OAK RIDGE NATIONAL LABORATORY FACT SHEET
MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY

MSSE Measurement Science and Systems Engineering Division

ROBOTICS AND ENERGETIC SYSTEMS GROUP RESG

Energy Efficient Hydraulics Through Quasi-Hydrostatic Control

Reducing Energy Losses for High Performance Hydraulic Systems

Technology Need

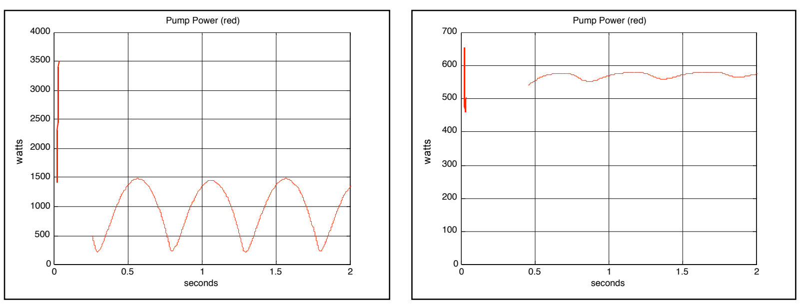
While hydraulics provide superior power to weight and power to volume ratios over electric actuators, hydraulics suffer from large energy losses in applications with large fluctuating loads. There is a need to improve the efficiency of these actuators without adversely affecting their performance.

General Approach

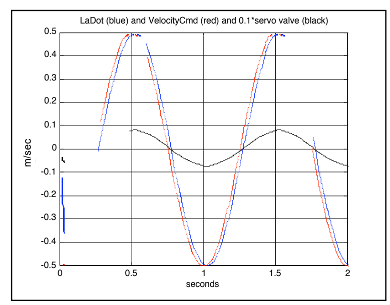
Traditional hydraulic control has been achieved by means of a constant pressure hydraulic source utilizing a fluid control device such as a servo valve. A servo valve is notoriously lossy and can consume at least 1/3 of the overall power generated by the pumping source. The quasi-hydrostatic control approach, a combination of flow control (to reduce losses) and pressure control (to achieve good tracking) has been explored to address this deficiency. The specific advantage of this approach is a large reduction in the peak power required from the pump, resulting in significant improvements in efficiency.

Example

As an example, a comparison was made between a conventional constant-pressure control system and the quasi-hydrostatic approach on a single hydraulic cylinder by means of computer simulations. The peak power from the constant pressure pump, after the initial transient, is 1,500 W whereas the peak power from the quasi-hydrostatic controlled system is 570 W. The savings are even greater if the transients in the system are considered. Just as important, is that there appears to be little difference between the two methods in terms of the tracking performance. As can be seen from these simulations, a quasi-hydrostatic actuation methodology shows significant improvements in efficiency (maximum actuation power requirements cut in half) without sacrificing tracking.



Power requirements for constant pressure and quasi-hydrostatic actuation.
(Constant pressure on the left and quasi-hydrostatic on the right. Note the different scales.)



Tracking for quasi-hydrostatic.
(Similar to constant pressure.)

Application Areas

Most research involving energy efficient motors has focused on electric motors. Ironically, according to the 1998 Manufacturing Profile from the U.S. Census Bureau, the U.S. market for fluid power products was $11.9 billion in comparison to $10.9 billion for electric motors and generators. There are significant potential crosscutting benefits to implementing this approach.

Points of Contact:

Dr. John Jansen (865-574-8154, jansenjf@ornl.gov)
Dr. François Pin (865-574-6130, pinfg@ornl.gov)
Oak Ridge National Laboratory, P.O. Box 2008,
Oak Ridge, TN 37831-6305

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