking water applications. Even so, borehole pumps still need to be sized and positioned correctly to prevent excessive velocity across a screen (which pulls in more particles, **see I.8**).

**Operation and Maintenance:** Deep Well Progressive Cavity Pumps have a simple mechanical design, which makes them generally more reliable and easier to maintain than other mechanised pumps. When the drive mechanism was at ground level in older designs, everything was easily accessible so maintenance was more straightforward, but issues with constant pump vibration commonly resulted in shaft seal failures. Submersible pumps are now designed with close-coupled motors and flexible shafts lacking joints, meaning the life of the parts is now five times greater than before, but here motor maintenance requires removing it from below ground, which involves removing the riser pipes as well. Stators will wear out first however, and for every two changes of stator, a rotor should also be changed. Stators in storage can degrade quicker with increased heat, humidity, sunlight or ozone, so they must be stored correctly. If stators are older than five years, there will already be some degradation before they are even installed, and the operational lifetime will be decreased. Metal is used for part of this type of pump; where these components contact groundwater with a pH of 6.5 or less, corrosion is likely to occur, which means more frequent replacement of affected parts. For this pump, the galvanised iron riser main is more at risk than the other metal parts, which are made from stainless steel (e.g. drive shaft, helical rotor).

**Health and Safety:** Only trained personnel should work on mechanised pumps. The equipment should be off limits to the general public, and any fast-moving V-belts should be shielded. Chemical water quality can be an issue with some metal pumps. Where groundwater has a pH of 6.5 or less, iron from the pipes may begin to dissolve, causing an indirect health risk, and lead can leach out from certain welds and fittings regardless of pH **(see A.2)**. If engine-driven pumps are employed, potential health risks with engine emissions should be evaluated.

**Costs:** Progressive Cavity Pumps cost around 1,250 USD for depths of 50 metres. Typically, stators (170 USD) last around 12,000 operating hours, though should be replaced every three years no matter what, due to the shelf life of the rubber. Rotors (140 USD) last around 30,000 hrs.

**Social and Environmental Considerations:** The end user of the water supply system typically does not interact with these pumps. The complexity of O & M of the system should be considered, as trained and capable staff are required. There is a risk of over-exploiting (ground)water resources that should be considered when using this type of pump. For motor driven pumps, major environmental considerations relate to use of consumables (lubrication, oil, chemicals) and power sources. A plan for the appropriate containment and disposal of consumables should be in place. The pump may also be driven with solar power **(see S.10)** to limit the environmental impact of its operation.

**Strengths and Weaknesses:**

- (+) More resistant to aggressive groundwater (through having more stainless steel)
- (+) Can cope with pumping solid particles
- (+) Flow rate does not vary too much with increasing head, so less design needed

- (−) Not as readily available in the marketplace
- (−) Running dry for even a minute will destroy the stator
- (−) Running against a closed valve can damage pump and fittings

→ **References and further reading material for this technology can be found on page 216**