

Drive & Control profile

Technical Article

Pump drive retrofit key to energy savings in hydraulic stamping presses



In a variable speed system, the flow control of the hydraulic system is accomplished using an electronic variable frequency drive along with either a conventional asynchronous or synchronous servo motor, a pressure transducer to measure hydraulic pressure and either a fixed or variable displacement hydraulic pump system.

Stamping presses that form and bend metal under pressure are themselves under pressure to improve throughput, process cost control and energy efficiency. Many stamping presses have been in operation for 20 to 25 years and typically operate under punishing conditions—with cycle times between 100 ms and several seconds, and utilization rates ranging from 3,600 to 6,000 hours per year.

That much operation consumes a lot of energy, which can significantly impact stamping press productivity and profitability—in the last decade, electricity prices have increased an average of 25 percent and higher in certain U.S. markets and to 50 percent in Europe. If the hydraulic systems driving your stamping press operate with less than optimum efficiency, there are multiple benefits

How variable speed drives benefit hydraulic stamping presses

1. Greater energy savings: A variable speed drive's intelligent adjustment of motor speed meets the load demand precisely and avoids inefficient energy waste.
2. Lower maintenance: A variable speed drive pump retrofit replaces fixed displacement pumps with relief valves, or variable displacement pumps with proportional valves, technologies that are all more difficult to maintain.
3. Improved work environment: A variable speed drive retrofit can dramatically reduce heat load in the system. Plus, lower average pump speeds and smoother accelerations and decelerations can reduce noise emissions.
4. Optimize drive and pump sizes: An advanced control platform used in conjunction with an "energy on demand" system design can optimize the use of controllers.
5. Improved operation and equipment life: A variable speed pump drive provides smooth transitions between position control and force control, generating smooth motion trajectories and multi-axis synchronization.

that can be realized by considering the value of a hydraulics retrofit.

Advanced hydraulics and intelligent drive systems are now available to provide greater energy efficiency and can improve stamping press productivity and product quality. Retrofits using new technologies provide a number of benefits:

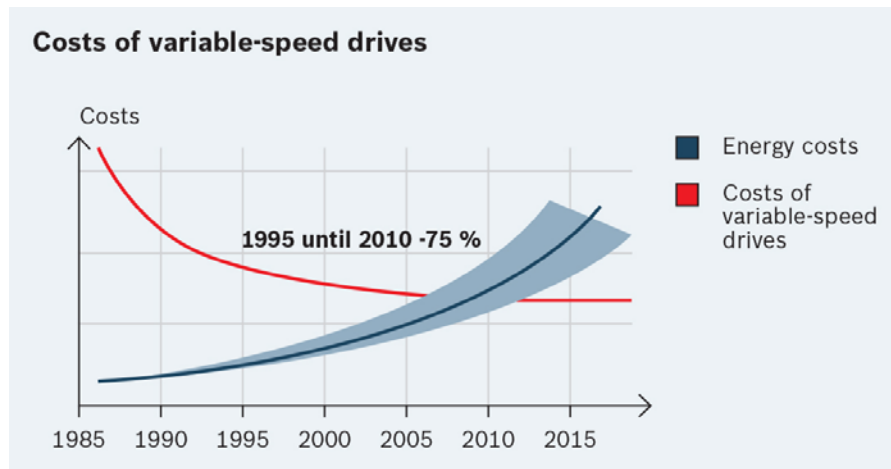
- More accurate and dynamic control of position and force of each stroke, to optimize performance and productivity
- Lowered cost per stamped part by lowering energy costs
- Reduced hydraulic system-generated noise, equipment wear and tear, and maintenance costs
- Extended operational life of the press and maximized uptime

While all of the above benefits ultimately contribute to a positive return on investment (ROI), the main cost savings result from energy reductions.

Focusing on the energy advantages of retrofitting

The primary reason to consider a retrofit is to improve energy efficiency. Even on standard machines, energy costs can represent 20 to 30 percent of total life cost—and a much higher share with energy-intensive applications.

In a typical hydraulic stamping press operation, a majority of the energy consumed is to generate the force to stroke the ram. Conventional approaches utilize a variable displacement hydraulic pump driven by an electric motor running at constant RPM. The hydraulic pressure requirements are regulated by a pump control, such as a pressure compensator, or by additional



On a standard machine, energy costs can represent 20 to 30 percent of the total cost of operation. A retrofit using variable speed drives can lower the cost per stamped part by controlling energy costs and improving ROI.

hydraulic flow and pressure control valves downstream of the pump.

With a constant RPM design, the motor is always running at rated nominal speed; even if the machine is operating at part load or idle, some motor horsepower is always being wasted. Simultaneously, internal hydraulic pump and valve leakage generate heat in the hydraulic fluid which must be cooled to maintain optimum operating conditions. The cooling process also results in an additional energy demand on the system.

With the latest technology, however, it is possible to obtain significant energy savings with a retrofit that replaces a constant speed electric motor coupled to a variable displacement or fixed displacement pump with a "smart" pump system. The "smart" pump system can also eliminate the need for downstream pressure and flow control valves in some machines.

What is a "smart" pump? It is a pump with intelligence to adjust flow and

system pressure based on the process demand by varying pump drive speed. This is accomplished by varying the drive speed and in some cases the swivel angle of a variable displacement pump. In the variable speed drive system, the flow requirements of the hydraulic system are controlled using an electronic variable frequency drive (VFD) coupled to either a conventional asynchronous or synchronous servo motor. A pressure transducer provides a signal to control the hydraulic pressure. The combination of VFDs and variable pumps allows the system to operate at the optimal efficiency point of both the pump and motor. This reduces energy losses directly at the source.

A minimal configuration, consisting of a fixed displacement pump and VFD, delivers a flow rate proportional to the drive speed of the motor. The closed loop control is located in the VFD and reduces the drive speed to match the load conditions. Additionally, the variable speed pump drive can be used to perform intelligent axis functions.

A properly integrated variable speed pump drive, such as the Sytronix system from Bosch Rexroth, can cut stamping press energy consumption by 30 to 80 percent. Using an on-demand control, the system can adjust the pump pressure and flow to the hydraulic actuator without the need for additional control valves. Consequently, the average input power is reduced over the entire machine cycle. Moreover, by not having valve induced pressure drops generating heat, the temperature rise in the hydraulic oil can often be kept at a small value, reducing or eliminating the additional energy required for the cooling system.

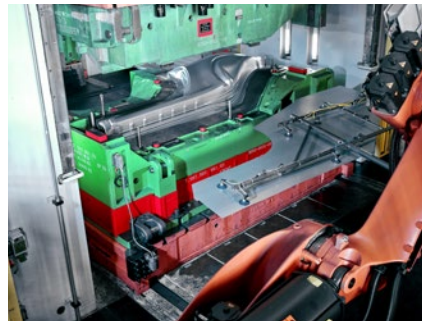
Additional improvements may be realized when using variable speed drives; the machine cycle can be smoother, minimizing maintenance and downtime. This can also extend the operational life of the press. Reducing the pump drive speed can lower noise levels of the hydraulic power unit by 10 to 20 dBA.

Investing in retrofits: When is it right for you?

Each stamping press operation is unique and the potential energy savings for any individual system varies. The important variable is the competitive pressure your operation faces in controlling costs and improving ROI. Here are five factors to weigh when considering a retrofit to a variable speed drive hydraulic system for your stamping press:

One: Account for hydraulic system energy consumption

Improper evaluation of pumps, motors and controls can have a significant negative impact on performance, reliability and efficiency. It is critical



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to assess your current stamping operation in terms of cycle times, stroke action and force to calculate the energy needed to generate the required flow and pressure.

It is also valuable to assess the level of control needed to deliver the desired throughput, including the position and force required to fabricate parts precisely to your customer's specifications.

For many applications, today's variable speed hydraulic pump systems are designed to be competitive replacements for constant speed motors with fixed or variable displacement pumps. The disadvantage with conventional systems is that motor speed cannot be reduced for partial load. Energy can therefore be wasted through a significant portion of the overall cycle.

In many cases, it is more efficient to achieve flow and pressure control by regulating pump speed and stroke than by using control valves. Because the energy is available as high-pressure hydraulic fluid, much of the energy is released in the form

of heat as the fluid passes through a control valve, from a high-pressure state to a low-pressure state. Control valve operation results in doubling energy waste. Energy is consumed when pressurizing the fluid, and then the energy is lost in the pressure drop that occurs through normal valve operation. This generates heat that will require additional energy for cooling. Additionally, dissipating the heat will require large heat exchangers that are operationally complex and expensive.

The solution: Take advantage of a variable speed drive's intelligent adjustment of motor drive speed to meet the precise demand and avoid inefficient energy waste. As an example, a machine retrofitted with a Bosch Rexroth Sytronix SvP 7000 system using a synchronous servo motor, or a Sytronix DFEn5000 system with an asynchronous motor, delivers only the required flow rate by adjusting the speed and displacement of the pump.

A pressure transducer is used to measure the hydraulic pressure and adjusts the pump speed accordingly. No excess flow is generated, and less efficient throttling control utilizing proportional valves can be eliminated. Energy is saved by avoiding the pressure drops and the corresponding heat generated by control valves, which must be dissipated using cooling systems.

Two: Consider modernizing and simplifying the hydraulic system

Because older stamping presses use fixed displacement pumps with relief valves, or variable displacement pumps with proportional valves, or older load-sensing directional control

valve technologies, the value of a retrofit can be determined by asking several age-related questions:

What are the ages of these components? Are they still available or re-buildable to like-new condition?

What are the maintenance requirements of the system? Is there fluid leakage from these components?

Do you need to operate at higher pressure/flow rates to maintain current production requirements, or are you operating frequently at less than full tonnage and wasting energy?

The solution: Retrofitting to a variable speed system that can simplify the hydraulic system and will head off future component replacements and greatly reduce maintenance costs.

Three: Evaluate hydraulic system environmental requirements

It is often assumed that noise and heat are the price to pay for a work environment needed to harness the power delivered by a hydraulic stamping press. Consider heat issues; it is worth assessing system fluid temperatures in regard to the double penalty of generating excessive pressure and/or flow, and the energy needed to remove that excess heat. It is also important to factor in the expense of cooling capacity and oversized oil reservoirs.

One of the main sources of machine noise in a hydraulic press is the hydraulic pump. The sound pressure level depends on the pump's rotational speed and operating pressure. Higher speeds will produce greater noise. Beyond pump noise, older control system designs and controllers may introduce high levels

of hydraulic "shock" during the press motion cycle, which can generate sound levels as high as 80 dBA, and can stress piping, valves and seals.

The solution: A variable speed pump can dramatically reduce heat load in the system. By eliminating throttling losses (pressure drops) using pump speed and stroke control, rather than throttling valves, heat transferred into the fluid is reduced, resulting in drastically decreased or eliminated cooling requirements.

Finally, variable speed pump control results not only in lower average pump speeds, but also smoother accelerations and decelerations with controlled transitions between force and position control. The result is reduction in average noise emissions from the hydraulic power unit by as much as 20 dBA.

Four: Assess and optimize drive and pump sizes

Typical hydraulic drive systems are oversized to deliver peak pressure and flow rather than what is optimum for real-world applications. It's not uncommon to see motors 50 percent larger than the actual stamping press process requirements. Oversizing is intended to compensate for inefficiencies in the hydraulic circuit due to pressure drops, leakage flows, etc.

For the electric motor driving the pump, proper sizing requires assessing dwell times and operation at partial and full loads to determine the actual required drive power. To determine optimal sizing of the drive components, simulation tools can be used to investigate dynamic stamping cycle variables, including pressures, flows, forces and cylinder motion.



A modern hydraulic controller platform, like Bosch Rexroth's MLC, can offer advanced control software packages tailored to the unique demands of the hydraulic system properties, and compensate for factors such as fluid compressibility and non-linear system dynamics.

The solution: Hydraulic and control system engineering experts equipped with advanced simulation tools can provide designs utilizing variable speed drives to retrofit a stamping press and ideally match demanding cycle requirements. For example, Bosch Rexroth Sytronix variable speed pump drives, used in conjunction with an "energy on demand" system design, can optimize the use of controllers, variable speed pumps and motors to deliver just the precise energy needed. In addition, optimal motor sizing coupled with variable speed pump drives can help a complete solution fit into a smaller footprint when compared to conventional designs.

Five: Improve controls for better operation and longer equipment life
Shocks transmitted through a hydraulic system can result in

mechanical stress and physical wear on the press frame, fittings, pipes, connections, valves and manifolds. This can have a negative impact on equipment life, increase downtime and present the need for more frequent maintenance. If these conditions prevail on your stamping press, the press controls regulating pressure and flow, as well as upper-level control, should be evaluated. These physical “shocks,” even if intermittent, may indicate that the legacy control system may be hampering performance and energy efficiency of your stamping press.

The solution: Consider retrofitting the existing controls with a state-of-the-art motion control system specifically engineered to take full advantage of modern electro-hydraulics and variable speed pump drives. These latest-generation systems provide intelligent, high-performance control of variable speed pump systems as well as systems controlled with traditional proportional valves.

As an example, a modern hydraulic controller platform, like Bosch Rexroth's MLC, offers advanced control software packages tailored to the unique demands of hydraulic system properties. Advanced software compensation for factors such as fluid compressibility and non-linear system dynamics can provide optimal control. Hydraulic-specific algorithms

for proportional valve and variable speed pump drives allow for smooth transitions between position control and force control, generation of smooth motion trajectories and multi-axis synchronization. These capabilities reduce system shocks and reduce the impact on tooling, while providing improved dynamics and accuracy, and increasing energy efficiency and productivity of the stamping press.

Re-energizing stamping press to meet new demands

Dramatically improving the energy efficiency and performance of hydraulic stamping presses is now possible with high-performance, intelligent pumps that can deliver the required speed and flow without the energy inefficiency of control valves. An analysis and comparison of existing hydraulic power units and related components against a variable speed pump drive system typically reveals energy usage can be reduced and the environmental impact of heat and noise can be improved.

Because each system is unique, the experts at Bosch Rexroth, who have real world hydraulics experience and access to advanced simulation tools, can work to assess how a retrofit can improve performance, extend stamping press system life and save energy.

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