Abstract

Mobile machines, especially excavators, still consume considerable amounts of fuel during their operating lifetimes. This is not only undesirable in economic terms but also adversely affects our environment. The hydraulic systems used to power these machines are often blamed for the majority of the losses. As a result, much research has gone into the development of more efficient hydraulic architectures capable of lowering throttling losses caused by hydraulic valves. Although these new systems are unquestionably more efficient, at least from a hydraulic point of view, they are also substantially more expensive and their ability to truly lower fuel consumption in combination with a diesel engine remains questionable.

The following work takes a more comprehensive design approach and shows that thinking in terms of efficiency, especially hydraulic efficiency, can be rather misleading. Although it may seem strange, a less efficient hydraulic circuit can in fact lower consumption. Concepts based on actual absolute losses and fuel consumption are far better suited for the design process and can help uncover simpler methods to improve today's machines. By analysing real test data from a machine and applying these concepts it quickly becomes apparent that a hybrid architecture, in which an additional energy storage device is installed, may present a viable alternative. Not only can the losses in the hydraulic system be lowered, energy can also be recovered from the actuators and most importantly engine operation can be improved greatly by implementing so-called downspeeding.

Instead of pursuing an electric hybrid approach, the work introduces a hydraulic hybrid system, called STEAM. By only changing the valves in the existing hydraulic system and adding hydraulic accumulators the machine can be transformed into a hybrid. The thesis shows the benefits of the new system by going through a series of theoretical considerations and by discussing measurements conducted using an 18 t prototype excavator.