Status report for the project: October 18, 2012

Test Bench for Energy Efficient Active Oscillation Damping on Mobile Hydraulic Machines

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A mid-size hydraulic crane (ATLAS 125.1 A5) was donated to Maha Fluid Power Research Center (Maha) of Purdue University by Parker Hannifin in 2011. The NFPA gift permitted to complete its installation on the outside area of Maha and the setting of the data acquisition and control system in the interior space of the Lab (Fig. 1). The Crane is utilized for a dual research/education purpose, and permits to:

a) Demonstrate the basic functions and the dynamic behavior of control valves and counterbalance valves
b) Understand the features of electrohydraulic control.
c) Test the effect of different valve configurations on the operation of the machine
d) Show inherent instabilities and oscillations
e) Research new solutions to prevent system oscillations
f) Understand and quantify the energy losses associated with a particular valve setting configuration.

A data acquisition software was developed utilizing IQAN software to automatically perform tests on user defined drive cycles. This activity involved two graduate students and two undergraduate students within Purdue – SURF (Summer Undergraduate Research Fellow) program (Fig. 2).

During 2012, the crane was used to study the energy consumption features of counterbalance valves, a topic never addressed with a rigorous scientific approach. Capabilities of high energy saving were experimentally verified (Fig. 3), showing the need of further research on this topic.

Being the counterbalance valve setting also related to the machine oscillatory behavior, a study on alternative methods for oscillation damping was initiated in 2012. The preliminary results (Fig. 4) achieved on the installed Crane permitted Dr. Vacca's team to obtain a research grant from CCEFP (Center for Compact and Efficient Fluid Power) for year Y7 and Y8.

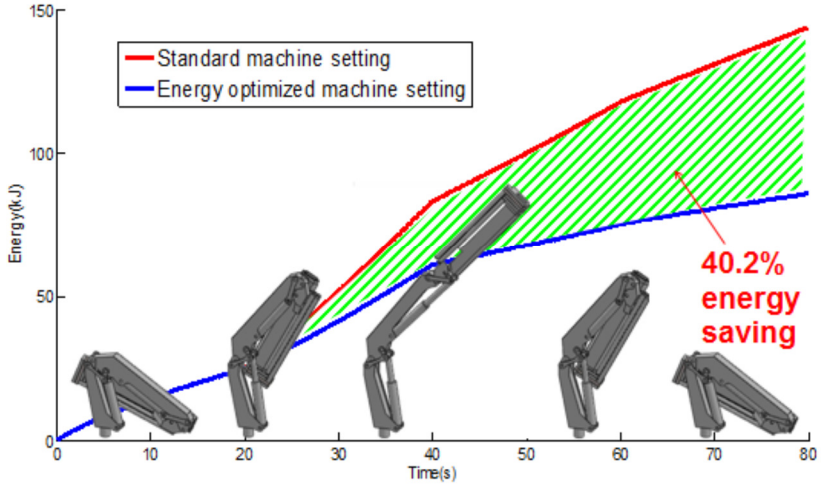
Outreach activities in 2012 include several lab tours to visitors and students; a poster presentation at NFPA 2012 Fluid Power Workforce Summit and CCEFP annual meeting; a poster presentation at SAE 2012 Commercial Vehicle conference. Also two conference papers and one journal paper were published on the basis of mentioned activities.

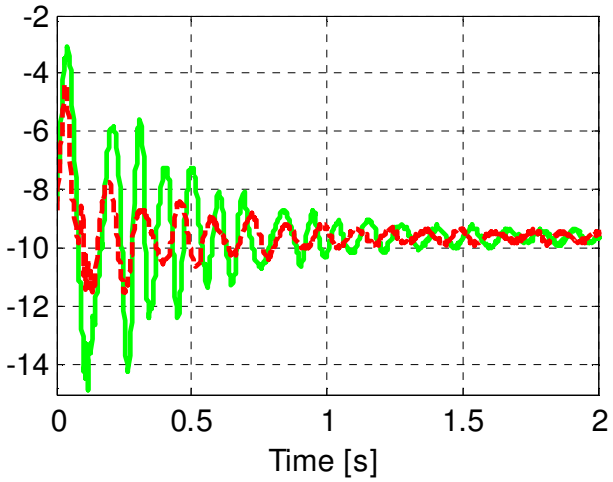
The crane will be utilized in 2013 for a lab experience within the ABE435 (Hydraulic Control Systems, about 25 students/year).

Fig. 1 – The experimental setup at Maha Fluid Power Research Center

Fig. 2 - Guido Ritelli (PhD student) and Roy Fisher (senior student) celebrating the award received at the final presentation of the project "Energy Characterization of Over Center Valves"

Fig. 3 – Measurement of energy consumption for a given drive cycle. With a different setting of the counterbalance valves a relevant energy saving is demonstrated





Boom Tangential Accel: a_T [m/s^2]

Standard Crane

Proposed Control

Fig. 4 – Measured boom acceleration. The effectiveness of a new method for oscillation damping under development at Purdue University is shown