Internal and external DC/AC converters: their roles in solar-powered water pumping systems

With solar playing a major role in today's move towards a renewable future, it is important to understand the difference in how products take advantage of the direct current (DC) power coming off a photovoltaic (PV) panel array. In the Grundfos solar offering there are two main methods of converting the DC power from the PV array into alternating current (AC) in order to drive Grundfos motors. The first is an internal inverter that can be found on the SQFlex pump and motor combination in the form of the MSF3 motor. The other option is an external inverter such as the Grundfos RSI (Renewable solar inverter) that inverts the DC in order to run a standard 3-phase AC motor. This article will go over the technical information, benefits of both types of inverting, and the tool needed to size a solar pumping system so that when it comes time to design and install the next solar powered unit the decision will be that much easier.

The SQFlex is available with either a helical rotor style liquid end for high heads and low flows or a centrifugal style liquid end for low heads and high flows. Though the helical rotor style uses a 3" liquid end and the centrifugal style uses a 4" liquid end, both styles come standard with the MSF3 motor. The MSF3 is a 2-wire permanent-magnet motor design with an integrated electronic unit allowing the SQFlex to operate on a wide range of either AC or DC voltage. The wide voltage range enables the SQFlex to operate at any voltage from 90-240VAC or 30-300VDC. Included with the integrated electronic unit is a built-in microprocessor with Maximum Power Point Tracking (MPPT), optimizing efficiency when connected to a DC power source.

Protect the pump and motor

Along with the MPPT capabilities, the electronic unit integrated to the MSF3 includes built-in pump and motor protection for dry running, overvoltage, undervoltage, overload, and overtemperature. The dry running protection is activated by an electrode attached to a single conductor, exiting from the bottom of the MSF3 motor, parallel to the motor leads.

Depending on the model of SQFlex, the electrode can be placed 30-60 cm (12-24 in), above the liquid end. The electrode measures contact resistance through the water to the case of the motor, if the water level falls below the level of the electrode the SQFlex will stop due to dry running. Once the water level rises above the electrode and resistance to the case of the motor is restored, SQFlex will resume operation after a 5-minute delay has elapsed.

The overvoltage and undervoltage protections are applicable when running the pump on either AC or DC. If the supply voltage goes outside of the permissible voltage range the SQFlex will automatically stop, once the supply voltage is restored within the permissible voltage range the SQFlex will resume operation. The overload protection prevents the motor from running above the maximum current rating, eliminating premature failures caused by high current draw. If the maximum current rating is exceeded the SQFlex will reduce speed until the current is below the maximum rating or the speed falls below the minimum speed and then alarm on an overload fault. The alarm will stop the SQFlex for 10 seconds before attempting to restart. The overtemperature protection is to ensure that the electronic unit integrated to the MSF3 does not overheat. If the motor temperature rises above 85°C (185°F) the SQFlex will shut down on overtemperature, once the temperature drops below 74°C (165°F) the SQFlex will resume operation.

Benefits of external control

Additional to the SQFlex line is the IO101 and CU200 controllers. These controllers are not required to make a SQFlex system operatable but are beneficial in some instances. The IO101 is a switch box that allows the system to be ran by a generator to increase production when DC power is low or unavailable. The CU200 is a combined status and control unit for the SQFlex. The benefits of the CU200 are the ability to view fault codes, monitor load power, and the ability to start and stop the SQFlex by float control.

Why use an external solar inverter

The RSI external inverter is designed to run Grundfos Pumps with standard 3-phase AC motors from 1.5 kW to 250 kW (2hp to 340hp). The RSI can operate with Three Phase AC or DC power at 230 VAC (2hp-15hp) and 460 VAC (3hp-340hp). You can switch the solar inverter to 3-phase AC grid power, or a generator when needed with an external switchover box during low irradiation conditions or at night.

The large horsepower range of the RSI greatly enhances the solar pumping options from Grundfos. The RSI enclosure is rated IP66, meaning it can be installed outdoors. RSI comes in 3 different enclosure ratings IP66, IP54 and IP21.

The RSI includes Advanced MPPT programming to compensate for environmental effect and improve power output up to 30%. MPPT benefits include following changes in sun irradiation, temperature variation optimization, and an oscillation damping regulator when clouds can rapidly cause changes in irradiation. Advanced MPPT allows the RSI to make the most efficient use of the power available from solar applications. The RSI also provides voltage and current overload protection for the motor.

The startup wizard on the RSI simplifies set up and allows easy entry of motor and system parameters. Preprogrammed digital inputs allow for several add on options for dry run protection including well level switch, or flow meter with built in delay to reduce nuisance trips. When one of the digital inputs is activated indicating a dry run situation, the RSI will fault for 8 minutes to allow the well to recover. The RSI also has analog inputs making it possible to add a sensor and enable the setup of PID controlled constant pressure. With the addition of the PowerAdapt the option of power blending will be possible with the RSI. PowerAdapt is a standalone cabinet that blends DC power with AC power to ensure continuous pump operation when it is needed.

Size correctly to match the application

When it comes to sizing the solar system for either the SQFlex or the RSI, the best way to do this is on the Grundfos Product Center (GPC). GPC can be used to confirm whether the SQFlex or RSI may be a better fit for your requirements by capabilities of flow and head, required equipment, labor required to install system, and cost of ownership. Other than confirming whether the SQFlex or the RSI is a better fit for the conditions on site, it will also provide a wide variety of information regarding the setup that it recommends. With accurate information entered, GPC will provide a list of required components along with the correctly sized pump and motor, as well as specification data for the system with links to specific product pages for the individual components. Among the components it will provide is the number of panels required in the array and how many should be wired in series and parallel.

While GPC will have the ultimate say in what system will be best for the parameters of each individual site, knowing the features and benefits of each type of system will help in narrowing down the options. The internal inverter (SQFlex) with its permanent magnet motor, wide voltage range, and plug and play capability, will normally provide the most efficient and cost-effective system on the market if flow and head are within the limitations of the SQFlex models, while the external inverters (RSI) usually requiring a more complex system with higher voltage requirements will allow for a much higher flows and head when required. The internal inverters (SQFlex) will work better on smaller systems, both physically and electrically, while the external inverters (RSI) will allow for a much larger system to be operated. Between these two methods of inversion, the Grundfos flex line will allow one to take advantage of the DC power from almost any PV array. Knowing the difference between these two methods of inverting power and when to use each is knowledge that will greatly assist in moving forward in this world of renewable energy.

For more information on Grundfos solar products, please visit: grundfos.com

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