

HPL110

POWER CONTROL MONITOR FOR PUMP DRY RUN PROTECTION

PUMPGEAR.CO.UK
SUPPLEMENTARY INSTRUCTIONS

WHY YOU SHOULD NEVER RUN A CENTRIFUGAL PUMP DRY OR WITH VALVES CLOSED

Pump dry running, or running with either the suction valve and/or the discharge valve is one of the most common causes of pump failure.

Tanker unloading and batch transfer are very common applications where dry running can happen, in many cases due to operator error.

In the case of single sealed pumps where sealing depends upon a film of the pumped liquid across the mechanical seal faces, lack of liquid will result in the faces coming together and failing because of friction.

With double sealed pumps the seal is generally cooled using a buffer liquid. This will usually prevent damage to the seals in the short term.

However, only part of the power transmitted through the shaft is converted into useful work by the pump. This defines the efficiency of the pump. The efficiency is a minimum at low or zero flow and the inefficiencies of impeller design and surface finish means the waste energy will be converted into heat by the pump, increasing the pumped liquid temperature.

This can result in vapourisation of the liquid in the pump casing. In many cases pumps fitted with double mechanical seals are pumping hazardous liquids – vapourisation therefore can be dangerous so dry running should be avoided.

With magnetic drive pumps which have internal bearings, dry running can result in catastrophic failure which always means an expensive repair, or in some cases a new pump. Some magnetic drive pump manufacturers offer coated, low friction bearings and advise short term dry run is OK.



UNIPOWER HPL110

Beware!! With non metallic pumps this is possible for a short time, although like sealed pumps, vapourisation can still occur and could be problematic as this type of pump is often used to pump hazardous liquids.

With metallic magnetic drive pumps eddy currents crossing the containment shell generate heat. This can build up quickly vapourising any liquid in the bearing area. If heat is allowed to build, damage can occur to O-rings and in some cases the magnets. This would be in addition to vapourisation in the pump casing.

Pumpgear's opinion is that no centrifugal pump should purposely be run dry (would you run your car without coolant or oil?).

Dry run can easily be prevented at low cost using a simply understood power control meter such as the Unipower APM110. This sheet gives supplementary instructions to enable easy installation and commissioning.

HPL110

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HOW THE UNIPOWER HPL110 POWER CONTROL MONITOR WORKS

The Power Control Monitor is located in the pump control panel, either DIN rail or panel mounted (HPL110A). This monitors the true power absorbed by the pump. Many users of the first generation dry run monitors (which used to measure phase angle or current) had problems with nuisance trips, and difficulty in setting up.

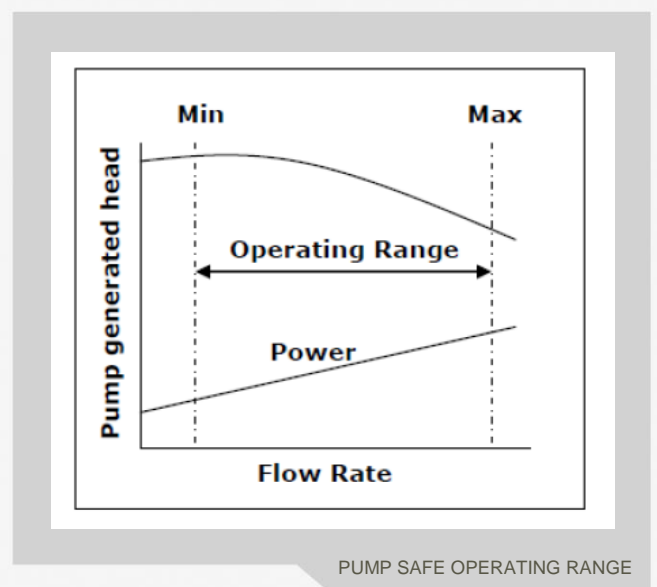
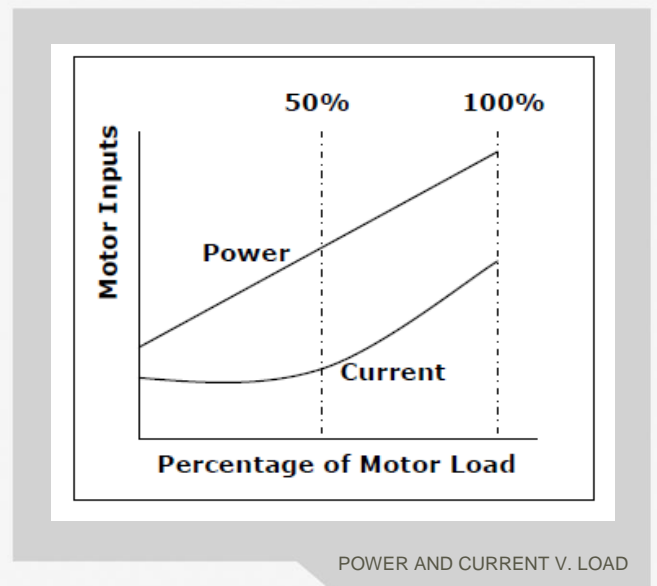
The reason for this can be explained with reference to this diagram which shows the relationship of motor power and motor current with respect to motor load. The motor current is almost constant up to 50% of the motor load and so is not a good measure at low pump flows.

The power curve however rises almost uniformly as the load increases, which means that settings are much easier and more reliable.

Motor power can be linked to the flow rate using the pump performance curve and the monitor is set to cut out the pump at the power corresponding to at least safe minimum flow, and at maximum rated flow.

A delay timer is provided so that nuisance trips can be avoided, for instance transient conditions or at start up.

One of the benefits of this device is that it is non intrusive – it does not come into contact with the pumped liquid so is especially suitable for hazardous liquids. There is no expensive mechanical work required – this alone can be more expensive than the unit itself. The unit will also prevent damage occurring because of closed valve operation and ensure that your pump will not operate outside its intended performance range.



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POWER CONTROL MONITOR
FOR PUMP DRY RUN PROTECTION



Determining the Low and High Trip Limits using Performance Curve:

The HPL110 measures true power consumption and shows this as a percentage of the selected power range. The power consumption is calculated from the formula $P = \sqrt{3} \times U \times I \times \text{Cos}\phi$.

The unit is therefore set up with $P_{\text{max}} = 100\%$ and $P_{\text{min}} =$ the percentage ratio of minimum power to the maximum power: $(P_{\text{min}} / P_{\text{max}}) \times 100$.

The HPL110's output relay will drop out when an alarm occurs and this can be used to cut out the pump or signal to a control system at these two points of the power curve ensuring protection against closed valve or dry run operation and overload due to (for instance) pump jam or change in viscosity or Specific Gravity.

The HPL110 is programmed by the use of only three keys located at the front panel. The Mode key selects one of seven parameters and the arrow keys change the value of the selected parameter.

The unit has a built in current range of 1, 3, 5 and 8 amps. If the motor current exceeds 8 amps (equivalent to a typical 4kw 2900 rpm motor) a low cost current converter (transformer), sometimes known as a CT is used.

For example, a CT 15:5 current transformer will increase the current range (100%) to 15 amps which is transformed down to 5 amps to suit the 5 amp current input range selected on the unit. Only the 1 or 5 amp range can be chosen when using a CT but the use of a CT with a 5A output (secondary winding) is advised

1. Determine your motor size P_{motor} in kw and motor efficiency from the nameplate or the manufacturers literature. Ensure P_{motor} is more than P_{max}

Determine the full load current (FLC) of the motor and choose the correct range for this on the HPL110, using a current converter if necessary.

(Example 7.5kw motor efficiency 87% at rated power, 86% at 75%, 85% at 50%, 75% at 25% 65% at 15% power FLC = 13.9 amps)

2. Select CT if required

(Example CT15:5 on 5 amp setting will give 15 amp range).

Calculate the equivalent power range using the formula P_{range} (watts) = $\sqrt{3} \times U \times I$ where U is the nominal voltage and I is the chosen current range (no CT) or the primary current of the external current converter.

(Example $P_{\text{range}} = \sqrt{3} \times 415 \times 15/1000 = 10.78\text{kw}$)

3. The High and Low limits (trips) can be estimated from the pump performance curve, illustrated above:

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CURRENT TRANSFORMER

From the manufacturers performance curve, (preferably the test curve of the actual pump being protected) note the power absorbed by the pump (shaft power) at minimum and maximum flow rates. P_{min} and P_{max} .

Note the curve will probably be based on water and the specific gravity of the liquid being pumped will have to be considered. If viscosity is more than say 10 centistokes refer to the manufacturer or to Epump for guidance unless you are familiar with viscous correction of centrifugal pump performance curves. The example allows for viscosity as water.

4. Multiply the P_{max} figure by the specific gravity of the pumped liquid and divide by the efficiency of the motor to give true power (P_1) absorbed.

(Example S.G. 1.3 $P_{max} = 4.5\text{kw}$ $P_1 = 4.5 \times 1.3 \times 100/87 = 6.72 \text{ kw}$)

5. Calculate this as a percentage of P_{range} this is then set as the Max. Limit.
(Example Max. Limit = $6.72 \times 100/10.78 = 63\%$)

6. Multiply the P_{min} figure by the specific gravity of the pumped liquid and divide by the efficiency of the motor referring to the motor efficiency curve at this load, to give true power (P_0) absorbed.

(Example S.G. 1.3 $P_{min} = 0.8\text{kw}$ $P_0 = 0.8 \times 1.3 \times 100/65 = 1.60 \text{ kw}$)

7. Calculate this as a percentage of P_{range} this is then set as the Min. Limit.

(Example Min. Limit = $1.60 \times 100/10.78 = 15\%$)

8. Set Start and Reaction Timers to suit. This figure should allow for pump starting time and any transient conditions that might occur – for example a short term valve closure. Observe manufacturers recommendations for this, some will advise a few seconds others a minute or more.

9. Calculate this as a percentage of P_{range} this is then set as the Min. Limit.

(Example Min. Limit = $1.60 \times 100/10.78 = 15\%$)

10. Set Start and Reaction Timers to suit. This figure should allow for pump starting time and any transient conditions that might occur – for example a short term valve closure. Observe manufacturers recommendations for this, some will advise a few seconds others a minute or more.

Please note that manufacturers published generic pump performance curves reflect an average and the power might vary from pump to pump. It is better to use actual test curves if they are available. Power can also change slightly over a period of time due to wear of components. Some fine tuning may therefore be necessary.

HPL110

POWER CONTROL MONITOR FOR PUMP DRY RUN PROTECTION



TANKER OFFLOADING PUMPS

Determining the Low and High Trip Limits Without Power Curve:

To operate the monitor when the limits are not known, it is recommended to set the parameters to values shown and/or calculated from the following:

Adjust Monitor Settings for Initial Start-Up as Follows

Start Time Delay 5 Seconds (Approx.) - $T_s(S)$

High Trip Delay 5 Seconds (Approx.) - $T_r(S)$
Upper

Low Trip Delay 5 Seconds (Approx.) - $T_r(S)$
Lower

Low Limit Low Trip Value 20%

High Limit High Trip Value - Motor rated full load amps power expressed as a percentage of the max amps of the unit (8 amps without CT, see above for CT example).

A simple way to set the Low and High Trip values is to operate the pump at the two extreme flow rates (maximum and minimum) defined in application parameters.

If the DIN rail mounted version is used, this process should be carried out by a competent electrician following risk assessment as access will be required to a live panel.

1. Open the suction valve and ensure the pipework and pump are full of liquid.
2. Start the pump and open the discharge valve until full flow is reached.
3. Decrease the power (range) setting slowly until the max LED turns on. The motor starter will switch off the pump after the time delay
4. Start the pump again repeating 1 & 2. Verify the pump shuts off
5. Press the reset button
6. Start the pump and adjust valve to "normal" operation.
7. Adjust the discharge valve to minimum flow. If this is close to no flow condition, consult the pump manufacturer. This is especially true of magnetic drive pumps where a safe minimum flow rate should be maintained for internal bearing lubrication and cooling of magnetic coupling.

Limit this operation time to a minimum.
8. Increase the low trip limit until the Min LED is on. Again the starter will switch off the pump at this point after the time delay.
9. Start the pump again and run normally, the two LED's load and contact only should be on. Repeat the procedure above to verify positive shut off, fine tuning if necessary.

Note: There may be a small power variation between cold (ie motor has not been run for some time) and hot (after running for an hour or more. Fine tuning may be necessary in this case.

HPL110

POWER CONTROL MONITOR
FOR PUMP DRY RUN PROTECTION



HPL110A POWER CONTROL
MONITOR

Alternative method using the HPL110 Real power capture facility.

The HPL110 features a capture facility for both the Max. and Min. power during a run period. These are accessed by pressing the Up arrow button (Max peak power) or the Down arrow button (Min peak power) while the pump is running. These values are also stored and available after a pump trip. The memories are cleared at the next start-up.

Note: The power measurement is made every 10mS but the display is updated every 0.5 seconds otherwise you would not be able to see the power % measurement. Because of this, the peak power memories may display a figure higher than the maximum power you have observed and lower than the minimum power you have observed.

By referring to these memories after a normal run period you can program suitable trip points at say Max. Power +10% and Min. Power -15%



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Epump Ltd. has over 33 years experience with pumping equipment engineering in many industries including Chemical & Pharmaceutical, Food Processing and Water & Waste.

This includes many applications requiring pump protection and control, often with associated energy savings. Experience shows that simple, easily understood methods work best and products have been chosen with this in mind.

Pumpgear.co.uk has been developed to offer the best in pump protection, monitoring and control together with first class technical support.

Pressure & Temperature Gauges, Flow Monitors, Pressure Switches and other equipment are available