WATERBOY

BW SOLAR

SOLAR PUMPS

PRODUCT CATALOGUE

- Helical Rotor Wet End
- Brushless DC motor
- Superior efficiency

For

- Game Farms
- Livestock water supply
- Rural water supply
- Isolated water supply

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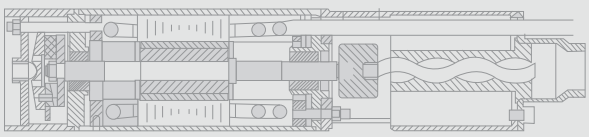

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SYSTEM CHARACTERISTICS

The WATERBOY system is a reliable water supply system based on renewable energy sources, mainly utilizing solar energy. The WATERBOY system incorporates a submersible pump. It is very flexible to its energy supply and performance, as the system can be combined and adapted to any need according to the conditions on the installation site.

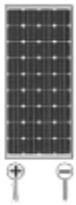
- This product consists of a non-position, permanent magnet brushless DC motor coupled to a helical rotor pump body or centrifugal pump body, matched with an above ground electronic controller.
- The motor is designed to be simple to operate and of sturdy construction, yet is compact and light weight when compared to its performance capabilities.
- Motor rotor and stator are double-plastic encapsulated to improve insulation performance. The motor is oil filled and can be submerged up to 40m below water lever. The maximum total dynamic head of pumps in the range is up to 140m and maximum flow rate is up to 8m³/Hr, depending on the system used.
- The controller includes features such as MPPT, over-current protection, under voltage protection, low water level sensor input and tank full input.
-

Being designed for continuous as well as intermittent operation, the WATERBOY system is especially suitable for water supply applications in remote locations such as:

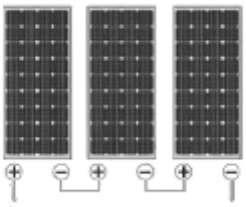
- Villages, Schools, Hospitals, Farms, Watering of cattle, Irrigation of fields and greenhouses, Game parks and game farms
- Watering applications, Conservation areas, Surface water pumping, Floating pump installations for pumping of water from ponds and lakes

PHOTOVOLTAIC (PV) CELLS

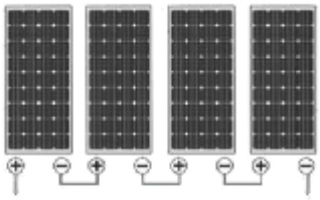
Solar array Photovoltaic (PV) cells produce electricity directly from sunlight (not from heat). Light causes electrons to jump from the top layer of the cell, into “holes” in the layer underneath. When a circuit is made between top and bottom layers, the electric current flows. As sunlight varies, the current (amps) varies and the voltage stays nearly constant. PV cells are connected in series to achieve the desired voltage, and sealed under glass to make a “PV module”. The assembly of modules is called a “PV array”. There are no moving or wearing parts in PV modules. The glass used in high quality PV modules is tempered, and is extremely strong. It is tested to federal standards that include resistance to a 1" hail stone. Some WATERBOY systems use a “passive” or active solar tracker, which tilts the array to follow the sun through the day. Daily output can be increased by up to 50%.



24V Pump Connection
(One piece of 24V solar panel)



36V Pump Connection
(Three pieces of 12V solar panels in series connection)



48V Pump Connection
(Four pieces of 12V solar panels in series connection)

MOTOR

The motor has been developed specifically for the WATERBOY system and is designed according to the brushless DC permanent-magnet principle. The WATERBOY 3" motor range comprises of two motor sizes:

1. 210 with maximum power input (P1) opf 360 W
2. 500 with maximum power input (P1) of 650 W.

The WATERBOY 4" motor range consists of two motor ranges including,

1. 500 with maximum power input (P1) of 720W
2. 1000 with maximum power input (P1) of 1400 W

The motor speed range is 500-3600 rpm, depending on power input and load. This consists of a special 3-phase AC motor (synchronous, permanent magnet), and a controller that changes the solar DC power to 3-phase AC. AC creates a rotating magnetic field that causes the shaft to spin. The motor’s speed is determined by the frequency of the AC power. The controller varies the frequency (and the voltage) to bring the motor up to speed slowly. It then adjusts the motor speed according to the power available from the sun.

Older-technology solar pumps have a traditional DC motor that uses “brushes” (small blocks of carbon-graphite) to conduct current to the spinning part of the motor. Not only do the brushes wear out in a few years, but it is necessary to have air in the motor and a perfect seal to keep water out. The brushless motor is filled with, and lubricated by oil.

The WATERBOY motor has been developed with a view to high reliability which is achieved through the following features:

- Carbon/ceramic bearings
- Excellent soft start
- Various protection components

PUMP

Helical Rotor Models

Positive displacement action, The helical rotor pump differs from centrifugal pumps in that it maintains high efficiency and lift capacity even at low rotational speeds and low flow rates. This allows the pump to work with a small, inexpensive solar array, and to function in low sunlight conditions. The helical rotor pump has only one moving part. It produces a smooth flow and required no valves to function. It is far more reliable than diaphragm and piston-type pumps.

The rotor sweeps the full surface of the rubber stator with every turn. It is impossible for deposits to accumulate. Solid particles tend to roll away from the contact area, making the pump extremely resistant to abrasion. Particles that are trapped against the rubber are tolerated by the flexibility of rubber.

CONTROLLER

Maximum Power Point Tracking, The built-in electronic unit gives the WATERBOY system a number of advantages compared to conventional products. One of these advantages is the built-in microprocessor with MPPT (MPPT= Maximum Power Point Tracking). Thanks to the MPPT-function, the pump duty point is continuously optimised according to the input power available. MPPT is only available for pumps connected to DC supply.

The WATERBOY controller starts the pump slowly and adjusts its speed according to the pumping load and the power available from the solar array. Power output from the array is optimally matched to the load by maximum power point tracker (MPPT) and linear current booster (LCB) functions, to produce maximum power transfer throughout all conditions. The LCB function is analogous to an automatic transmission in an automobile. It starts the pump in “low gear” (it lowers the array voltage and boosts the current). Under low sun conditions, it stays in “low gear” to resist stalling. As sunlight increases, it advances continuously toward “higher voltage). The MMPT refines the LCB function by tracking changes in the array voltage. Array voltage varies primarily with temperature (it is higher at low temperatures).

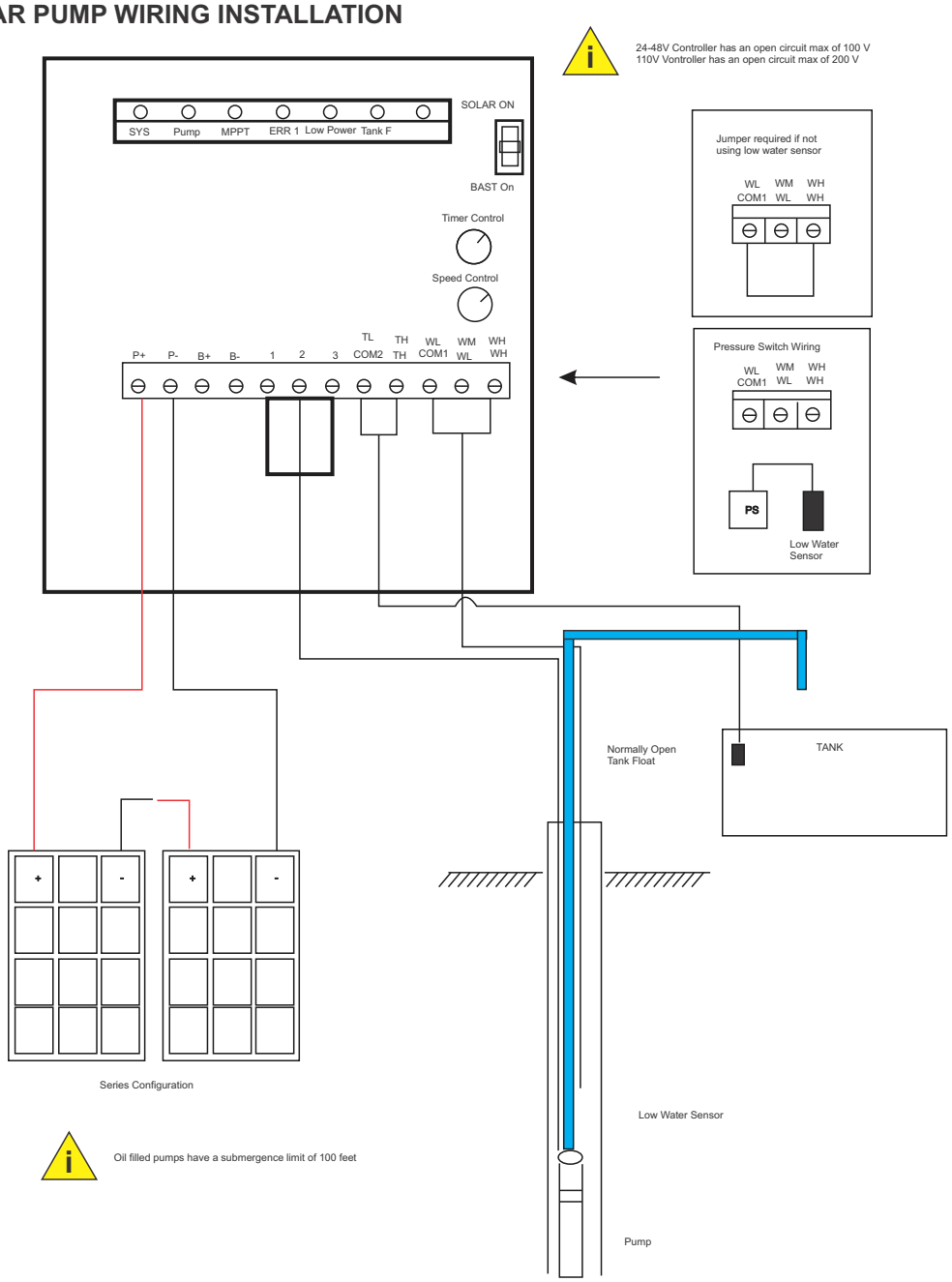
When the pump stalls in low sunlight, the controller switches the pump off. The controller converts the DC power from the solar array to 3-phase AC power to run the motor. Due to the special nature of this AC voltage which is made with PWM technology it cannot be measured with a multi-meter. Motor speed (RPM) is proportional to the AC frequency. The frequency starts low (about 20 Hz)< and increases gradually to a maximum of 3,400 RPM (70Hz). The float switch circuit operates at 12 V DC, carrying maximum current of 4.7 mA. The controller has terminals for either normally open (N.O.) or normally closed (N.C.) switching. The low-water probe circuit applies 5 V DC to a probe. The water conducts a small amount of current between the two electrodes of the probe. If the probe is out of the water, the controller stops the pump. When the water level recovers, there is a fully adjustable 5 - 30 minute delay before restart.

SPEED ADJUSTMENT

Although the water level sensor protects the pump from running dry, it is possible that the system could cycle on and off rapidly during peak sun hours when the pump gives its greatest output. By using the low level timer delay knob in the controller, it is possible to delay the pump from restarting as soon as the water level recovers. This prevents the rapid cycling of on and off but may mean that your daily flow rate is lowered as you miss some of those peak sun hours.

The solution to this is to use the speed control knob. By observing the system when it is pumping at its greatest rate during the middle of a clear summer day, you will be able to see whether the borehole is able to keep up with the pump output. If the pump is shutting off on “low level” more often than you would like, even with the time delay being used, you may wish to reduce the speed of the motor. Just turn the speed control knob down by twisting it, counter clockwise, a small amount. This will lengthen the time between the shut-offs. Continue reducing the speed in small stages until you are satisfied with the compromise between the flow rate and the amount of time that the pump shuts off on “low level”.

TYPICAL SOLAR PUMP WIRING INSTALLATION



3HRSS - 360 SOLAR PUMP (129000)

TDH	L/Min	L/Day
0	22.3	8028
5	21.9	7884
10	20.4	7344
15	18.2	6552
20	16.8	6048
25	15.0	5400
30	12.6	4536

3HRSS - 390 SOLAR PUMP (129001)

TDH	L/Min	L/Day
15	25.2	9072
20	24.0	8640
25	18.0	6480
30	15.0	5400
40	9.0	3240
50	4.2	1512

3HRSS - 490 SOLAR PUMP (129002)

TDH	L/Min	L/Day
10	24.0	8640
20	21.6	5184
30	19.2	4608
35	17.4	4176
40	15.9	3816
45	14.7	3528
50	12.5	3000
55	10.2	2448

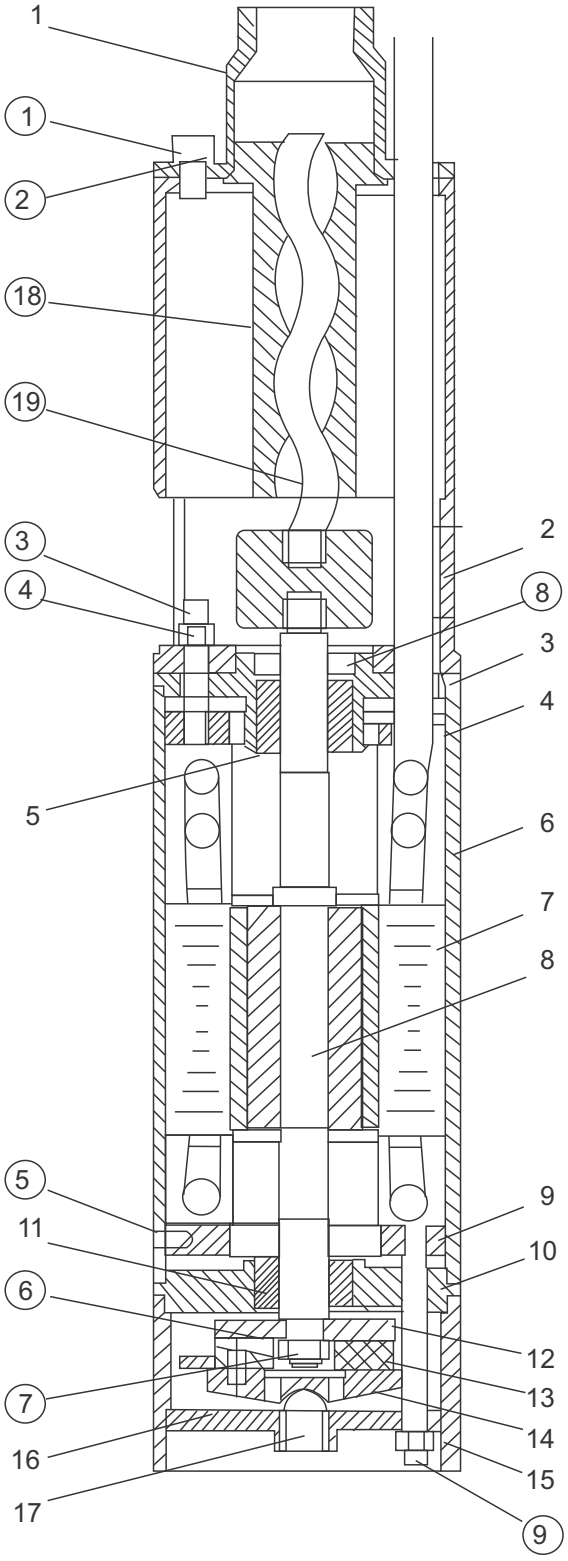
3HRSSH - 4120 SOLAR PUMP (129003)

TDH	L/Min	L/Day
10	33.0	7920
20	30.0	7200
30	27.0	6480
35	24.0	5760
40	21.0	5040
50	15.0	3600
60	9.0	2160
70	4.5	1080
80		

CROSSSECTION

NO	PART
1	extrude room
2	suction inlet
3	bearing seat
4	cover
5	bearing
6	motor body
7	stator
8	rotor
9	cover
10	bearing seat
11	bearing
12	plate
13	oil lubricated bearing seat
14	bearing seat
15	pump base shell
16	pump base plate
17	adjust nut
18	screw bush
19	screw

NO	PART
①	bolt
②	spring washer
③	bolt
④	hexagonal nut
⑤	key
⑥	spring washer
⑦	hexagonal nut
⑧	head oil seal
⑨	studs



GLOSSARY

Glossary of Solar Electricity and Water Pumping

Basic Electricity

AC - Alternating Current, the standard form of electrical current supplied by the utility grid and by most fuel-powered generators. The polarity (and therefore the direction of current) alternates. In U.S.A., standard voltages for small water pumps are 115 V and 230 V. Standards vary in different countries.

DC - Direct Current, the type of power produced by photovoltaic panels and by storage batteries. The current flows in one direction and polarity is fixed, defined as positive (+) and negative (-). Nominal system voltage may be anywhere from 12 to 180 V. See voltage, nominal.

Current - The rate at which electricity flows through a circuit, to transfer energy. Measured in Amperes, commonly called Amps, Analogy; flow rate in a water pipe.

Efficiency - The percentage of power that gets converted to useful work. Example: An electric pump that is 60 % efficient converts 60 % of the input energy into work - pumping water. The remaining 40 % becomes waste heat.

Energy - The product of power and time, measured in Watt-Hours. 1,000 Wh = 1 kWh, Variation: the product of current and time is Ampere-Hours, also called Amp-Hours (abbreviation: AH). 1,000 W consumed for 1 h = 1 kWh. See power.

Converter - An electronic device for DC power that steps up voltage and steps down current proportionally (or vice-versa). Electrical analogy applied to AC: See transformer. Mechanical analogy: gears or belt drive.

Inverter - An electronic device that converts low voltage DC to high voltage AC power. In solar-electric systems, an inverter may take the 12, 24, or 48 V DC and convert it to 115 or 230 V AC, conventional household power.

Power - The rate at which work is done. It is the product of Voltage times Current, measured in Watts. 1,000 W = 1 kW, An electric motor requires approximately 1 kW per Horsepower (after typical efficiency losses). 1 kW for 1 h = 1 kWh

Three-Phase AC - Three phase power is AC that is carried by three wires. Power waves are applied in a sequence. Three-phase is used for large industrial motors, variable speed motors, and brushless solar water pump motors. Analogy: 3-cylinder engine.

Transformer - An electrical device that steps up voltage and steps down current proportionally (or vice-versa). Transformers work with AC only. For DC, see converter. Mechanical analogy: gears or belt drive.

Utility **Grid** - Commercial electric power distribution system. Synonym: mains. **Voltage** –

The measurement of electrical potential. Analogy: Pressure in a water pipe.

Voltage Drop - Loss of voltage (electrical pressure) caused by the resistance in wire and electrical devices. Proper wire sizing will minimize voltage drop, particularly over long distances. Voltage drop is determined by 4 factors: wire size, current (amps), voltage, and length of wire. It is determined by consulting a wire sizing chart or formula available in various reference tests. It is expressed as a percentage. Water analogy: Friction Loss in pipe,

Voltage, Nominal - A way of naming a range of voltage to a standard. Example: A "12 V Nominal" system may operate in the range of 11 -15 V. We call it "12 V" for simplicity.

Solar Electricity

Charge Controller - A device that regulates the charge current to a battery in order to prevent overcharge. It prevents excessive voltage and maximizes the longevity of a battery. It may also contain other control functions (see Low Voltage Disconnect).

Deep Cycle Battery - Batteries that are designed to discharge as much as 80% of their capacity, hundreds of times. They differ from engine-starting batteries by having thicker plates and different metal alloys.

Low Voltage Disconnect - A control function in a battery-based power system in which the load or loads are disconnected before the battery gets over-discharged. Over discharge will damage a lead-acid battery. Typical settings for a 12 V system are 10.5 or 11 V disconnect and 12,5 or 13 V reconnect.

Photovoltaic - The phenomenon of converting light to electric power. Photo = light, Volt = electricity, Abbreviation: PV.

PV - The common abbreviation for photovoltaic.

PV Array - A group of PV (photovoltaic) modules (also called panels) arranged to produce the voltage and power desired,

PV Array-Direct - The use of electric power directly from a photovoltaic array, without storage batteries to store or stabilize it. Most solar water pumps work this way, utilizing a tank to store water,

PV Cell - The individual photovoltaic device, Most PV modules are made with around 36 or 72 silicon cells, each producing about. volt.

PV Module - An assembly of PV cells framed into a weatherproof unit, Commonly called a "PV panel". See PV array,

Solar Tracker - A mounting rack for a PV array that automatically tilts to follow the daily path of the sun through the sky. A "tracking array" will produce more energy through the course of the day, than a "fixed array" (non-tracking) particularly during the long days of summer.

Voltage, Open Circuit - The voltage of a PV module or array with no load (when It is disconnected). A "12 V Nominal" PV module will produce about 20 V open circuit. Abbreviation: Voc.

Voltage, Peak Power Point - The voltage at which a photovoltaic module or array transfers the greatest amount of power (watts). A "12 V Nominal" PV module will typically have a peak power voltage of around 15 - 17 V. The solar array for a PV array-direct solar pump should reach this voltage in full sun conditions, or a multiple of this voltage. Abbreviation: Vpp,

Pumps & Related Components

Booster Pump - A surface pump used to increase pressure in a water line, or to pull from a storage tank and pressurize a water system. See surface pump.

Centrifugal Pump - A pumping mechanism that spins water in order to push it out by means of centrifugal force, See also multi-stage,

Check Valve - A valve that allows water to flow one way but not the other.

Diaphragm Pump - A type of pump in which water is drawn in and forced out of one or more chambers, by a flexible diaphragm. Check valves let water into and out of each chamber.

Float Switch - An electrical switch that responds to changes in water level, it may be used to prevent overflow of a tank by turning a pump off, or to prevent a pump from running dry when the source level is low.

Float Valve - A valve that responds to changes in water level. It is used to prevent overflow of a tank by blocking the flow of water.

Foot Valve - A check valve placed in the water source below a surface pump, It prevents water from flowing back down the pipe and "losing prime". See check valve and priming.

Helical Rotor Pump - A pump with a helix-shaped rotor that fits closely into a rubber stator that has a helical groove. It forms sealed cavities that trap water, As the rotor turns, the cavities move toward the outlet. See positive displacement pump. Synonyms: progressive cavity pump, screw pump.

Impeller - The device that spins inside of a centrifugal pump, in order to develop centrifugal force.

Jet Pump - A surface-mounted centrifugal pump that uses an "ejector" (venturi) device to augment its suction capacity. In a "deep well jet pump*', the ejector is down in the well, to assist the pump in overcoming the limitations of suction. (Some water is diverted back down the well, causing an increase in energy use,)

Multi-Stage Centrifugal - A centrifugal pump with more than one impeller and chamber, stacked in a sequence to produce higher pressure. Conventional AC deep well submersible pumps and some solar submersibles work this way,

Positive Displacement Pump - Any mechanism that seals water in a chamber, then forces it out by reducing the volume of the chamber, Examples: piston, diaphragm, helical rotor, vane. Used for low volume and high lift. Contrast with centrifugal. Synonyms: volumetric pump, force pump.

Priming - The process of hand-filling the suction pipe and intake of a surface pump. Priming is generally necessary when a pump must be located above the water source. A self-priming pump is able to draw some air suction in order to prime itself, at least in theory. See foot valve,

Pulsation Damper - A device that absorbs and releases pulsations in flow produced by a piston or diaphragm pump. Consists of a chamber with air trapped within it or a length of flexible tube.

Pump Jack - A deep well piston pump. The piston and cylinder is submerged in the well water and actuated by a rod inside the drop pipe, powered by a motor at the surface. This is an old-fashioned system that is still used for extremely deep wells, including solar pumps as deep as 1000 feet.

Self-Priming Pump - See priming.

Submersible Pump - A motor/pump combination designed to be placed entirely below the water surface.

Surface Pump - A pump that is not submersible. It must be placed no more than about 20 ft., above the surface of the water in the well. See priming. (Exception: see jet pump)

Solar Pump Components

DC Motor, Brush-Type - The traditional DC motor, in which small carbon blocks called "brushes" conduct current into the spinning portion of the motor. They are used in most solar surface pumps and in some low-power solar submersibles. The motor chamber must be filled with air and perfectly sealed from moisture. Brushes naturally wear down after years of use, and must be replaced periodically.

DC Motor, Brushless - High-technology motor used in more advanced solar submersibles. An electronic system is used to precisely alternate the current, causing the motor to spin. See three-phase AC. A submersible brushless motor is filled with water and requires no maintenance.

DC Motor, Permanent Magnet - All DC solar pumps use this type of motor in some form. Being a variable speed motor by nature, reduced voltage (in low sun) produces proportionally reduced speed, and causes no harm to the motor. Contrast: induction motor

Induction Motor (AC) - The type of electric motor used in conventional single-phase AC water pumps, it requires a high surge of current to start, and a stable voltage supply, making it relatively expensive to run from by solar power. See Inverter.

Linear Current Booster (LCB) - An electronic device which varies the voltage and current of a PV array to match the needs of an array-direct pump, especially a positive displacement pump. It allows the pump to start and to run under low sun conditions without stalling. Electrical analogy: variable transformer. Mechanical analogy: automatic transmission. Also called pump controller. See pump controller.

Maximum Power Point Tracking (MPPT) - An added refinement in some linear current boosters, in which the input voltage tracks the variations of the output voltage of the PV array to draw the most possible solar power under varying conditions of temperature, solar intensity and load.

Pump Controller - An electronic device that controls or processes the power to a pump. It may perform any of the following functions: stopping and starting the pump; protection from overload; DC-to-AC conversion; voltage conversion; power matching (see linear current booster). It may also have provisions for low-water shutoff and full-tank shutoff devices, and status indicators,

Water Well Components

Borehole - Synonym for drilled well, especially outside of North America,

Casing - Plastic or steel tube that is permanently inserted in the well after drilling, Its size is specified according to its inside diameter,

Cable Splice - A joint in electrical cable, A submersible splice is protected by a water-tight seat,

Drop Pipe - The pipe that carries water from a pump in a well, up to the surface. It also supports the pump.

Perforations - Slits cut into the well casing to allow groundwater to enter. May be located at more than one level, to coincide with water-bearing strata in the earth.

Pitless Adapter - A special pipe fitting that fits on a well casing, below ground. It lets the pipe pass horizontally through the casing so that no pipe is exposed above ground where it could freeze. The pump may be installed and removed without further need to dig around the casing. This is done by using a 1" threaded pipe as a handle.

Safety Rope - Rope used to secure the pump in case of pipe breakage,

Submersible Cable - Electrical cable designed for in-well submersion. Conductor sizing is specified in square millimeter or (in North America) by American Wire Gauge (AWG) in which a higher number indicates smaller wire. It is connected to a pump by a cable splice.

Well Seal - Top plate of a well casing that provides a sanitary seal and support for the drop pipe and pump. Alternative: See pitless adapter

Water Well Characteristics

Driller's Log - The document on which well characteristics are recorded by the well driller, in most states, drillers are required to register all water wells and to send a copy of the log to a state office. This supplies hydrological data and well performance test results to the well owner and the public. Synonym: well record.

Drawdown - Lowering of level of water in a well due to pumping.

Drawdown Level - Depth to the water surface in a well while it is being pumped.

Recovery Rate - Rate at which groundwater refills the casing after the level is drawn down. This is the term used to specify the production rate of the well,

Static Water Level - Depth to the water surface in a well under static conditions {not being pumped). May be subject to seasonal changes or lowering due to depletion.

Wellhead - Top of the well. **Pump System**

Engineering

Friction Loss - The loss of pressure due to flow of water in pipe, This is determined by 4 factors: pipe size (inside diameter), pipe material, flow rate, and length of pipe. It is determined by consulting a friction loss chart available in an engineering reference book or from a pipe supplier. It is expressed in PSI or Feet (equivalent additional feet of pumping). Pipe fittings, especially 90° elbows, impose additional friction.

Head - See synonym: vertical lift

Suction Lift - Applied to surface pumps: Vertical distance from the surface of the water in the source, to a pump located above the surface. This distance is limited by physics to around 20 ft at sea level (subtract 1ft per 1,000 ft altitude) and should be minimized for best results,

Submergence - Applied to submersible pumps: Distance below the static water level, at which a pump is set.

Total **Dynamic Head** - vertical lift + friction loss in piping (see vertical lift and friction loss),

Vertical Lift - The vertical distance that water is pumped. This determines the pressure that the pump pushes against. Total vertical lift = vertical lift from surface of water source up to the discharge in the tank + (in a pressure system) discharge pressure, Synonym: static head, Note: Horizontal distance does NOT add to the vertical lift, except in terms of pipe friction loss. NOR does the volume (weight) of water contained in pipe or tank. Submergence of the pump does NOT add to the vertical lift. See total dynamic head*

Water Distribution

Cut-In **Pressure and** Cut-Out **Pressure -** See pressure switch.

Gravity Flow - The use of gravity to produce pressure and water flow. A storage tank is elevated above the point of use, so that water will flow with no further pumping required. A booster pump may be used to increase pressure. 2,31 ft. vertical = 1 PSI, 10 m vertical = 1 bar, See pressure

Head - See vertical lift and total dynamic head. In water distribution, synonym: vertical drop. See pressure.

Open Discharge - The filling of a water vessel that is not sealed to hold pressure, Examples: storage (holding) tank, pond, flood irrigation. Contrast: pressure tank,

Pressure - The amount of force applied by water that is either forced by a pump, or by the gravity. Measured in pounds per square inch (PSI) or bar (atmospheres). PS! = vertical lift (or drop) in Feet/2.31. Metric: 1 bar = vertical lift (or drop) of 10 m vertical.

Pressure Switch - An electrical switch actuated by the pressure in a pressure tank, When the pressure drops to a low set-point (cut-in) it turns a pump on. At a high point (cut-out) it turns the pump off.

Pressure Tank - A fully enclosed tank with an air space inside. As water is forced in, the air compresses. The stored water may be released after the pump has stopped. Most pressure tanks contain a rubber bladder to capture the air. If so, synonym: captive air tank.

Pressure Tank Precharge - The pressure of compressed air stored in a captive air pressure tank. A reading should be taken with an air pressure gauge (tire gauge) with water pressure at zero. The air pressure is then adjusted to about 3 PSI lower than the cut-in pressure (see Pressure Switch). If precharge is not set properly, the tank will not work to full capacity, and the pump will cycle on and off more frequently.

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