The dual-displacement pump concept is especially suited for applications with presses, where the pressure and flow rate requirements can vary greatly during the work cycle. The system enables you to reduce the required torque of fixed displacement pumps for challenging applications, resulting in a smaller and more cost-effective drive system.

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New drive concept for **presses**

Advantage of the variable-speed axial piston pump with two-point control

Parker Hannifin shall be showcasing a new variant of the variable-speed pump system at the Hanover Trade Fair 2017. The company has combined an axial piston pump, which has two displacement volumes, with a synchronous servo motor and the AC30V inverter drive.

Variable-speed pumps have meanwhile proven themselves in many different industrial applications. For this, pumps with a constant displacement such as internal gear pumps and vane pumps are most often used. This combination of a variable-speed motor and fixed pump is the simplest and most self-evident. However using variable-speed dual-displacement pumps certainly offers some comparative advantages.

The flow rate and pressure requirements during the work cycles vary between industrial applications. Typically, you require either high flow rates with low pressures or low flow rates with high pressure. A good example are the rapid and creep speeds offered by presses: Depending on the application, the phases vary in length, during which high pressure is to be applied. Blanking presses only require the maximum pressure level for a short time when cutting. By contrast, rubber or composite presses often require sustained pressure levels for more than ten minutes. Since high pressure and high flow rate are seldom required simultaneously, electric drives with excessively high torque are chosen. This is an area where savings could be made.

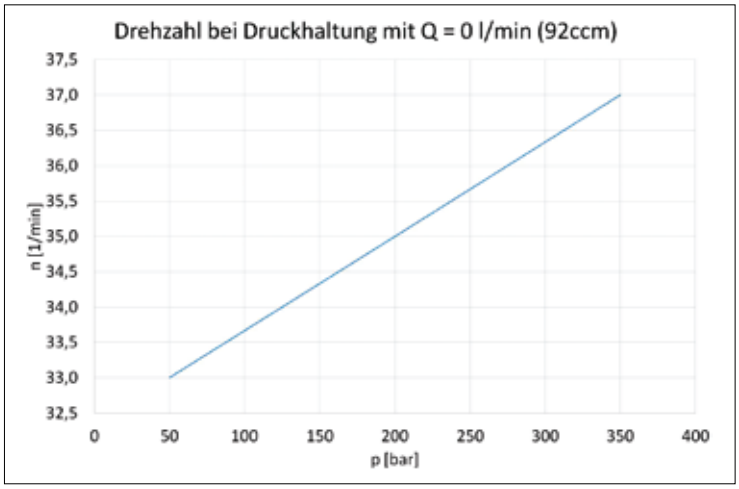

Photo: Parker

The image illustrates the minimal speed at constant pressure of the pump being used.

Current pump systems and their limitations

For variable-speed applications, where the pumps are designed with a constant displacement, the maximum torque is always achieved at maximum pressure. It is irrelevant to the torque whether a high or low flow rate is being required, meaning a faster or slower speed for the constant pump. This results in a high motor current for the drive system, which is determined and set by the frequency inverter.

By using double and multiple pump systems, you can turn off pump stages, which influences the displacement in a targeted way, thereby changing the torque at working points that require a lower flow rate. If only one pump stage is used with a low displacement to generate high pressure, a smaller motor and inverter drive can be used. There are significant savings to be made since the cost of the whole system is greatly influenced by the motor and converter.

Double and triple vane pumps such as the T7 series, used by Parker in its Drive-Controlled-Pump concept, are suitable for this application thanks to its compact design. They are used in casting machines and trimming presses.

When shutting on or shutting off pump stages, the motor speed must quickly adjust to the sudden flow rate change in order to maintain the traversing speed of the machine at a constant rate. Brief discontinuity is unavoidable. Such systems only have limited applicability in demanding application, where a switch-over is required during a molding process.

Variable pumps are a further option for adjusting the displacement of the pump, reducing the required maximum motor torque. In contrast with multiple constant pumps, the speed of the machine can in this case be kept constant by continuously changing the flow rate. This does not result in any discontinuity. In addition to this, assembly and pipework is easier, since only one suction port and one pressure port are required.

Depending on the design or controller type, the displacement of the pump can be freely set or is adjusted by the pressure compensator. As a result, variable-speed variable displacement pumps offer an additional degree of freedom in that you can adjust the flow rate. If you want to set the displacement directly, you will need a displacement controller. This means additional costs for a proportional control valve, position sensor and controller as well as more cabling. To fully exploit the benefits of the variable-speed variable displacement pump, you will require a multi-variable control for displacement and speed.

Pump systems with two-point control

Parker now offers the dual displacement pump as a new variant of its PVplus axial piston pump. The pump displacement can be switched between two continuously adjustable settings. When combined with a variable-speed drive, you get the following advantages:

- Low torque due to de-stroking in pressure holding, resulting in reduced acquisition costs for the motor and frequency converter
- High traverse speed through up-stroking when in rapid drive mode
- No discontinuity in the movement since no changeover between multiple pumps is required
- Easier pipework and commissioning
- High operating pressure, high productivity and high energy efficiency.

The minimum and maximum displacement of the dual-displacement pump can be mechanically set via two continuously variable adjustable spindles. You can changeover simply using an on-off control valve on the pump. Pump control becomes redundant and no additional electronics are required. This does not result in any limitations as to the pump installation. It can also be installed in the tank as V1 set-up.

The control valve has been designed by the manufacturer for use in the new pump system, ensuring it switches over very smoothly between the two displacements. While switching over, the system automatically adjusts the speed, ensuring a constant flow rate and

Technology in detail

Comparing different pump concepts

Variable-speed fixed-displacement	+ Single pump, easy installation and commissioning - The pump has a great speed range - High torque with low speed are required for continuous pressure
Variable-speed double pump (constant)	+ Low torque for maintaining pressure - Double pump, more costly installation - Discontinuity during changeover
Variable-speed displacement pump, lets you switch between two displacement	+ Single pump, easy installation and commissioning + Low torque for maintaining pressure + No discontinuity when changing over + High operating pressure and high energy efficiency
Variable-speed displacement pump, fully variable displacement	+ Single pump, easy installation and commissioning + Low torque for maintaining pressure + No discontinuity when changing over + High operating pressure and high energy efficiency - additional costs of proportional control valve and electronics - complex regulating of the motor speed and pivoting angle I required

For the Drive-Controlled-Pump concept, the manufacturer uses a dual-displacement pump and the GVM synchronous servo-motor.

traverse speed. The two-point-control offered by the on-off valve improved the efficiency of the pump, since regulator losses while stroking are reduced to almost zero.

Another critical feature of variable-speed pumps is that they can generate high pressure levels at low speeds. The axial piston pump was developed to be able to offer and maintain an operating pressure level of 350 bar at speeds near zero for a long time.

In contrast with constant pumps, these pumps hardly generate heat, since the minimal internal leakage goes through the leak port, rather than being pumped in circulation internally. The company has also tested a start-stop mode, where the pump is stopped and then runs up against the system pressure.

The system's synchronous servo motor

The manufacturer has combined the pump with a GVM-series synchronous motor, which is connected without a coupling or bell housing via a wave-in-shaft system to the pump. Drive power of up to 125 kW rated power and 400 Nm rated torque are currently available. Another build size is being developed with a peak torque of up to 800 Nm. The GVM in 'GVM synchronous motor' stands for General Vehicle Motor and serves as a reminder of its original use in mobile working machines. This motor proved itself by driving hydraulic pumps of container handlers or harvesters. Due to its design and power density, the motor was lately used to drive motorbikes at the Isle of Man TT Zero, the electric road competition of the oldest road-race in the world.

According to the manufacturer, the liquid-cooled motor can produce the same output at half or a quarter of the size of the normal IE3 motor, without any of the annoying fan noise. The 22 kW motor of the Drive Controlled Pump concept has a rated torque of 100 Nm and its foot print would fit on an A4 page (210 mm x 297 mm). The overall length varies depending on the required torque. Due to its high heat capacity, water is

especially suitable as a coolant, but you can also use mineral oil and water glycol. The permitted inlet temperature sits at up to 65°C, enabling direct cooling via the cooling circuit of the hydraulic unit.

The newly developed liquid cooling system does not increase the motor size, which is the reason for its compact build and power density. The speed is controlled via an integrated speed sensor (resolver).

Suitable applications for the concept pump system

The supplier recommends using the dual-displacement pump concept for presses, where the pressure and flow rate requirements vary greatly during the work cycle. The supplier claims the system will enable you to reduce the required torque versus constant pumps, thereby requiring a smaller and more cost-effective drive system. The installation and commissioning of the pump used is similar to other commercially available solutions. In addition to this, no multi-variable control is required. ■

Parker at the Hanover Trade Fair Hall 23, stand A48

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