Canadian ADVANCED INC.

Electric Submersible Pumps

1.0

Advanced Thinking – Down to Earth Service

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By bringing together a highly experienced team with state-of-the-art manufacturing and a deep commitment to customer service, Canadian Advanced is able to deliver superior high pressure pump applications and leading variable speed drive systems to the global oil and gas industry. Located in the heart of Canada's energy sector, our focus is on Electric Submersible Pump Systems for Artificial Lift applications, Horizontal Pump Systems for a variety of high pressure applications, and innovative Variable Speed Drive Systems.

Engineered Operating sophisticated production processes in challenging conditions, extreme climates and remote locations requires reliable pumping systems. Canadian Advanced pumping systems are the industry choice, producing more flow, more head, greater efficiency and wider operating ranges than most competitor's offerings.

Canadian Advanced creates high quality, innovative, safe and environmentally sound solutions by applying advanced state-of-the-art technologies, strict quality management and superior engineering capabilities. Our detailed process and application knowledge has allowed us to develop several patented engineering solutions as well as custom design systems when required.

Quality All Canadian Advanced operations are certified to ISO 9001:2000 standards to ensure the highest quality products with the greatest value for customers worldwide. Quality assurance begins with a contract review and continues throughout the entire process. All products are inspected and performance tested in line with relevant API and other specification criteria before leaving the factory.

CAI Electric Submersible Pumping System

The CAI Electric Submersible Pump System consists of several components that are carefully selected to combine into the most economical and efficient solution for each set of well conditions.

Surface Equipment (1) Above ground a system controller combined with a variable frequency drive and related transformer or the patented CAI Variable Frequency Generator provide controlled power supply to the ESP.

Power Cable (2), Motor Lead Extension (3), The electrical main cable and the flat cable motor lead extension with pot-head connect the surface equipment with the ESP motor and well monitoring device.

Pump (4) The pumping unit itself consists of the multi-stage centrifugal pump housed in a pressure sleeve with the capability of producing capacities up to 50.000 BPD from depths of up to 13.900 ft.

Gas Seperator/Intake (5) Immediately under the pump is the intake combined with a gas separator if required. The gas separator allows for troublefree operation in well conditions with free gas contents of more than 10%.

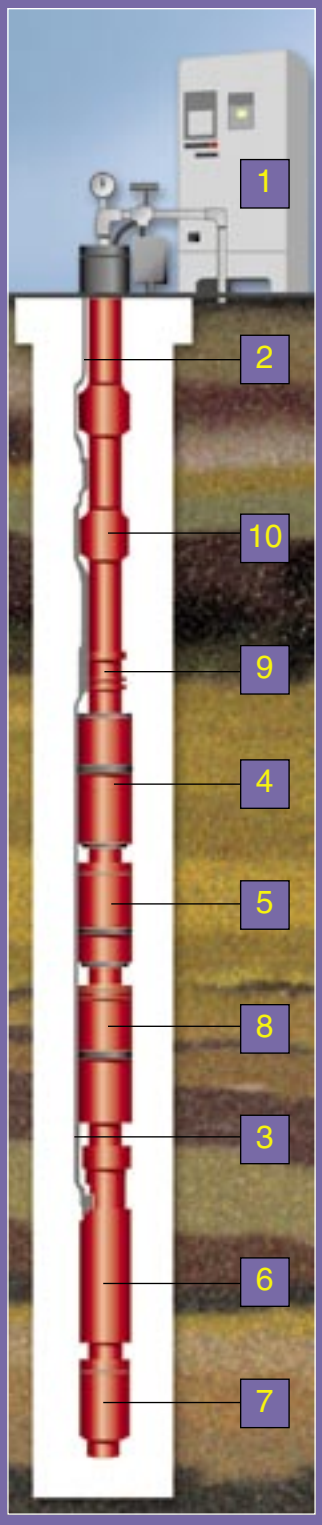
Motor (6) The high quality electrical motor (6) for well casings 41/2" and larger is a squirrel cage, two pole, three phase induction motor. The motor turns at a speed of approximately 3500 RPM at 60 Hz and 2900 RPM at 50 Hz power source.

Sensor (7) The down hole sensor is located below the motor and transmits important well and system data via the main power cable to the surface.

Protector (8) Located between motor and pump intake is the protector. The protector isolates the motor from the well fluid and contains the high capacity thrust bearing.

Check Valve (9), Drain Valve (10) Other protective devices are located above the pump discharge: The check valve that closes on shut down of the unit and prevents back spinning and the drain valve that allows for pulling the ESP without a wet tubing string.

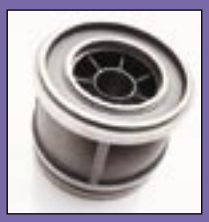
Expert Advice The correct application of technology is the critical success factor for any down hole pumping solution. You can count on Canadian Advanced's professional engineers to design an Electric Submersible Pumping System that provides optimum performance in each of your well applications.



Pump

The pump is a multi-stage centrifugal design. Each stage consists of an impeller (1), a diffuser (2) and a bearing (3).

Impeller with GFR Phenolic Resin Washer



Diffuser

Impeller and Diffuser

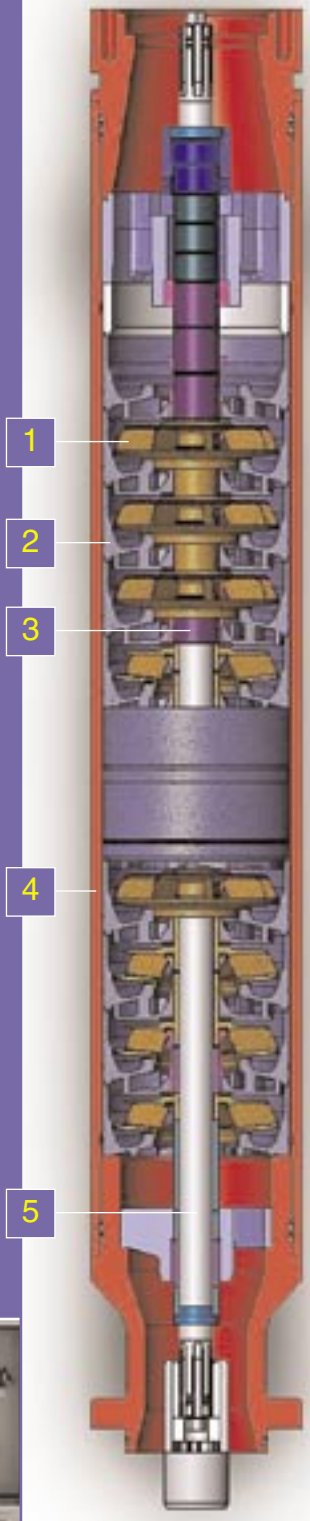
The impeller is the rotating element and adds velocity to the pumpage; the stationary diffuser converts this velocity into pressure energy and redirects the pumpage to the entrance of the next stage impeller.

The impeller/diffuser design combinations are available in a variety of Ns (Specific Speed) designs – from axial to mixed flow – to provide optimum efficiencies for any given well condition. The hydraulic designs are such that a positive downward thrust is generated throughout the operating range to assure stable hydraulic operation and to prevent thrust reversal. The standard hydraulics can handle 10% to 15% of free gas.

The CAI standard material for both impellers and diffusers is a stable austenitic cast material of Ni-Resist which provides sufficient corrosion and erosion resistance in most well applications. Other materials such as Super Duplex SS or Boronized Ni-Resist are available to allow for additional protection in extremely corrosive or abrasive services.

Bearings

In each stage of the standard configuration the impeller shroud and the diffuser act as bearing surfaces, in addition the upper and lower journal bearing of each pump section are supplied in Tungsten Carbide for added protection against abrasion and vibration. Optional stage bearing designs are available to handle well conditions with high content of abrasives.



Compression Pump

1) Impeller 2) Diffuser
3) Bearing 4) Housing
5) Shaft

Housing

The pump stages are housed in a pressure sleeve (housing) (4) made of high grade alloy steel. The inside diameter of the housing is isolated from the pumpage; the outside surface may be treated with a special coating as an added protection from hostile fluid in the well casing.

Shaft

Standard pump shafts (5) are machined from Monel K-500 matrial which provides excellent mechanical strength in normal conditions. Special extra high strength shafting material (Inconel) is available for special applications.

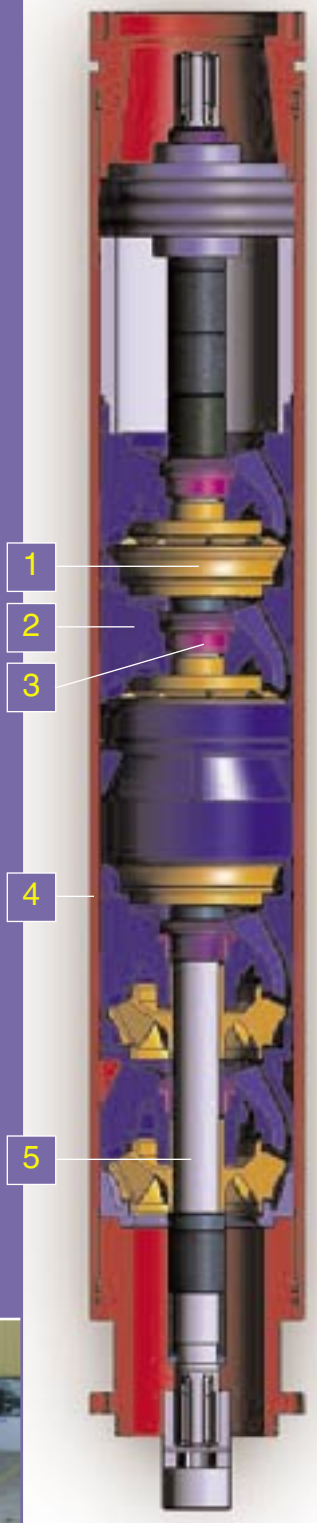
This modular construction concept provides for the optimal selection of hydraulic flow and head combinations to suit any range of well requirements and can produce fluids from depths of up to 13.000 ft (3.960 m)

CAI Compression Pump Design

In this design the impellers are fixed to the pump shaft with lock rings. The full hydraulic down thrust of impellers and shaft and the weight of the rotating element is carried by the tilting pad thrust bearings in the protector. This design is commonly used in higher rated pumps (675 Series and above).

CAI Floating Impeller Pump Design

This design uses a sliding impeller whereby the impeller, driven by a key, can slide freely in axial direction on the shaft. The hydraulic thrust of each individual stage is carried by three GFR phenolic resin thrust washers, embedded in the impellers, that run against the stationary diffuser. With this design no hydraulic thrust is transmitted from the impellers to the shaft. The weight of the shaft plus the down thrust created at the top end of the shaft are carried by a tilting pad bearing in the protector assembly below the pump. Optional stage bearing designs are available to handle well conditions with high abrasive content.



Floating Impeller Pump

1) Impeller 2) Diffuser
3) Bearing 4) Housing 5) Shaft

Submersible Motor

The design of the CAI Electric Submersible Motor is guided by the harsh environmental conditions found in most oil well applications.

The motors are AC two pole, three phase squirrel cage induction type designs. All motors are filled with highly refined mineral oil. The oil is specifically selected to provide optimum dielectric strength, sufficient thermal conductiviity to secure proper motor cooling and ample lubrication for the thrust (1) and journal bearings (7) in the motor and protector assembly. An internal thrust bearing carries the thrust load generated by the rotor element.

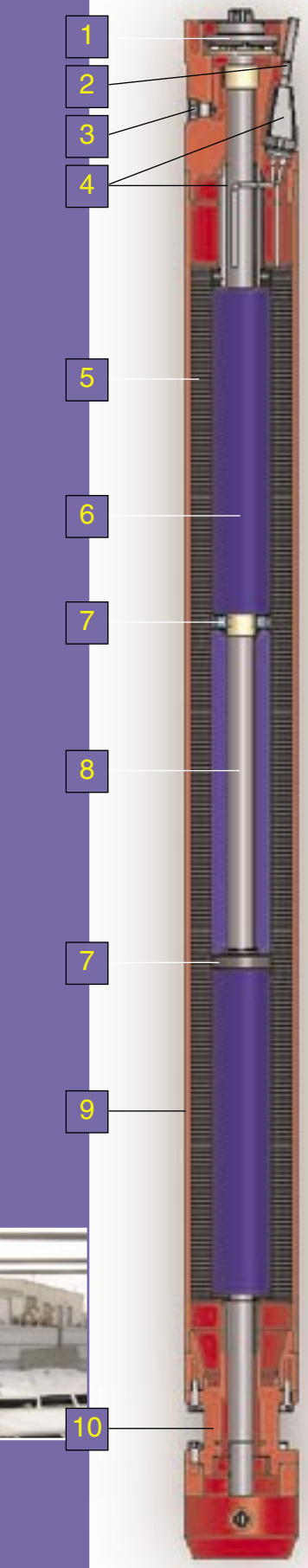
Depending on motor size and cable length, the operating voltage of the motor can range between 380 and 5000 Volts. The horse power ranges from 8 to 1000 HP in single, tandem and TUT configurations (tandem-upper-tandem, creates 1000 Hp and larger motor systems with standard motor sections coupled mechanically but not electrically – request separate leaflet for TUT technology). Standard design operating temperatures can be as high as 190°C (375°F).

The motor shaft (8) is rifle drilled to allow for sufficient oil circulation for all journal bearings and the motor thrust bearing. Shafts are available in high strength materials for high torque / high horsepower applications.

The rotor (6) and stator (5) designs are optimized to provide high electric efficiency and uncompromised performance under all operating conditions.

The flat Motor Lead Extension (2) is connected to the motor by means of a taped-in pothead connector (4).

A downhole sensor can be attached to the motor base (10) to transmit critical information such as intake pressure, intake temperature, motor temperature, motor vibration etc. via the main power cable to the surface controls.



Submersible Motor

1) Thrust Bearing 2) Motor Lead Extension 3) Drain and Fill Plug
4) Pothead Connection 5) Wound Stator 6) Squirrel Cage Rotor
7) Journal Bearings 8) Rifle Drilled Shaft 9) Motor Casing
10) Motor Base

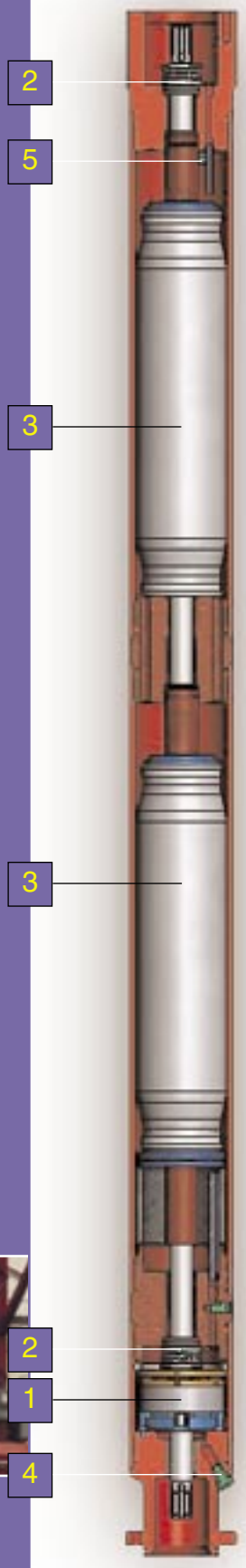
Protector

The Protector is located between the pump and the motor. The Protector is a key element in providing efficient trouble free operation and extended longevity to the entire ESP system; the primary functions of the Protector are:

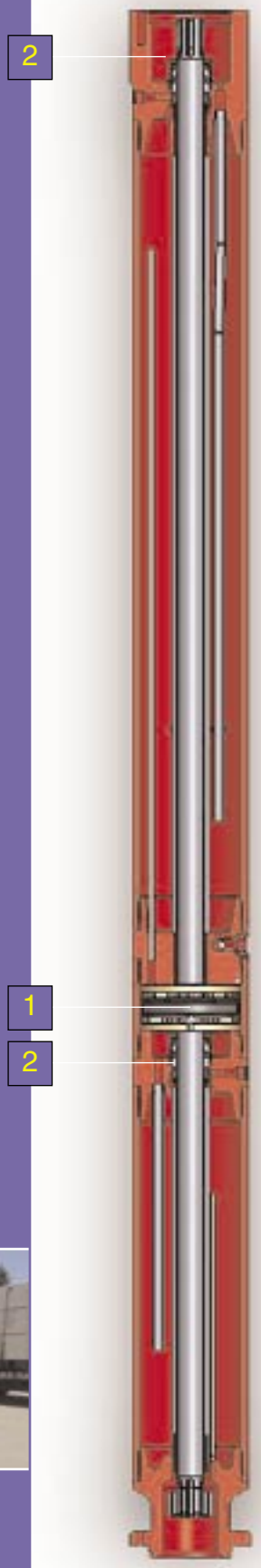
- To act as physical barrier between the well fluid and the motor oil under all conditions.
- To carry the (residual) hydraulic downthrust generated by the centrifugal pumping action as well as the weight and thrust generated by the rotating element of the ESP.
- To equalize the pressure inside the motor to the pressure conditions in the well bore.
- To maintain a minimum pressure differential across the seals. Specially designed mechanical seals exclude well bore fluid from entering the motor.
- To provide a flexible chamber (Viton bags) that allows the motor oil to expand and contract as a function of changing well and motor temperatures during installation, motor start-up and shut-down. The specially designed labyrinth and a check valve allows movement of the expanding motor oil into the well bore and blocks the entry of well bore fluid during the contraction of the motor oil.

The CAI standard protector configuration consists of a labyrinth section and a bladder section. This configuration combines ample volume to allow for sufficient thermal expansion with extensive protection against well fluid entering the motor and thrust bearing cavities

1) Thrust Bearing 2) Mechanical Seal
3) Elastomer Expansion Bag 4) Fill Plug
5) Check Valve



Double Bag Section



Double Labryrinth Section

Gas Separator

In wells with high Gas to Liquid Ratio (GLR) the free gas has to be separated from the liquid to prevent the ESP system from cycling, cavitation and gas locking which would reduce production and the run life of the ESP system.

The gas handling parameters of each well and ESP combination are affected by a large number of variables such as specific speed of pump stage design (axial, mixed or radial flow), fluid properties, well geometry and completion details etc.

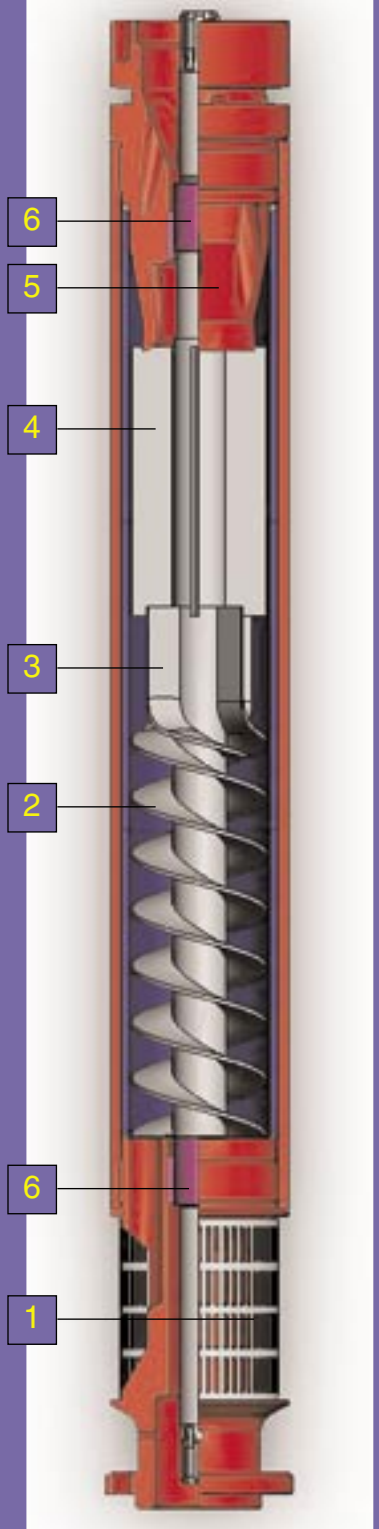
Two principal separator designs are commonly used either separate or in combination or as tandem setups for severe gas handling requirements:

- Reverse Flow Separator
  (moderate separation efficiency)
- Rotary Gas Separator
  (high separation efficiency)

In the Reverse Flow Separator the entering well fluid is forced to change direction; the lighter free gas continues to rise and vents to the annulus, the heavier liquid stream turns in a downward direction and is then lead to the first pump stage.

In contrast, the Rotary Gas Separator (RGS) uses centrifugal force to separate the gas and liquid streams. The mixture of gas and liquid enters through the intake screen (1) into the inducer section (2). The inducer increases the pressure of the liquid stream and moves the mixture through the guide vanes (3) into the centrifugal rotor chamber (4) where the heavier liquid stream is forced to the outer area of the chamber whereas the lighter gas stream concentrates in the centre of the chamber. Through the separation chamber (5) the liquid stream is directed towards the pump intake stage and the gas stream is vented into the annulus. Radial bearings (6) and an oversized shaft provide dynamic stability to the Separator.

Canadian Advanced provides two RGS options: The Open Rotor Design RGS (medium gas content) and the Closed Rotor Design RGS (high gas content). CAI application engineers will help you to find the best solution for each particular well situation.



Rotary Gas Seperator

1) Intake Screen 2) Inducer
3) Guide Vanes 4) Rotor
5) Divider 6) Bearing

Open Rotor Design

Closed Rotor Design

Surface Equipment & Power Cable

The electrical Surface Equipment and Power Cable are an essential part of a complete Electric Submersible Pumping System. Canadian Advanced is using leading brand quality components engineered to offer optimum efficiency and maximum run life. Approvals from different Certification Authorites are available.

Switchboards Switchboards are normally used for fixed speed ESP applications. A large variety of options exist to meet the specific requirements of each application.

Motor Controls The Motor Controller monitors and provides information such as motor load, power supply, down hole sensor data. The controller also protects the motor against unsafe operation and start-ups. SCADA connections allow operation and control from remote control centers.

Variable Speed Drives Variable Speed Drives (VSD) allow for variable speed operation of the ESP unit. State-of-the-art technology will be applied to reduce the damaging effect of system inherent harmonics on insulation and mechanical components. Harmonic filters are commonly used to reduce this effect.

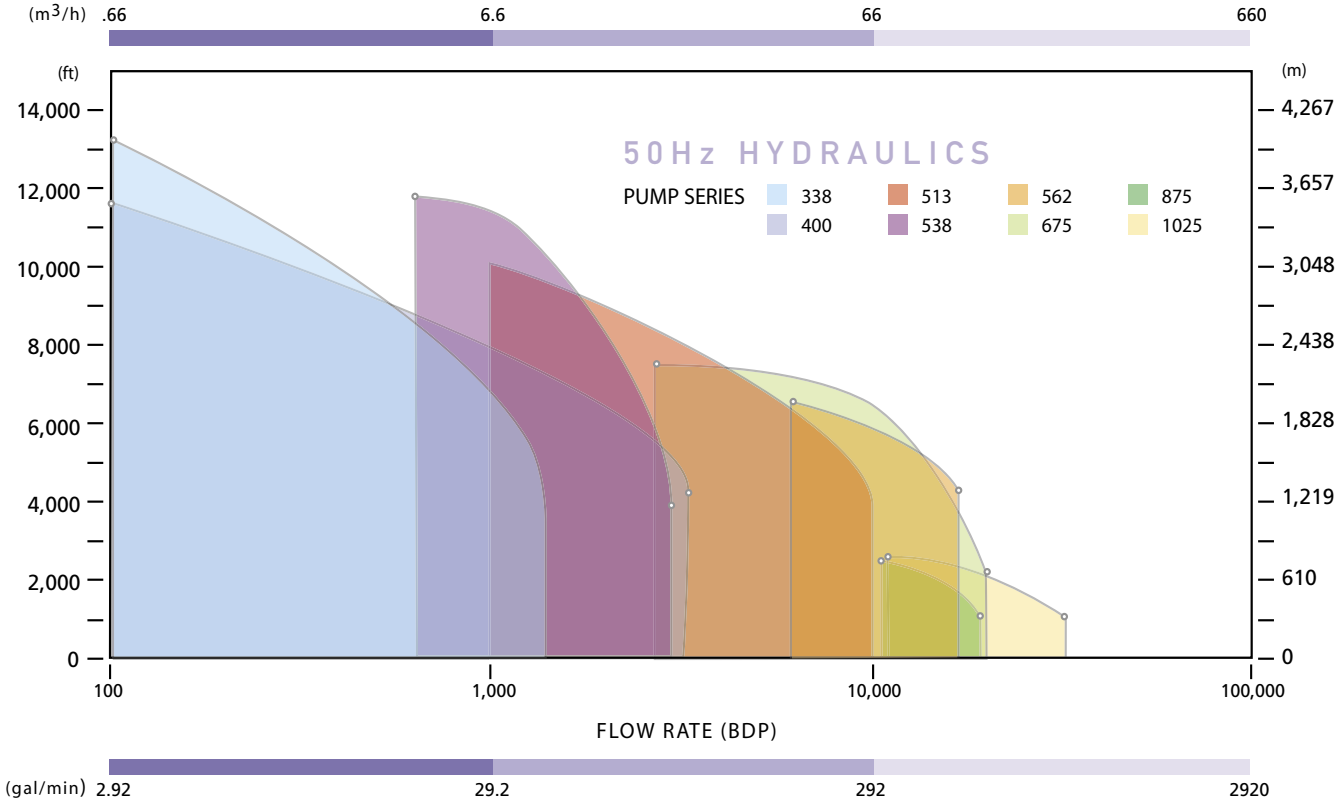
Transformers Specialized three phase transformers are required in various system configurations in the step-down and step-up function. Our transformers are designed to work in the rugged oil field environment and feature a wide range of taps to allow for optimum voltage supply to the ESP motor.

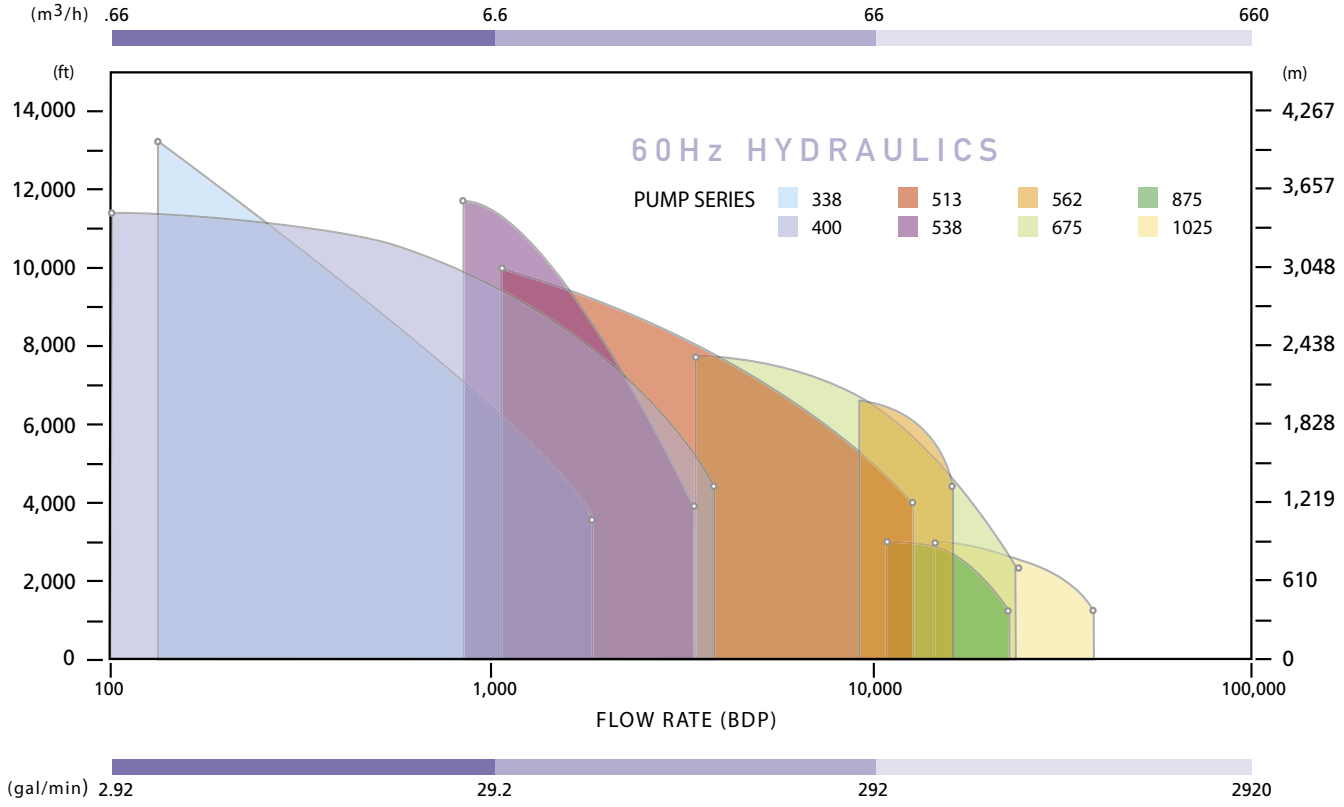
Variable Frequency Generator The Variable Frequency Generator (VFG) is an innovative and patented Genset technology engineered by Canadian Advanced. The VFG generates a pure sine wave output with no harmonics across its full variable speed and variable power range. The VFG features additional production and high electrical efficiency combined with an extended run life of ESP systems.

Power Cable Canadian Advanced features power cable in a wide range of sizes and construction types from reputable manufacturers to provide its customers with the most economical and efficient solution.

Operating Range Charts

Typical operating ranges of Canadian Advanced Electric Submersible Pumps. For applications outside the shown range please contact CAI Sales Engineering. Top chart shows 50 Hz hydraulics, bottom chart shows 60 Hz hydraulics.





Customer Support Service

The long-term success of any pumping system depends upon the quality and availability of customer support services.

Canadian Advanced prides itself on providing fast and efficient response to any situation, without compromising quality.

Fast Response

Our field technicians will install, start and monitor the pumping system to ensure successful operation. The crews are equipped with state-of-the-art tooling and modern truck-mounted spooling units for all cable spooling and banding needs. Canadian Advanced service centres, strategically located across the globe, offer our customers easy access to a full range of repair and maintenance services including unit installation, troubleshooting and preventive maintenance.

Servicing All Markets

In addition to supplying parts and services for all of our equipment, Canadian Advanced's in-house re-engineering specialists will design, deliver and fit high integrity components for other manufacturer's machinery – including upgrading and retrofitting existing pump installations. Using root-cause failure analysis, system investigation and material assessment, Canadian Advanced can modify existing installations to meet new duty conditions, improve operating efficiencies and increase MTBF.

Canadian Advanced also provides all the accessories needed during installation and overhaul of Electric Submersible Pumps and Horizontal Pump Systems including bleeder valves, check valves, banding materials, MONEL bolting and couplings, as well as flat cable extensions for most designs used in the industry.

Commitment

At Canadian Advanced, we constantly strive to improve our customer service performance and deliver the highest possible life cycle value in the industry.

Canadian Advanced provides a broad range of pumping systems.

Variable Frequency Generators (VFG)

Canadian Advanced has developed and manufactures a unique power supply system that eliminates the need for variable speed drives, harmonic filters and step-up transformers. It provides a pure sine wave and significantly extends your MTBF and production rates. Combined with an improved electrical efficiency the VFG reduces both, your capital and operating costs.

Horizontal Pumping Systems (HPS)

Canadian Advanced manufactures a range of HPS for low flow/high head applications like crude oil transfer, pipeline booster, water injection and reverse osmosis. The HPS technology distinguishes itself as a cost effective alternative to other designs like multi-stage barrel, split case and segmental pumps. The HPS technology is based on the proven multi-stage centrifugal pump design that is used in our ESP product range.

Rebuilding of ESP's

Canadian Advanced rebuild used ESP's of most known manufacturers into "as new" condition. Systems are completely tested and certified before leaving the factory.

Speciality Engineering & Testing

In addition to our standard product ranges Canadian Advanced specializes in Custom Product Engineering. Our modern and extensive testing facilities guarantee you thorough testing of each engineered solution before the product is shipped to the field.

Consumables

Canadian Advanced offers all of the materials and accessories needed for the installation and overhaul of Electrical Submersible Pumps and Horizontal Pump Systems.

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