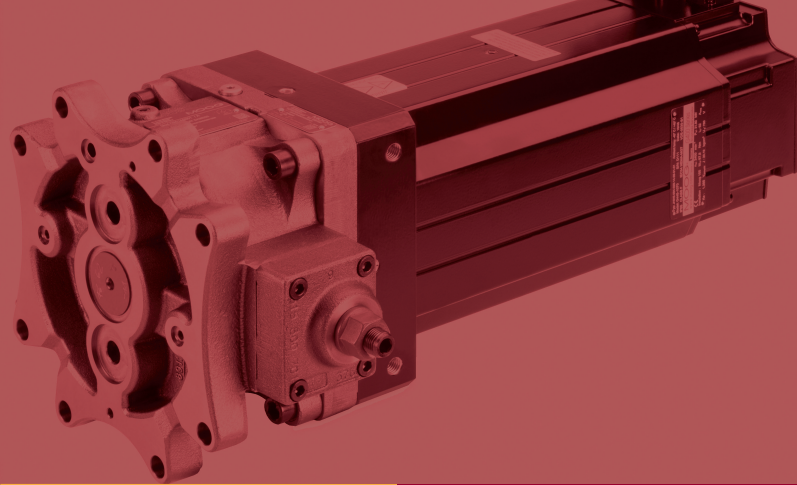


CASE STUDY



THE BEST OF BOTH WORLDS

New electro-hydrostatic actuation concept for the machine builders boosts energy efficiency and productivity

Rising electricity costs have design engineers and buyers looking for ways to make energy-intensive machines more efficient to produce and operate. Machine builders and operators can potentially save large costs by taking advantage of new actuation technology for their machines. Moog's electro-hydrostatic actuation concept can increase productivity with minimized energy consumption, while offering simplified and inexpensive installations.

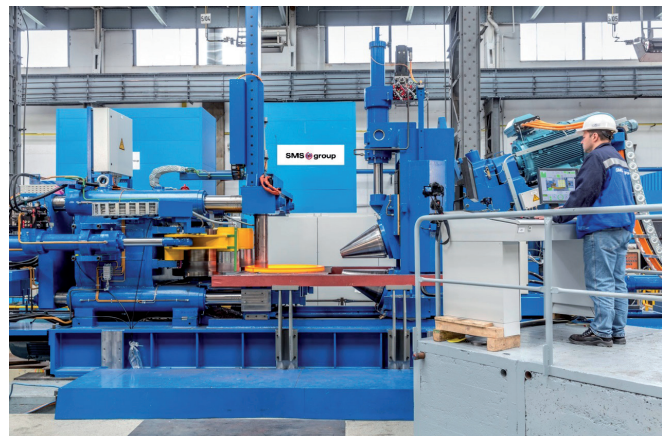
The price of electricity for industrial customers has doubled since the year 2000. Since this trend is unlikely to change anytime soon, machine builders and operators must improve the energy efficiency of their systems. The most effective way to achieve this is to start with the technology - generally either an electro-hydraulic or electro-mechanical actuation, depending on the power requirements. Both technologies have system-related advantages and disadvantages. But which concept is best suited for a machine application? The electro-hydrostatic actuation system combines the advantages of both technologies and eliminates many of the disadvantages. This article describes how electro-hydrostatic actuation saved operating costs and boosted productivity, both during the installation and operating phases, for a specific customer.

Manufacturer develops new actuation concept

SMS group GmbH, the leading manufacturer of ring rolling mills, developed with Moog a new actuation concept for its next generation of machines. SMS group's older machines have a central hydraulics system with a large oil tank and elaborate pipework. These designs required machine operators to implement additional machine infrastructure (e.g., extra rooms in the basement for housing the central hydraulic system). Consequently, installing and commissioning a traditional hydraulic system, including pipework, is very time consuming and costly for the customer.

Inside a ring rolling mill

Ring rolling is a forming process for manufacturing metal rings. SMS group GmbH can seamlessly produce a broad spectrum of rings with various diameters up to several meters, wall thicknesses and heights on a machine. The rings are used in numerous applications such as flanges for machine and plant construction, ring-rolled gear blanks for gearbox manufacturing, turbine discs for aircraft engines, rings for compressors and gas turbines, and large bearing rings for construction machinery. To produce larger rings, factory managers normally use rolling machines with a hydraulic tool and in these machines, at least five linear axes work simultaneously to shape the rings.



Ring rolling machine with EAS of the processing axes (SMS group GmbH)

Examining the legacy central actuation system

Design engineers built the previous SMS group GmbH actuation solution on a central hydraulic system concept with accumulators, which are not energy efficient, particularly in partial load operating conditions. In the accumulator-assisted hydraulic system, the pumps work constantly under high pressure. A high-resolution, dynamic servo hydraulic system was located on linear rolling axes with a servo valve controlling the energy or power. There was considerable throttle losses in the system, which had a detrimental effect on the overall efficiency of the machine. The machine cycle involved rapid movements without force, and slow, high-resolution movements under high forces with partially changing force directions cycle. The control type changed from position to force control and vice versa.

The SMS group GmbH and Moog engineering teams developed this concept to be robust and overload-proof, with a high level of availability and wanted to continue these advantages in the new generation machine.

Goals for developing a new actuation system

The requirements analysis for a new actuation concept included these primary considerations:

- Phase out the complex central hydraulic system with its numerous connection hoses and pipes
- Ensure a simplified, shortened installation and quicker commissioning of the rolling machine on-site at the end customer
- Eliminate the central hydraulic system to significantly reduce the noise level and any associated safety or environmental hazards

Combining electro-hydraulic and electro-mechanical advantages

With the results of the requirements analysis in hand, the joint engineering team looked at using an electro-hydrostatic actuation system or EAS, which combines the energy advantages of electro-mechanical actuation based on the power-on-demand principle with the advantages of electro-hydraulics for robust power transmission, low cost and high availability. The EAS design concept incorporates electric and hydraulic components in one system, including the servo drive-controlled servo motor, the speed controlled radial piston pump in four-quadrant operation as well as a manifold and a hydraulic cylinder. The cylinder velocity is proportional to the motor speed.



Moog Electro-hydrostatic Pump Unit (EPU)

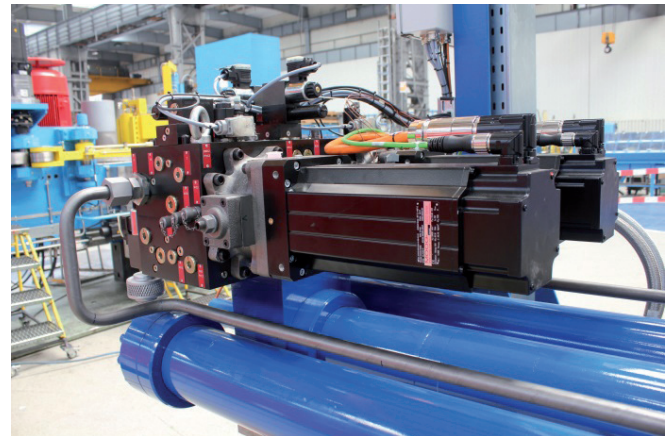
New decentralized Electro-hydrostatic Actuation solution

SMS group GmbH chose the Moog EAS and implemented it on the new generation machine. SMS preferred this solution because very high forces (> 1 MN) are applied and extreme impact loads can occur in this machine and the EAS can handle these forces in its hydrostatic gearbox. To save space, the design engineers flanged the motor pump unit directly on the manifold. The manifold contains all of the necessary overload and logic functions, and machine makers mounted it directly on the hydraulic cylinder. As the electro-hydrostatic pump unit (EPU), manifold and hydraulic cylinder are integrated in a unit, it helped the designers to also minimize the amount of hydraulic piping on the cylinder.

The design team also integrated the EAS directly on the machine axes. Since the EPU can be switched in its displacement volume, rapid movements with high speed as well as those with low speed and high force are easy to implement. A common DC bus, which is powered by a regenerative power supply unit (PSU), electrically connects all servo drives.

Up to 40 percent less energy consumption

The possibilities for saving energy with the EAS are impressive. Compared with conventional ring rolling machines, the modified axes in this machine use up to 40 percent less energy. The factory installed power is significantly reduced due to up to 40 percent less main disconnect amperage requirement on each machine. The new machine design reduces also machine and infrastructure piping, so installation is a lot easier. The new design reduces also the quantity of oil from approx. 2,500 liters to approx. 200 liters and there is a much smaller footprint than previous generation machines with a large hydraulic power unit (HPU). Since the machine uses far less hydraulic oil, the customer saves a substantial amount operation and installation costs. Additionally the machine had improved productivity and considerably quieter operation.



EAS of the processing axes (SMS group GmbH)

Teamwork from the start

Implementing an EAS is new for this field for many engineers developing next generation machines. Moog and SMS group GmbH needed approximately eight months to develop and implement the machine new concept, requiring the teams from both companies to cooperate at a remarkably high level. Working together, the engineers began by sizing the axes and continued collaborating closely to realize optimized machine integration, functional safety, efficient commissioning and analysis of the machine's performance. In the fall of 2016, SMS group GmbH and Moog engineers celebrated the industry's first EAS-driven rolling mill in operation at a customer's site.

For further information visit moog.com/industrial

Authors at Moog: Werner Händle, Senior Applications Systems Engineer, Klaus Kirch, Senior Account Manager