AUTOMATION OF HYDRAULIC PRESSES ENERGY SAVING SYSTEM

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The production and utilization with high energy efficiency for industrial practices are significant to the world economy. Mounting concerns on climate change and fossil fuel depletion have led to effort to develop renewable energy technologies and enhance energy efficiency. Energy saving is an important concept in various fields, including manufacturing.

Since the 1960s, various complex large-tonnage and high-precision hydraulic presses have emerged continuously and have been widely used in various fields. Hydraulic presses are extensively used in metal forming because of their simple structure, easy operation, and ability to deliver a large force.

However, hydraulic presses consume enormous energy and have low energy efficiency. The dynamic process of hydraulic pressure refers to the process from the original equilibrium state to another equilibrium state. In the hydraulic drive system, the energy consumption acts on the power grid with the asynchronous motor as the outlet. Due to the large power density, corresponding power energy loss occurs. Besides, because of the frequent load switching in hydraulic system, additional energy consumption is easily generated. The efficiency of the hydraulic system is low, generally 6% to 40%, resulting in a great waste of energy [1].

Therefore, it is extremely important to reduce the energy loss in the working process of the hydraulic system and realize low-carbon manufacturing. Substantial research has been conducted over the past years to improve the efficiency of hydraulic presses.

The first group of research approached the issue from the perspective of load sensing (LS). The basic idea of the LS technique is to control the flow of the hydraulic fluid via the load feedback [2]. An extensively used system is the volume control electrohydraulic system that is driven directly by various types of variable-speed motor, such as variable-frequency motor and servo motor. However, conventional control approaches are based on a linear model; hence, this model may not guarantee satisfactory control performance for the direct drive volume control system. Therefore, considerable research has focused on adaptive control approaches to improve the overall performance, as well as the control method of the pressure and flow to follow the load change. Moreover, the high cost of variable frequency motors and slow response are obstacles for its commercialization [3].

The second group of research approached the issue from the energy regeneration perspective, where the potential energy is converted into another type of energy that is easily stored and released when needed using a hydraulic accumulator or flywheel [4]. The accumulator-assisted fast forging hydraulic press has gained popularity because of its advantage in energy saving [5]. However, the accumulator has a significant impact on the motion control performance of the fast forging hydraulic press, and the smooth and accurate motion control of the press is a difficult task. In addition, energy loss is observed in the process of recovery, storage, and release, thereby reducing the utilization ratio of potential energy.

These methods above are mainly focus on reducing energy consumption by optimizing the procedure of a single hydraulic system.

In this abstract, an energy efficient-system is carried out from the perspective of combining procedures. A quadruple actuator, that is, four hydraulic presses that share one drive system is proposed.

Four hydraulic presses are grouped to share the only drive system which is partitioned into several regions corresponding to hydraulic press operations named drive zone. The same operations of different hydraulic presses are carried out with the drive of the same drive zone. The output power of each drive unit matched the consumed power of the operations corresponding to the drive unit after energy efficiency optimization. The scheduling method of hydraulic press group is analyzed to ensure that different hydraulic presses in a group shared a drive zone in different time after the adjustment of working beat.

In practice, a workshop may have more than one hydraulic press. This situation provides opportunities to combine four presses and stagger their procedures to reduce the energy consumed by these auxiliary procedures. Consequently, the matching between drive system and load can be improved because only one drive of the originally installed power is needed for the press pair. Therefore, this set-up can save energy and reduce forming time.

This power scavenging acts as an energy recovery mechanism, thereby reducing the overall system power use. Numerous cycles could result in substantial savings on energy costs. Accordingly, the idea is potentially beneficial to the industry and hydraulic press manufacturers, thereby enabling them to cut energy costs by utilizing the presented idea.

References:

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