

Open Accumulator Approach for High Density Fluid Power Energy Storage

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Traditional hydraulic energy storages based on compressed gas charged accumulators have very high power density, but relatively low energy density (<10kJ/liter at 35MPa) compared to electric batteries. If accumulators with significantly higher energy storage density are available, new applications (such as hydraulic hybrid vehicles) can be more attractive, and the efficiencies of existing fluid power applications can be improved as regeneration and energy management practices become more feasible. Open accumulator is an approach being investigated in the CCEFP which has a potential energy storage density that is an order of magnitude higher than traditional accumulators.

Traditional gas charged accumulators (or closed accumulators) have limited energy densities because the optimal pressure ratio is limited to only between 2 to 3. This is a consequence of the fact that they have to contain the larger expanded gas volume as well as the volume of any displaced oil. The open accumulator concept overcomes this by difficulty by compressing air from the atmosphere during storage and expanding air to the atmosphere during regeneration. By doing so, one liter of compressed air at 35MPa can potentially store 170kJ of energy (a ten fold increase in storage density) with a pressure ratio of 350.

The fundamental challenge of the open accumulator approaches lies in the need for a compact, efficient and powerful air motor/compressor. In this poster, we will discuss the various methods that are being investigated to achieve this. They include: a configuration that allows the accumulator to utilize both the power dense hydraulics path, and energy dense pneumatic path; optimal control of the compression/expansion process in the air motor/compressor to increase efficiency and power density; and a liquid piston motor/compressor for improved volumetric efficiency, and mechanisms for improving heat transfer within the air motor/compressor.

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