

Monitored cooling for robot spot welding units – How a fast detection of leaks in the cooling system enhances the reliability of welding robots

A background image showing a microscopic view of numerous water droplets of various sizes, some in sharp focus and others blurred, against a light blue background. Two semi-transparent blue rectangular boxes are overlaid on the image: one on the left and one on the right. The 'bürkert' logo is positioned in the bottom right corner of the right-hand box.

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Monitored cooling for robot spot welding units – How a fast detection of leaks in the cooling system enhances the reliability of welding robots

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Robot spot welding units are widely used in the highly automated production lines of the automotive industry and its suppliers. To meet the stringent quality requirements for welding while ensuring 100% availability and reliability of the individual components and welding robots, controlled optimised cooling of the welding is imperative. Operators must therefore be in a position to quickly and accurately detect any leaks in the cooling system caused by worn electrode caps and other defects.

In the assembly halls of car manufacturers, there are often several hundred spot welding robots at work. In the production of cars along large assembly lines, robots produce up to 40 high-precision spot welds within extremely short cycle times - in three shifts around the clock. In order to dissipate the heat produced by the high currents in the welding process, it is necessary to cool the tips of the electrode clamps commonly known as electrode caps. The copper electrodes used in the process are designed as wear parts and must be regularly replaced. Without cooling the tips, the electrodes would however be worn much more quickly. This would not only result in higher costs due to electrode failure, but also in loss of production due to frequent shutdowns for maintenance of the equipment. To prevent this, the electrode caps of spot welding robots are cooled with six to eight litres of water per minute. The cooling water has a temperature of between 20 and 40 °C and is supplied at a pressure of up to 10 bar.

Despite continuous cooling, the electrode caps remain highly susceptible to wear, so that there is a high risk of leakage of cooling water in the plant. Such leaks do not only lead to downtimes but can also cause damage to sensitive plant components such as electronic parts. In addition, there is a risk of injury to the machine operator from water escaping under pressure. The systems used to cool the electrode caps must therefore be able to detect leaks quickly and to interrupt coolant flow instantly by means of suitable shut-down devices. In the event of a defect at an electrode cap, the cooling system must respond within less than half a second. Depending on the quality of the cooling water, the task in hand and the potential effect of a leak, car manufacturers have chosen different solutions that are discussed here in more detail.

Conventional large-size system

Electrode caps in spot welding robots must be replaced when leakage occurs or the cap is lost due to wear. In addition, operators have adopted strategies to prevent downtimes, whereby electrode caps are replaced at the beginning and end of each shift as a routine measure. Cooling systems for electrode caps typically consist of components from various manufacturers. In such systems, a flow controller, a feed and return valve and possibly some pneumatic control valves are connected through tubes to each other. One of the main disadvantages of this type of system is its large size. Dimensions of 1000 x 600 mm are fairly common. In plants where several robots are operated in close proximity to each other, the space requirements for such systems can pose a problem. Another disadvantage of these systems lies in the sensory equipment. The flow controllers that are normally used here are inexpensive, but their switching point is not very accurate. This significantly limits the flexibility of the system. Due to the large hysteresis of the flow controllers, response time in the event of a leak is rather long. In addition, these controllers are unable to respond adequately to small flow rate deviations of less than one litre per minute or small leaks (cause for example by hairline cracks in the feed or return line), as they often fail to switch altogether or switch too slowly to close the cooling water circuit within the necessary time limit.

Compact, integrated tailor-made solutions

The combination of sensory equipment, valve technology and controllers in small compact units provides a flexible and reliable solution for these problems. Such high-performance integrated systems can be assembled according to the requirements of the operator and the specific application from predesigned modules. This approach allows for the production of tailor-made intelligent systems for the cooling of electrode caps that guarantee zero leakage in the event of a loss of an electrode cap or during replacement.

Depending on the type of electrode clamps used, these modular cooling systems can be equipped with pneumatic or hydraulic drives respectively. Operators of electrode clamps with servo motor drives are often looking for cooling

and monitoring systems that are electrically controlled. Electrically driven electrode clamps are mainly used in applications where extremely accurate positioning is required. In practice, pneumatically operated electrode clamps are however still the more popular and reliable solution, as such clamps can easily be positioned with the accuracy typically required for spot welding applications.

Modular cooling systems with pneumatic drive elements

The integrated cooling water monitoring block consists of a pilot valve, a feed and return valve and a flow rate sensor (see fig. 1). The main advantages of the block solution are its compact size and the option to provide additional connections for secondary cooling processes such as for example a thyristor cooling system.

During operation, the pilot valve is switched in such a way that both the feed and return valves are opened. The cooling water can thus flow freely through the electrode clamps. As soon as a leak occurs, the flow rate sensor actuates the pilot valve. As a consequence, the feed valve is switched to close the cooling water circuit. The return valve closes with a delay that is preset by means of a restrictor. This delayed shut-off ensures that the pressure in the electrode clamps is reduced through the return valve. The backpressure occurring in the return lines continues pressurising the lines of the electrode clamps. This pressure can reach up to 2 bar so that some small leakage still occurs when the electrode caps are being replaced.

No leakage with relief cylinder

To prevent this, the modular cooling system can be equipped with a relief cylinder in the form of a MasterJet unit from Bürkert (see fig. 2). This cylinder is pneumatically preloaded during operation and relieved in the



Fig. 1: Cooling water monitoring block with diaphragm valves and flow switches

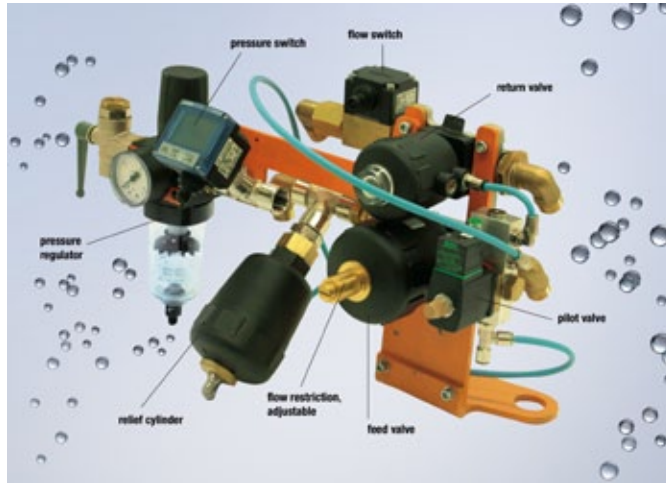


Fig. 2: Air unit and Cooling water monitoring block with Pressure regulator, Pressure switch, diaphragm valves, flow switches and MasterJet relief cylinder

event of a leak or during cap replacement. The pressure inside the electrode clamps of maximum 2 bar is thus relieved through the cylinder. This ensures that no water can escape the system while the caps are being replaced, irrespective of the actual pressure in the electrode clamps. The MasterJet offers another significant advantage: when the cooling system is restarted, water is fed

back from the cylinder into the pipeline, effectively preventing air bubbles in the lines. There is thus no need for additional bleeding measures and the system can be restarted without faulty sensor signals. Restarting therefore takes only two to three seconds. Without the MasterJet, the restart time would be around 15 to 20 seconds. Taking into account all these advantages, the relief cylinder pays for itself within a very short period of time. In addition, MasterJet solutions are very compact in design so that the monitoring block can be installed directly at the base of the welding robot close to the actual process.

Modular cooling systems with electric drive elements

The design and function of the integrated cooling blocks with electrically operated solenoid valves correspond to that of the pneumatically operated systems (see fig. 3). They also provide additional connection ports for the cooling of thyristors. The use of electrically operated cooling systems is particularly recommended for plants where the electrode clamps are equipped with electric servo motors, as the cooling blocks do not require compressed air supply lines. On request, electrically operated cooling systems can be fitted with an auxiliary pump. In the event of a leak or during the replacement of the electrode caps, the pump removes the trapped coolant to the return line, thus preventing cooling water escaping during electrode cap replacement. There are however some disadvantages to this solution. Apart from the relatively high cost of the pump, air is trapped in the line when the machine is restarted, which is not the case with the relief cylinder of pneumatically driven systems. The trapped air causes faulty measurements of the sensory devices, which in turn delay the restart and cause longer downtimes of the robot welding units.

Customised sensory equipment and valve technology

The choice of the optimum sensor and valve technology for cooling systems for spot welding robots is determined by a number of different factors. One

of the most important issues is thereby the quality of the cooling water. It is often contaminated and contains iron (Fe) and oxygen (O₂) magnetite resulting from chemical reactions. In this case, we recommend using direct-acting valves such as seat valves or diaphragm valves rather than electrically driven valves, as particles in the cooling water can block the pilot channel that is crucial for the proper functioning of the latter.

Diaphragm valves also have the advantage of very low flow rate losses and pressure drops in the valve. If the required flow rate can only be achieved with servo-assisted solenoid valves, we recommend using media-separated valves (see example in fig. 3) where the cooling water containing magnetite is not in direct contact with the magnetic coil.

Key factors for the choice of the correct sensors are the number of adjustable electric switching points (one or two), the design of the outputs (analog or frequency) and the response time in the event of a leak (normally between 300 and 500 milliseconds). In addition, operators must consider whether the



Fig. 3: Cooling water monitoring block with solenoid valves and flow sensor with integrated temperature sensor

sensory equipment can be properly integrated into the system. The integration of paddle wheel sensors is for example much easier than that of ultrasonic sensors, (see fig. 4), as paddle wheel sensors tend to be smaller in size. When choosing between these two sensor types, the level of contamination of the cooling water must also be considered. As an alternative to systems with summary coolant return flow monitoring of both electrode caps, operators can opt for solutions where the cooling water flow of each electrode cap is monitored separately (fig. 4). Such solutions allow operators to easily determine the level of contamination in the cooling lines.

For the cooling of electrode clamps in spot welding robots, the use of compact devices with integrated sensory equipment, valve technology and controllers offers a range of advantages. Such modular systems can be individually configured to provide optimised cooling solutions for specific applications and operator requirements. In contrast to conventional solutions consisting of products from various manufacturers, integrated solutions are much more compact in size and their components are specially chosen for optimised interoperability. Integrated systems are suitable for various water quality levels, are available with a wide range of diameters and sensor types and come with or

without display. Pneumatic and electric drive units allow for perfect integration into the existing plant environment. By using a configurable control system with operator-specific software, customers can acquire intelligent tailor-made cooling systems that guarantee zero leakage in the event of loss or replacement of electrode caps in their production environment.



Fig. 4: Sensor technology for electrode clamp cooling (from left) Paddle wheel sensor for systems with 4-20 mA/frequency and switching output Ultrasonic sensor with 4-20 mA or frequency output Dual paddle wheel sensor for separate flow monitoring at each electrode cap

Contact

Can we help you to detect leaks faster in your cooling system of welding robots? Just contact

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