



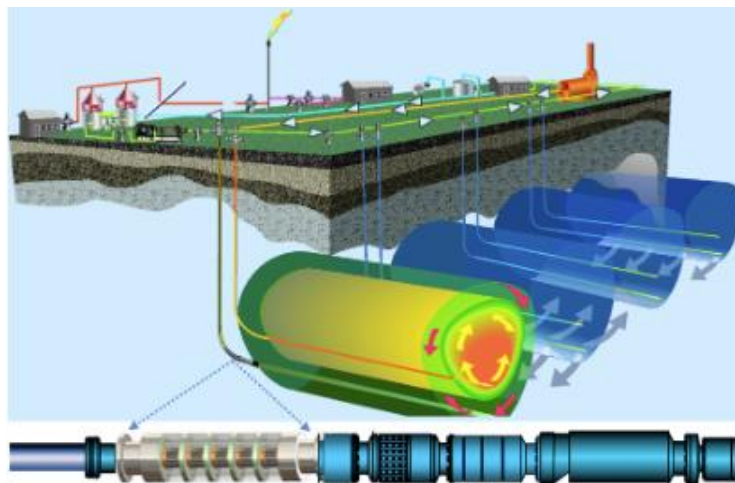
There is an increasing evolution of artificial lift technology for SAGD or thermal heavy oil recovery in the industry in an effort to improve production run time and reduce capital and operating costs. APT has combined resources in an effort to design, develop and provide an innovative alternative solution for harsh extreme temperature environments suitable for SAGD applications.

The **Rotary Gear Pump System** design concept differs from the more common ESP used for artificial lift in that the RGP is a robust high volume low speed positive displacement gear pump that has the ability to operate throughout ranges untouched with centrifugal pumps, delivers optimal production and does so in a cost-effective manner. Although the RGP connects directly to an ESP production string by replacing only the centrifugal pump component, the operation and functional specifications are significantly different.

Although the RGP utilizes the latest technological advances in high temperature motors, protectors, gas handling equipment and power cables developed by the major ESP vendors, there is a growing demand for advanced thermal pump development and performance.

Listed below are the operating features and advantages of the SAGD gear pump over the current thermal centrifugal / progressing cavity (PCP) pumps:

Features / Specifications	ESP Pump	PCP Pump	RGP Pump
Gas Handling Capacity (Stages)	Up to 20%	Poor	50%+
Operating Speed	3,500 RPM @ 60 Hz	400 RPM+	0 – 3,500 RPM+
Pump Efficiency	60%	30– 40%	>80%
Upthrust Downthrust	Yes	No	No
Pump “Driver” Options	Induction / PMM	PMM / Rods	Induction/PMM/Rods/Hydraulic
Max Operating Range	10,000 bbls/d	2,500 bbls/d	10,000 bbls/d
Required Minimum Casing Size	7”	7”	5 ½”
Pump Specifications (equivalent rate) (a) Pump Length (ft) (b) Pump OD (in) (c) Temperature Range (°F) (d) Sand Concentration (%)	(a) 10 – 15 ft (b) 5.38” (c) 250°C (485°F) (d) 0 – 3 %	(a) 25 – 30 ft (b) 5.50” (c) 250°C (485°F) (d) Trace Amounts	(a) 5 – 10 ft (b) 4.00”, 6.00” (c) 250°C (485°F) (d) 0 – 3%



538 Thermal (SAGD) ESP-RGP