

ALTERNATIVE HYDRAULIC DRIVE SYSTEMS - INDEPENDENT METERING

Ideas on utilisation

In many machines, multiple hydraulic drives (functions 1...i) are supplied by one single pump. The actuators are very often operated independently and simultaneously. The hydraulic control system has to distribute the hydraulic power among the actuators depending on their flow and pressure requirements. Continuously increasing demands on cost effectiveness, productivity and energy efficiency of machines constantly push new developments in the fields of hydraulic systems. A reasonable and promising way to fulfil these requirements is the use of independent metering valve systems (IM). By doing so, the opening cross section of the meter-out edges can be manipulated independently from the inlet and adapted to the load situation. By influencing the pressure level, regeneration and recuperation modes become feasible. This leads to higher energy efficiency of IM systems compared to conventional valve controlled systems. In addition, with the used structure the application of simple and standardized valves is possible. This lowers the investment costs. Besides good structural properties and the further degree of freedom to control the system, there are additional potentials by transferring the functionality into the electronic control device (software implementation). Thereby, the function's flexibility increases. Despite these potentials, there are only a few industrial applications with independent metering systems. Main reasons are the complex control algorithms, lack of modular and flexible software concepts and sufficient safety concepts.

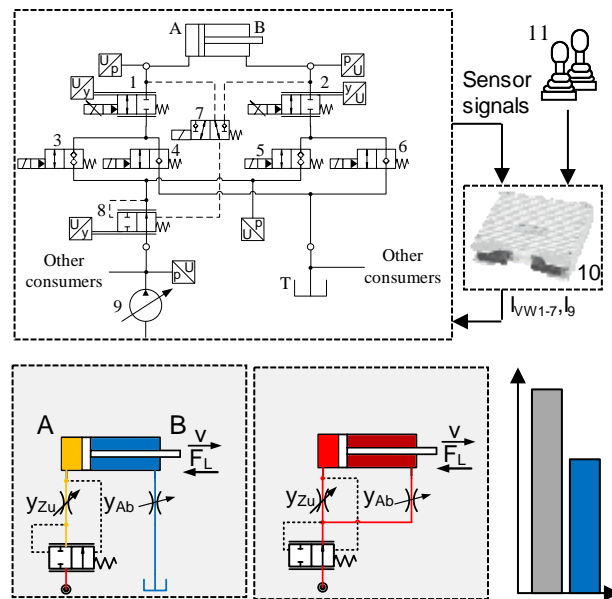


Figure 1: top - conventional system; bottom - IM

Potential adopters of technology

The big advantage of hydraulic drive systems is the power density compared to electrical drive systems. This means that the focussed branch is mechanical engineering, especially drive technology. Independent Metering Systems themselves are useful in every application where simultaneously driven actuators are supplied by one single pump. For that reason, adopting enterprises can be the following:

- Machine manufacturers (OEM)
- System suppliers
- Component manufacturers

Due to this wide range of enterprises, the size can vary from micro-enterprises to large companies.



Advantages of technology

The main advantages of Independent Metering Systems are higher energy efficiency, flexibility in providing additional functions as well as machine design possibilities with respect to integration and the chance to use standardized and therefore cheaper components.

Significant disadvantages of conventional systems regarding both functionality and energy efficiency arise from structural coupling of the metering edges. Pressure losses at meter-in edges are bound to pressure losses at meter-out edges by a fixed relationship defined by the design parameters of the valve. Furthermore, fixed overlap characteristics limit the implementation of different control aims, such as force or position control, or restrict them to specific operating points. For instance, force and position control demand different requirements in terms of overlap characteristics, when implementing these strategies using 4/3-valves. Independent metering systems are capable to overcome these problems.

Measurements at the research unit prove energy savings of IM by approximately 43 % depending on the working cycle with off-the-shelf components. Different control algorithms regarding an industrial application have been proven and evaluated. Predefined trajectories could be driven without disturbances during switching into energy efficient modes.

Market and context of technology

Nowadays, conventional hydraulic valve-controlled systems using one 4/3-proportional valve are the most common way to control an actuator. Industrial acceptance of newly developed systems with independent metering heavily depends on investment costs, reliability and simplicity. It seems that currently published approaches hardly satisfy these demands yet, since implementations of individual metering hardware in serial production are still rare. Some examples are the Incova system by HUSCO and the Ultronic valve block offered by EATON. In summary, the technology is tested in operational environment, offers improvements in energy efficiency and functionality, covers a lot of potential for further development but is too expensive and needs more implementation effort up to now.

Preconditions in adopting enterprises

Adopting enterprises should fulfil at least some of the following preconditions:

- Knowledge in developing and testing control algorithms for hydraulic drives
- Knowledge in developing (application) software
- Development and manufacturing of hydraulic proportional valves
- Development and manufacturing of electronic control devices
- Development and manufacturing of industrial or mobile machines with hydraulic drives