Applications for high-pressure equipment are numerous in industry. The more efficient the technology, the more savings can be made.

Source: WOMA

Full automation marks a milestone in water jet technology

Stephan Venhoeven

Automatic transmissions have been used in industry for years. However, it's only now that they can yield their full benefits, thanks to an innovative control system. In water jet technology, this offers enormous advantages in terms of efficiency, particularly for users who have a wide range of cleaning tasks. Water consumption can be reduced and the safety of operating personnel improved. Optimally coordinated working parameters increase the equipment's cost-effectiveness, make for shorter inspection times and enhance productivity. The user effectively becomes the operator of a smart control centre.

It is impossible to imagine industrial cleaning without the use of high-pressure equipment. This is an elementary tool when it comes to cleaning heat exchangers, pipelines, tanks and all kinds of surfaces. Whether you are in the energy sector or the chemical industry, the applications are numerous. Cleaning capacity is based solely on the power of the water. The efficiency of the cleaning task is the result of the correct combination of water tool, water pressure and flow rate. Innovative control technology combines these factors with the high-pressure device. In future, therefore, cleaning tasks can be carried out with increased efficiency, speed and safety and the required volume of water can be metered out appropriately so that resources are conserved.

Fuel savings resulting from a reduction in speed also cut CO_2 emissions. At the same time, both pollutant and noise emissions can be reduced significantly.

More efficiency reduces costs

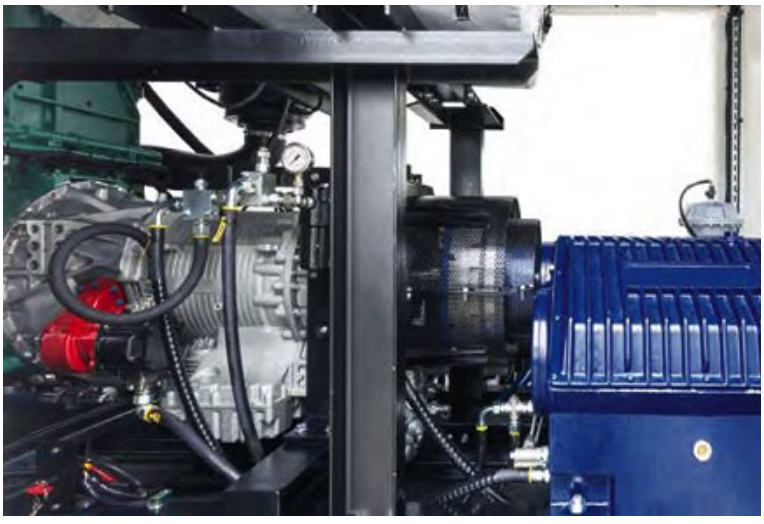
The savings involved are significant. On average, continuous use of a device with an intermediate gear consumes up to 40 litres less diesel fuel per hour. At peak times, the gearbox can save up to 35% of total operating costs compared to a device without an intermediate gear. A variety of gear ratios means that the engine speed is always reduced precisely to the optimal performance point of the application. As a result, the required volume of water is available at all times and no excess volume needs to be discharged as bypass water, even in low-consumption mode. Wear and energy costs are minimised and the energy supplied by the motor can now be converted almost 100% to hydraulic power. Powerhosing is also a cost-effective and environmentally friendly cleaning method compared to alternatives. For example, it can cut costs by up to 60% vis-à-vis sand or wet blasting.

The automatic transmission – gentle, safe and flexible

When it comes to high-pressure equipment, the automatic transmission represents a milestone in water jet technology. The pump speed can be controlled within a power range of 50-500 kW via the unit, which is integrated between the high-pressure pump and the motor. The volume of water appropriate to the tool is therefore metered out precisely. Five gear ratios enable fine-tuning to suit a variety of applications. The multistage gearbox is also equipped with an overdrive function: an exceptionally energy-saving gear, enabling efficient consumption at high output. The unit can therefore operate at full capacity with comparably low fuel consumption. At the same time, both pollutant and noise emissions can be reduced significantly.

The robust and reliable gearbox was developed on the basis of decades of experience , can withstand harsh working conditions and has a long service life. Its use in a variety of applications involving constant load changes and shifting as well as continuous operation can be taken for granted. Its six gears enable fine-tuning, a low-consumption speed range and an optimal flow of water. Comparable transmissions with fewer gears have harsh shifting behaviour and coarser tuning, leading to high wear in the unit components.

The wide ratio spread of 11.92 ensures a gentle transition between the individual gears. Such a large ratio between the lowest and highest gear is one of the quality features of the gearbox.



Source: WOMA

Fig. 1: The automatic transmission is installed between the engine and the pump.

Source: WOMA

Fig. 2: Overall structure with intermediate gear

This applies not only to manual transmissions, but also to automatic and continuously variable transmissions. The soft-start torque converter assists with gear changing and helps balance larger spread stages. The materials are thus protected significantly in comparison to direct starting at engine speed. Three planetary sets with multi-plate clutches ensure that power shifting can be carried out without interrupting the flow of power or reducing the engine speed or torque. The adaptive shifting processes select the shifting parameters depending on the situation, thereby protecting the drive components.

In pump technology too, lower operating speeds resulting from the gear ratios protect all the components.

The integrated torque converter acts as a damping element between the drive and the high-pressure pump, supporting a soft start and increasing the engine torque for faster start-up processes. The converter has a lock-up clutch for greater efficiency, with direct through-drive from the engine to the gearbox. The clutches work in parallel, i.e. clutch 2 closes to the same extent as clutch 1 opens. As a result, shifting takes place without interrupting the tractive force. The omission of the starting clutch means that clutch damage and clutch changes, which occur in manual and automated transmissions, do not occur. The smooth, seamless full-load shifting protects the entire drivetrain and facilitates operation, even when working on a range of different applications. There is no need to switch off the engine or struggle with any stiff levers and controls.

With continuous power technology, the transmission is put into neutral in milliseconds in the event of a breakdown, thus preventing any potentially expensive consequential damage to the high-pressure machine. Only the routine oil and filter changes need to be carried out as maintenance work on the transmission components. These ensure that the gearbox and clutches are practically wear-free. With synthetic special oils, maintenance cycles of four years or even up to 6000 operating hours can be achieved without significant wear on the gearbox or clutch.

The high-pressure plunger pump: developed further to meet the latest requirements

In pump technology too, lower operating speeds resulting from the gear ratios protect all the components. Not only do they ensure a longer service life for the high-pressure pump, they also significantly reduce the noise emission of the entire system. In water jet technology, carbide plungers are used in pumps with an operating pressure in excess of 1000 bar. These are particularly stable, guaranteeing a long service life and associated low maintenance costs. The optimised plunger guide design also ensures a long service life for the seal system. High volumetric efficiency is achieved thanks to the central valve design in the water section. The employed sealing water system prevents leakage and the ingress of air, making the high-pressure seals particularly durable.

Pumps with 400-700 HP are preferred in conjunction with fully automatic intermediate gears. With water pressures of up to 1500 bar, this performance class achieves a maximum nominal flow rate of up to 744 litres per minute. Some pumps in this performance class, which are used in potentially explosive gas atmospheres, are also available with ATEX certification for safety level 2 (zone 2).

The control system – a step towards automated cleaning

The demand for a high degree of automation and the desire for a simple representation of complex processes are also taking water jet technology in new directions. Electrical control systems became established some time ago in many parts of the world with the aim of increasing efficiency. The combination of technological efficiency and expertise in the field of control systems has meant that efficient plunger pumps operate almost completely automatically. In water jet technology, fully automated transmission control and innovative functions of modern control technology represent a further step towards automated cleaning.

Source: WOMA

Fig. 3: The high-pressure plunger pump with 700 HP has a maximum operating pressure of 1500 bar.

The control system combines the functions of motor, pump, valve and sensor control, keeping the operating status and all operating parameters completely manageable at all times. A 7-inch HMI colour display guarantees high resolution and the output of all machine data via intuitive menu navigation. The symbols and short plain texts enable all operating parameters, such as operating pressure, temperature or gear preselection in the intermediate gear, to be displayed clearly on just one page. The user can

therefore enjoy intuitive guidance and carry out cleaning with ease. Handling the machine is simple thanks to numerous interfaces including CAN bus, Ethernet, RS-232 and USB 2.0, along with the integrated keys and rotary controls on the display. These are easy to operate, even with work gloves on. In future, updates will be installed via a USB interface without the need for any complex programming. Error messages can be read out, analysed and, if necessary, operating errors can be transferred onto a USB stick just as easily. The controller, with its large number of connection options, is a response to user demand to also have flexible interfaces in ultra-high pressure technology. Developers also focused on time-saving operation as well as easy expandability through the addition of further functions or the integration of application solutions.

The automated control system, which regulates the flow rate, makes it easier for the user to coordinate the water tool to suit the equipment settings. The nozzle arrangement and the preselected operating pressure serve as indicators. Tailoring automated water tools to the high-pressure machine enables huge time-savings to be achieved. In cases where multiple cleaning cycles are required with operating parameters that are less than optimal, or if manual reworking is necessary, care must be taken to select the right water tool settings. Apps for smartphones and tablets also help making correct calculations for water tools and assist the user in selecting aids. Fine-tuning and the resultant final coordination between the tool and the machine is carried out by the control system.

Source: WOMA

Fig. 4: The control display clearly shows the machine status and all operating parameters.

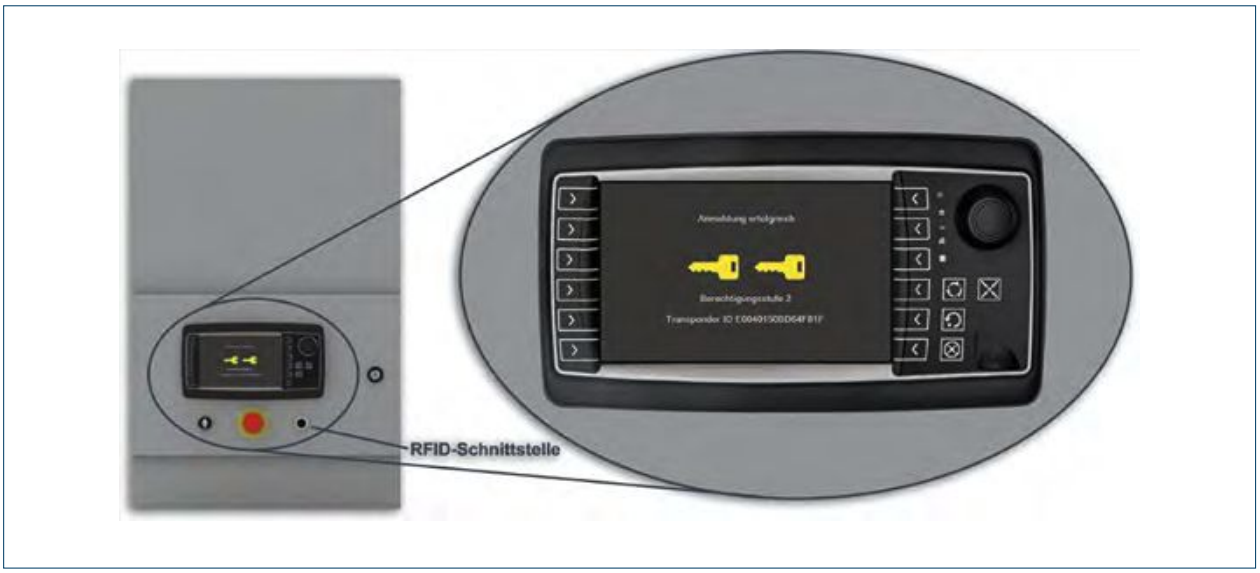
RFID technology improves safety

In the field of water jet technology in particular, complex machines should be operated only by trained personnel. This guarantees protection for both the operator and the machine and its components. The new control system uses RFID technology to ensure that each user is assigned a role appropriate to his experience as an operator, supervisor or service technician. A reader installed in the controller assigns an authorisation level or an application profile to users via a transponder. Whereas an operator has various rights, specifically with regard to application, such as starting the machine, changing the operating mode, preselecting the set pressure and set speed and starting high-pressure operation, a supervisor or service technician has additional authorisation.

The supervisor also has the right to specify the pressure range, set operating parameters such as water hardness and idle speed, read the event memory or install new updates. The service technician can also activate the service mode and define or reset maintenance intervals for the individual components or define minimum and maximum settings for the load speed, control pressure or operating pressure of the machine. RFID rights allocation prevents the machine from being operated incorrectly, whether through negligence or wilful intent, or even tampered with. Profile assignment enables clear, fast and simple traceability of events and also protects against unauthorised use or intervention in the working process.

Reduced risk of injury

The control system for the high-pressure device also helps to prevent health problems caused by incorrect handling and significantly reduces the risk of injury. Through the automatic preselection of the flow rate to suit the nozzle diameter and operating pressure, the prescribed maximum recoil forces are indicated when working



Source: WOMA

Fig. 5: After RFID authentication, the equipment release is shown on the display.

with hand-held spraying equipment. Users are obliged to comply with these regulations. However, the reality, is very different. Many users do not calculate the recoil forces correctly, but work close to the limits or even exceed them in order to achieve better cleaning results or complete the cleaning task in a shorter time. In the long run, however, the increased physical strain leads to illness and malfunctions. This can specifically be prevented thanks to the transparency of the control system and targeted profile assignment with automatic flow control and plus aids, such as nozzle preselection via the controller or the app.

The control system keeps the operating status and all operating parameters completely manageable at all times.

For the first time, condition monitoring enables complete management of entire fleets in Germany or abroad.

Stay up-to-date at all times with condition monitoring

A newly introduced telematics module provides information about the current operating status of the high-pressure unit at all times. The current operating status of the machine can be called up at any time and from any location via a GPS signal. Moreover, an online portal offers the option of viewing the current location of all personal systems or of monitoring and planning maintenance intervals. Along with status information and error messages, it is also possible to inform and warn the supervisor if the machine is being operated incorrectly by the operator.

Source: WOMA

Fig. 6: The cloud analyses operating conditions and therefore enables maintenance cycles to be planned better.

The advantage of this condition monitoring becomes particularly obvious when multiple devices are in use at different locations in Germany or abroad. This makes the proactive monitoring and management of entire fleets considerably easier. Effectiveness monitoring enables evaluations to be made with regard to fuel consumption, engine load or availability over defined periods of time. All data is presented online in a transparent manner and is available at all times or can be read out from the control system by a service technician. Thanks to the optional relaying of malfunctions, specific measures can be initiated for maintenance preparation. This reduces downtimes to a minimum. Fleet management does not only help with capacity and investment planning, but also enables optimal utilisation of individual machines and entire fleets.

A huge step forward

Through telematics, RFID user profiles and complete automation of the machine control system, high-pressure devices with automatic transmissions are setting the trend for cleaning tasks in industry with water jet technology. In addition to the significant savings potential in terms of fuel and emissions and maximal operator safety, users also benefit from significantly greater variability and flexibility, enabling them to carry out a wide range of different industrial cleaning tasks better and faster than ever before. All in all, that's an impressive degree of safety and efficiency.

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