EMG

SAFETY IN AUTOMATION

DEVELOPMENT OF THE BRAKE THRUSTER

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In principle, everything that is moved also needs to be slowed down. Safety has always been the single most important factor in this regard. As the last link in the chain of safety measures, the braking system and the corresponding brake thruster ensures the safety of man and machine, even in the event of a power failure. Increasing safety standards demands almost complete condition monitoring of the systems, including early wear detection to prevent unplanned system standstills. This trend has had a significant impact on the development of brake thrusters and it has resulted in increased availability and reliability.

THE FIRST BRAKE THRUSTERS

The first braking systems in recent history were so-called band brakes, which were used, for example, in the crane and textile machinery sectors. This involved a textile or leather belt being wrapped around a drum. The friction created between the belt and the drum generated the braking force during a braking procedure. The respective ends of the belt are secured to fixed points and loaded by means of a weight, a spring or a wire rope hoist that is operated by muscular force.

These types of brakes have often been vented/opened via a magnetic brake thruster. However, the shock-like operating method caused by the hard impact of the laminated cores against the magnetic iron and the comparatively high starting current were, and are, a major disadvantage of this generation of brake thrusters. Another disadvantage is that if the tension rod is clamped in the brake, the magnet does not become fully activated and the coils can be burned as a result of the high starting current.

THE ELECTROHYDRAULIC BRAKE THRUSTER

While developing the band brake through to the drum brake and disc brake, the electrohydraulic brake thruster was developed. The electric motor and the coaxial enclosed hydraulic system together form the essential components of this brake thruster. The operating medium of the hydraulic system is utilized as the medium for generating the force. When the thruster is switched on, the centrifugal pump conveys the operating medium under the piston and forces it against an external load (brake spring in the brake thruster or brake) to the upper end position. The pressure under the piston depends on the speed of the impeller wheel and the surface area of the piston. The work resulting from the product of force x stroke (W= F x s) is transferred to the device to be actuated via the piston rod and pressure plate.

At the respective end position, the power consumption of the motor reduces in comparison to the power consumed during the lifting process due to the laws of hydraulics. As a result, an electrohydraulic brake thruster is not susceptible to a mechanical overload, e.g. blocking of the brake. For this reason, a thermal protective circuit is not required. When switched off, the piston travels quickly, yet smoothly (due to oil damping) to the lower end position under the influence of the brake spring (in the brake thruster or brake). This ensures that the brake always closes, even in the event of an operating error or a possible power failure. This principle of operation is thereby 'fail safe', as the impact of an error can be reduced to a minimum without suffering any damage.

Further advantages of this new development include the high permissible switching frequencies and continuous operation in conjunction with low energy consumption and a constant lifting force. In addition, the small footprint of the electrohydraulic brake thruster and its lower weight in comparison to a magnetic or motor brake thruster offers yet further advantages. The lifting and lowering times can be infinitely adjusted by using a lifting and/or lowering valve. Brake thrusters are used, for example, with a lowering valve in static storm brakes to prevent a port crane from moving as a result of external environmental influences.

AREAS OF APPLICATION

This type of brake thruster has become established over the years in a wide variety of applications and has gained acceptance worldwide. The structurally robust design forms the basis for trouble-free operation, even when subjected to the most adverse environmental conditions.

Whether they are used in Siberian opencast mines at minus temperatures or in steelworks at very high temperatures, the electrohydraulic brake thrusters operate in an extremely reliable manner and ensure a high degree of availability. These brake thrusters have proven to be particularly successful when used in port crane systems. When subjected to heavy loads with regard to the switching frequencies, the brake thrusters help to ensure the goods are handled as quickly and smoothly as possible.

STANDARDIZATION

The standardization of industrial brakes and brake thrusters presented a further milestone in terms of development. The dimensions, technical characteristics and specific properties have had a significant influence on the standardization of modern industrial brakes. In cooperation with renowned brake manufacturers, the industry itself and standard committees, the electrohydraulic brake thruster has been developed to its present status and is specified, for example, in standards DIN15430 and SEB 602471. In order to eliminate barriers to trade within the market, national norms and regulations have increasingly been adapted to suit established international standards.

MILESTONE OF FURTHER DEVELOPMENT

Significantly increased market requirements in terms of faster loading and unloading times for container ships mean the brake thruster has been continuously developed over the years to fulfil market requirements. On the one hand, the brake thruster needs to demonstrate faster lifting and lowering times with increased lifting forces and, on the other hand, it also needs to offer the option of monitoring components while maintaining the same installation dimensions. By optimizing the geometries at the pump stage, the requirements with regard to the lifting force and lifting/lowering times could be realized.

In terms of its monitoring sensors, the electrohydraulic brake thruster is equipped with mechanical or inductive (contact free) limit switches to indicate the braking position electrically. These sensors were yet another milestone in the development phase. From this point on, for example, it was possible to detect the level of wear of the brake pads based on the residual stroke or to visualize the condition of the braking position at the decentralized maintenance station. The integration of sensors plays a key role in monitoring the braking systems

with regard to the information 'brake open' and/or 'brake closed', as well as wear detection of the brake pads. These types of sensors have influenced the condition monitoring of systems and machines by personnel and have made it unnecessary for them to conduct inspections in partially dangerous areas. From now on, personnel only had to intervene in the event of an error and replace a worn component when required.

This possibility of monitoring, however, also has its limits. In principle, for example, an end position sensor can only deliver two signals. Either the sensor is actuated and issues the signal 'brake open' or 'brake closed' (OK), or no signal is generated (not OK), which in turn results in an error message. Unfortunately, this limited monitoring function has resulted in components being operated up to a state of total failure and only then being replaced or maintained. As such failures do not usually announce themselves, system standstills were, and are, not that uncommon. To deal with these types of worst-case scenarios, operators usually have a spare component in stock that can be used as and when required.

BRAKE THRUSTERS OF THE FUTURE

In the future, the practice of using a component up to the point of failure will no longer be state of the art. The networking and condition monitoring functions, which are a result of the increasing digitization (Industry 4.0), are not limited to the brake systems and play an increasingly important role. Key safety-related components in particular need to be equipped with sensor technology in order to deliver the relevant status information to the port interface, thereby enabling them to be recorded and evaluated by the evaluation electronics. Only having one piece of information available, such as whether the component is OK or not OK, is far from sufficient. Today, all of the information provided by sensor technology must be combined in the interface and various physical variables such as the temperature, pressure, power consumption, etc. need to be evaluated in relation to the switching frequencies and/or operating time. Only then is it possible to develop a logarithm that can calculate and evaluate the wear behaviour of the component.

The aim is to provide a kind of 'yellow' signal, which would mean that the component is showing signs of progressive wear and a maintenance procedure is due within the next few weeks. Using continuous condition monitoring and the referencing of environmental influences as a basis, the next maintenance period would be able to be predicted extremely accurately. This would give the port operator the security of being able to maintain the component during the next scheduled system standstill before an unplanned failure could occur.

In addition, the safety stock of spare components could be reduced to a minimum, as it is now no longer necessary to plan for unforeseeable failures. Automotive manufacturers have been using this technology for several years to calculate the next oil change, for example, which is based on driving behaviour and relates to a specific mileage or a particular period of time.

As a result, the 'red' signal will gradually disappear completely from the monitoring electronics. What would remain is the 'green' signal, which describes the perfect operating condition of the component and a 'yellow' signal, which indicates the next maintenance period in a timely manner.

The intelligent braking system of tomorrow is fully connected to the port interface and delivers continuous information about the current condition of the brake. Permanent condition monitoring, which is used to monitor the key components, is evaluated by the system in order to enable precise maintenance recommendations. When combined with evaluation intelligence, sensor technology can ensure maximum planning reliability and system availability.

A further report will be published in the fourth quarter of this year that follows on from this report; this will address the initial ideas and solutions for connecting the brake thruster to the operator's PLC control system to ensure permanent condition monitoring

ABOUT THE AUTHOR

Eduard Musalf started his career at EMG back in 2006 and has since worked in several areas within the organization. During his 12 years of service he has worked in the strategic quality management sector and is now the After Sales Manager for drive technology. Thanks to his extremely close contact with the end customers, he is able to classify market requirements and make targeted proposals for solutions.

ABOUT THE ORGANIZATION

80 years of experience, more than 2 million installed thruster, 100% safety. The ELDRO® and ELHY® brake thruster brands from EMG Automation GmbH in Wenden, Germany, ensure the safe operation of port crane systems all over the world. The brake thrusters that are "Made in Germany" are used, for example, to actuate braking systems in large gantry cranes and port crane systems.

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