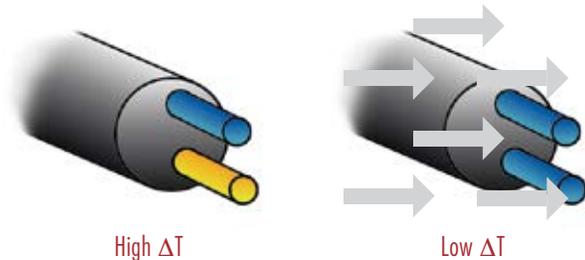


# Advantages of Thermal Dispersion Switches for Pump Protection



## Technology

Thermal dispersion switches use similar principles as thermal mass flow meters. Fluid carries heat away from the probe tip reducing the temperature difference between a heated resistance temperature detector (RTD) and a reference RTD. As the temperature difference increases or decreases due to heat transfer, the set point is reached and the relay de-energizes. Manufacturers will refer to the switch being in “alarm” at set point. How the relay is wired (NC-CO or NO-CO) depends on the needs of the application.



High or low flows can both be detected by thermal dispersion switches. For the purpose of this paper, it will be liquid flows as opposed to gas, and low flow detection that is desired. Running pumps in a dry state can damage parts or cause cavitation in centrifugal pumps. Replacement parts can add up to thousands of dollars. These costs do not include inefficiencies in pump operation or downtime that affects production or operation.

## Advantages

There are many technologies that can perform the function of pump protection. Flow meters can be used, but a continuous flow measurement is not always needed and flow meters typically cost more than switches.

Mechanical flow switches use a mechanical operation to actuate a relay. Typically, a vane or paddle is in the flow stream that swings in the direction of the flow. When the vane moves a specific

distance, a magnetic sleeve rises to draw the magnet in to actuate the switch. Moving parts can be subject to wear and increased maintenance over time. If it is a viscous liquid or build-up is present this can decrease reliability of the switch. A mechanical flow switch may be desirable if there is limited on-site power. In terms of the installation, the pipeline must be horizontal.

Tuning forks and ultrasonic gap switches are a few other technologies that are used for pump protection. It is inherent in the technologies that the fork or gap must be wet or dry for detection. Therefore, they cannot detect decreasing flow rates and the opening creates room for possible plugging. Common applications for these switches are sumps or wet wells. Dual ultrasonic gap switches have pump control modes where the unit performs auto-fill or auto-empty as needed.

With thermal dispersion, the user gets the most robust feature set and flexibility. This would include:

- No moving parts means less maintenance
- Many probe types for water or more viscous liquids
- Installation in horizontal or vertical lines and does not need to be installed top dead center
- Optional remote mount electronics
- Hot tap options available
- Low flow detection as opposed to dry pipe
- Current output for trending and fault indication
- Temperature compensation to reduce set point drift under varying operating temperatures

## Probe Types

The standard probe design offered by thermal dispersion switch manufacturers is a twin tip construction to house the sensors. The

twin tip is essentially two tubes welded to the end of the probe that are in the process liquid.

Twin tip probes can be beneficial as multiple manufacturers have similar designs. It has a very high pressure rating and is available in many different materials of construction. While this probe is suitable in liquid applications, it is typically recommended in gas applications unless the specifications require the use of this design.

A unique design that is preferred for liquid applications is the spherical tip probe. The lack of pins at the end of the probe eliminates plugging in viscous applications while the thin wall allows increased sensitivity with the process liquid. With pressure ratings up to 600 psig (41 barg) and standard 316 stainless steel material of construction it is suitable for most pump applications.



Thermatel® Model TD1  
with twin-tip probe



Thermatel® Model TD2  
with spherical tip probe

## Electronics

The electronics are offered integral or remote to the probe and are enclosed in an explosion proof housing. Wiring is simplified with the terminals easily accessible without removal of the bezel or any circuit boards. Along with the ease of installation come many diagnostic features due to the microprocessor based electronics.

A useful diagnostic feature in the electronics is the current output. It is not a linear 4-20 mA output, similar to a flow meter, but the current will act as a live signal that varies with heat transfer. For example, in a low flow condition the current may be 8 mA and at normal flows 12 mA (output varies for each application). The

current will be repeatable for a given low flow set point. If there is turbulence in the line, possibly being caused by a closed valve with the pump still running, the sensor will see this turbulence as a higher flow rate than what is actually occurring. Knowing this live signal allows the user to monitor what the sensor is seeing inside of the pipe.

Along with the trending capabilities of using the current output, this output will also go low or high when a fault condition occurs according to NAMUR NE 43. For pump applications where a low flow alarm is desirable, the current will fall to less than or equal to 3.6 mA during the fault. The microprocessor-based electronics is essential for monitoring any open wires or if the flow goes out of range. Without a microprocessor, the flow switch could be subject to more noise, have drift issues and need more frequent calibration to maintain the set point.

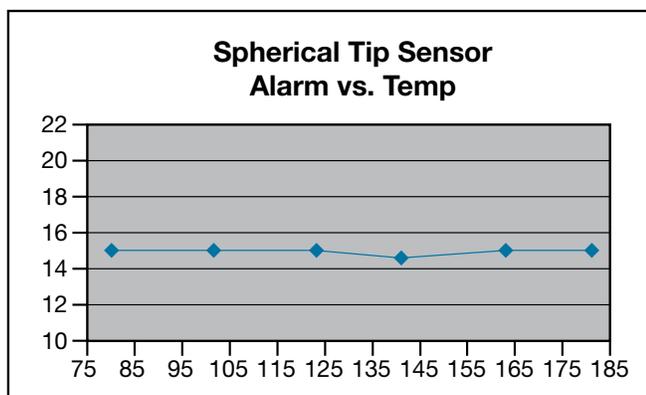
The user also has the option to select a window in the housing of the electronics. This window allows viewing of the LEDs to show normal operation (relay energized), alarm/set point (relay de-energized) and fault conditions (relay de-energized). It is very beneficial to confirm switch and process operation at a glance by viewing the LEDs.



Thermatel® Model TD2 with Window

Because the principal of operation of thermal dispersion switches is temperature dependent, manufacturers should provide temperature compensation in the electronics circuitry. The purpose of temperature compensation is to reduce set point drift under varying operating temperatures. The Thermatel Model TD2 with

spherical tip probe was tested in water for a set point of 15 GPM in a 2" pipe and showed minimal set point drift over a 75-185°F (24-85°C) temperature swing.

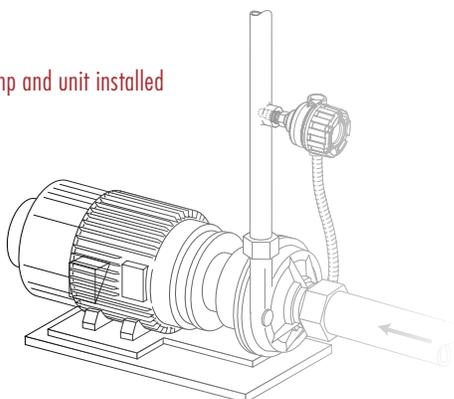


## Pump Installations

Both positive displacement and centrifugal pumps have performance curves to maximize efficiency. There is an ideal combination of differential head and flow rate that will provide the best results. If monitoring the differential head, a thermal switch can be set up to shut the pump down when it is operating below the ideal flow rates. Worst case scenario, the thermal switch is installed to verify there is liquid flow to prevent wear, eventual replacements and downtime.

Installing the thermal switch in the suction or discharge piping is acceptable. It is important to install in a location where the sensor tip will see liquid movement (in case of a partially filled pipe). When field calibrated, which is most often the case for thermal switches, it is not necessary to install at the centerline of the pipe. As long as the probe is far enough into the pipe to see liquid movement then it will provide repeatability at the given flow rate. A quarter to half way into the pipe is common.

Pump and unit installed



Installing a few diameters away from the pump will reduce excess turbulence. Turbulence may cause the switch to see higher flow rates than what is actually occurring inside of the pipe. Movement of liquid due to turbulence can theoretically create as much heat transfer as the liquid flow itself. The aforementioned current output is a helpful diagnostic feature in more difficult installations.

## Summary

Thermal dispersion switches are used in pump protection applications ranging from standard water to high viscosity liquids. There are unique sensor designs for each individual application, including the popular spherical tip, low flow bodies and high temperature/pressure probes. The multitude of probes in conjunction with the advanced electronics make thermal dispersion switches the most competitive technology on the market for pump protection.



Model TD2  
with low flow body



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