HB Products WE INCREASE UPTIME AND EFFICIENCY IN THE REFRIGERATION INDUSTRY

What does the industrial refrigeration industry gain from electronic components?

There is a great potential for energy and optimisation of operations in the industrial refrigeration industry. The natural way is using new technologies, implementation of intelligence as well as making gradual improvements in the refrigeration process, such as avoiding oil, air and water in places where these should not be. This article focuses on sensors as the first step towards the optimisation of refrigeration plants. Similar to the automotive industry where sensors have been essential in car production. Likewise sensors are essential for an optimised regulation of refrigeration plants within the refrigeration industry Furthermore, sensors allow new possibilities as they may be successfully adjusted to specific applications.

From the very beginning, the industrial refrigeration industry has been characterised by mechanical solutions and has remained unchanged until today. Compared to the commercial refrigeration industry, the volume of the industrial refrigeration industry on a global scale is considerably smaller and may be seen as a niche market. Another reason why the mechanical solutions have been retained is that the market is influenced by 2 large manufacturers (Danfoss and Parker RS) due to their historically immense experience with mechanical solutions.

A very long time ago, the personnel were responsible for the service of plants, i.e. checking of liquid indicators, oil level, manometers, etc. Today, there is a strong financial incentive to optimise monitoring of plant operations in one display. It is also preferred that the plant operates 100% automatically: it closes down automatically in case of safety precautions or turns on an alarm if the plant requires inspection or maintenance. Here the electronic sensors are essential.

A short insight into the history of industrial refrigeration branch

The first types of instruments used in the refrigeration branch were a mechanical pressure sensor, thermometers, liquid indicators as well as mechanical/electrical switches. Later, the mechanical pressure sensor was replaced with electronic pressure transmitters, thermometers by electronic temperature displays, whereas liquid indicators were replaced with level sensors. During the last 10-15 years, the mechanical/electrical switches are gradually being replaced by electronic ones.

Some of the first mechanical solutions are still being widely used today. They are simple and do not require adjustment to other components.

What are the limitations of mechanical solutions?

Mechanical solutions have their limitations! The greatest disadvantage related to optimisation is that they are not able to transmit a signal to a control board, and their reaction time is long. Mechanical components are bound to wear out, they are affected by dirt and oil, and they are much more elaborate to mount. Furthermore, their maintenance is very expensive since the pressure in the system must be cut off before maintenance, and a new cooling agent must be filled in.

Limitations of mechanical switches: it is not possible to install intelligence as, for example, in electronic switches.
A mechanical switch is digital: either ON or OFF. This limits the mechanical switches from achieving the most optimal position and thus the effectiveness of the entire plant. Furthermore, mechanical switches cannot identify the medium inside in the respective level (phase measurement).

Mechanical flow switch. Compared to electronic switches, the mechanical flow switch is twice as expensive to install and requires maintenance.

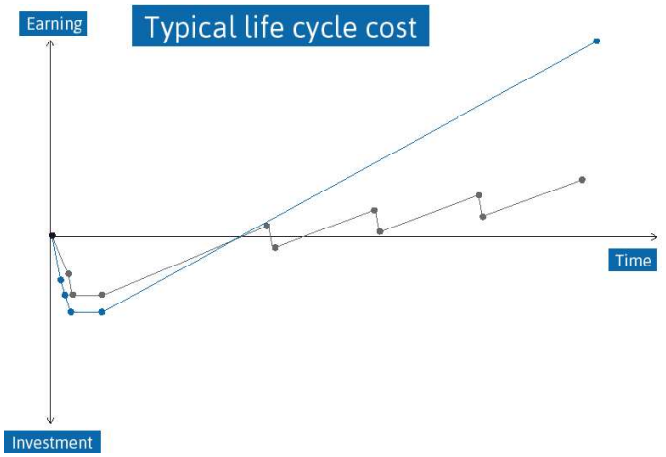
Limitations of liquid indicators: liquid indicators are mainly affected by dirt in the system and also to some degree by oil. When liquid indicators are dirty, they do not function properly and may have difficulty to identify the actual level. If the level is higher than the liquid indicator is able to detect, several liquid indicators must be mounted on a vertical column. In situations where the level must be read from a vertical column, it may be difficult to identity the level in the system with large fluctuations in a short period of time. This problem has been solved by measuring the level in a measurement meter, where wave movements are suppressed.

Limitations of mechanical level regulators: for instance, in chillers, level regulators are mounted that are in fact float switches, identical to the ones mounted in tanks. This restricts the mounting possibilities since the physical size and design require a certain location in the plant. Mechanical level regulators are also affected by the amount of oil in the system, because the oil may cause the valve to drop as well as cause wear on all moving parts. The valve is also digital, i.e. ON/OFF with no possibility to install intelligence.

Mechanical flow controller. Compared to an electronic flow controller, a mechanical flow controller is substantially larger and cannot be placed optimally in a chiller due to its size.

Are there any solutions to all mentioned limitations of using electronic sensors?

The answer is YES! Electronic sensors may also be used in other situations where there were no available solutions before. One of the greatest advantages of electronic sensors is that they have split design that allows performing diagnostics and maintenance without cutting off the pressure in the tank.
Are there no disadvantages at all? YES and NO – sensors are usually very expensive to install, because it requires both mechanical installation and connection to the control board. If one should consider sensors from the latter point of view, then they are not the right choice. But if one considers sensors together with the life cycle costs of a refrigeration plant, then sensors will minimise the need for operating staff.

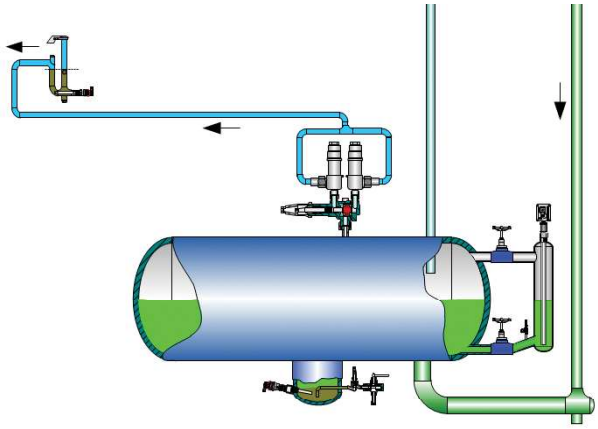


In the table, typical costs for the purchase and installation of mechanical and electronic components are indicated for the first period. The investment depends on the type, but in most cases the installation costs are slightly higher since the electronic components must be connected to the refrigeration system's controller. On the other hand, the revenue on electronic components is somewhat better, since the time needed for servicing and maintenance is eliminated.

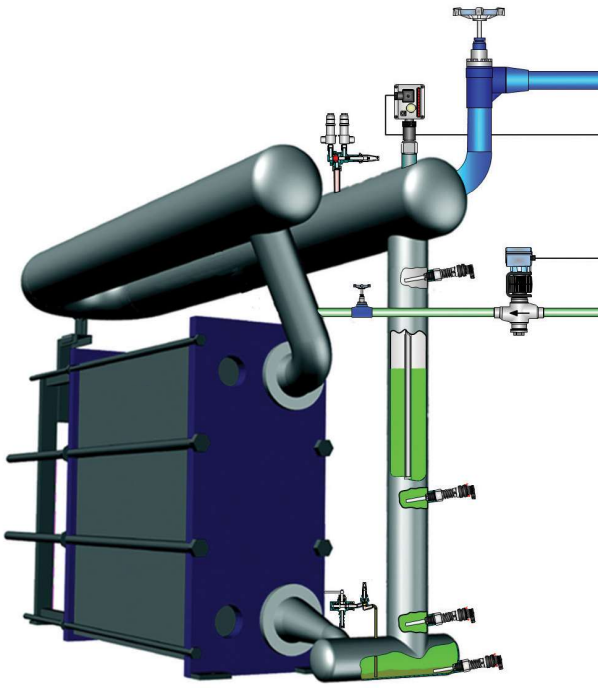
Advantages and possibilities of electronic switches:

An electronic switch can replace either a liquid indicator or a mechanical float switch. The technology often applied in the branch is the capacitive principle, where the sensor measures the dielectric constant, and the measured signal is then processed in a microprocessor with an opportunity of several output signal types. The switch functionality allows installing the following applications:

1. Detect whether there is a specific level in the tank. In this application, the sensor has been programmed so that it activates only the cooling agent and not oil or dirt.
2. Detect whether there is a specific level in the oil tank, flow in a tube or oil in the compressor. In this application, the sensor has been programmed so that it activates only the oil and not the cooling agent. A mechanical solution or other electronic sensors with other measuring principles would not be able to measure this difference and would result in break down of the compressor.
3. Detect whether there is a specific medium at a define level in the tank. In this application, the sensor functions as a phase difference indicator, i.e. it can signal whether the oil or cooling agent is present. The measurements are taken at the bottom of the tank where the oil is accumulated (ammonia plant). An operationally reliable identification was not possible before when oil draining was necessary.
4. Detect whether the pressure in the system has been too high, and thus whether the safety valve had been activated. The sensor is mounted at the outlet tube with the water seal function, and the oil is filled in the water seal. In this application, the operational improvement of safety valves is simultaneously performed since they are not disturbed by air or air traps in the tube system.



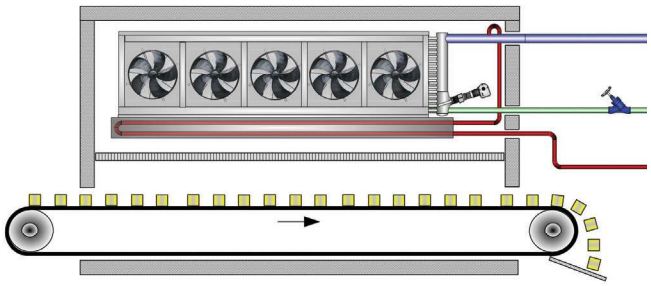
Electronic switches allow for many possibilities since they have built-in intelligence. Here you can see a sensor that sends a signal to the operator when the oil sump needs to be tapped. In conjunction with the safety valve, a sensor is placed at the outlet of the pipework, which sends a signal if the safety valves have been opened.



U-tube plate heat exchangers from Alfa Laval are fitted with electronic level control, min./max. level, as well as alternative detection of oil in the outlet of the exchanger. This allows for automatic monitoring and control of the level in the plate heat exchanger, as well as safety monitoring.

5. The electronic switch can replace liquid indicators in refrigeration tunnels that are used for identification of the level of cooling agent. This switch type may be used at -50 C and has a high level of tightness that allows high-pressure washing and high temperatures.

All application types may be mounted according to



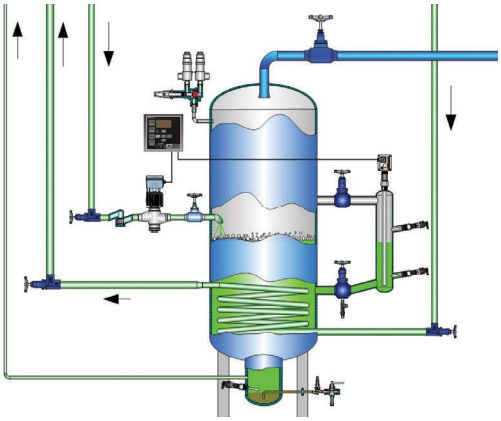
In the freeze tunnel, an ice-proof switch is used which provides an indication of the level of the cooling liquid. The alternative to this was sight glass, which was inappropriately placed and was therefore not always monitored, with the risk that the pipework might burst during defrost.

PED Directive category 4. At category 4 installation, signals must be doubled and connected according to the EN50156 standard via a safety relay or a safety PLC. There are several possibilities for this on the market, for example, Wieland's safety PLC Samos Pro complies with the requirements of the EN50156 standard.

Advantages and possibilities of electronic level sensors:

Level measurements in tanks are also performed according to the capacitive principle, where the same advantages are reached as for switches, i.e. the sensor is less affected by oil and dirt. The function is also the same, where the sensor measures the dielectric constant and the level that is turned into charging (capacity). The level of charging is linear with the level in the tank. Also here, the signal is processed in the microprocessor with an opportunity to adjust it to a specific application. Usually, a 4-20 mA signal is used from the sensor as a linear indication of the level in the tank. In addition to the function of measuring the level, the microprocessor has a range of other functions:

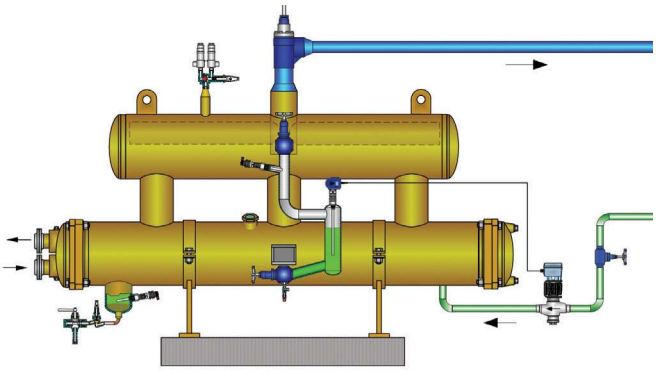
1. Alarm limit may be set in the area 0-100 %.
2. A filter may be installed that subdues the signal and provides an average measurement in case of wave ripples in the tank. Allows mounting the sensor directly in the tank during the welding of the measurement meter.
3. In addition to measuring, the sensor can also function as a regulator, i.e. pump or valve control may be performed directly from the sensor. This allows reducing board installation costs.



Economisers are fitted with an electronic level control, and min./max. level switches are installed in the tank. Similarly, a switch is installed for detecting the oil level in the oil sump. This allows for automatic operation of the receiver, as well as the possibility of controlling the liquid level.

Advantages and possibilities of electronic level regulators:
An electronic level regulators are merely a short level bar with the same regulating functions as described in point 3 under level sensor. The set-up functions of the microprocessor in this application have been expanded. Here, it is possible to set:

1. Regulation functions: low or high pressure switch.
2. Min. or max. alarm
3. Set point and P-band



Chillers are fitted with an electronic level control. The minimalistic design of the control system allows for better placement of the control system and the liquid level in the chiller.

4. Output function: NC or NO in addition to programming functions, this solution is considerably more flexible in relation to the mounting, and the regulation may be performed at a more optimal location.