Design Study and Parameter Optimization for a Light-Weight Series Hydraulic Hybrid Vehicle

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Hydraulic hybrid drives are one potential way of improving the fuel efficiency of vehicles, including the possibility of recuperating braking energy in a hydraulic accumulator. The high power density of fluid power is mainly advantageous for heavy vehicles, or duty cycles characterized with frequent braking and acceleration. For smaller vehicles, hydraulic hybrid drives are thus most interesting under urban and suburban driving conditions. Amongst the existing architectures, the series hydraulic hybrid offers the advantage of operating the internal combustion engine independently of the vehicle speed, at the cost of a less efficient transmission path than a purely mechanical one. Previously, a series hydraulics hybrid light-duty vehicle was modelled in the transmission-line modelling (TLM)-based simulation software Hopsan from the division of Fluid and Mechatronic Systems (Flumes) at Linköping University. This paper studies through simulation-based optimization how the fuel-optimal vehicle design is affected by various mixes of urban and suburban driving requirements. Both the system’s hardware and the parameters of a basic control strategy are considered. The results show quite similar designs for most performance requirements combinations, and can be the base for further studies addressing additional requirements, conditions and objectives.