Second Quarterly Report

ERIP #519 Aerodraulic Cylinder

Accomplishments

Efforts in this quarter centered on two areas: 1) Upgrading and enhancing the data logging system and 2) continuing field trials to evaluate improvements made to the Aerodraulic system.

Data Logging System

Previous experiments involved recording pressure data with a strip chart recording system which limited our ability to effectively conduct post-processing analysis and had limited frequency response to allow us to evaluate die shock. A pc-based data logging system was assembled and tested during this quarter. This system, based on a Data Translation 2805 A/D board, is capable of simultaneously recording and storing to disk four channels of data at acquisition speeds of greater than 1 Khz per channel.

A graphical user interface (GUI) was designed to meet the needs of this program. This GUI allows one to simultaneously display from four sensor channels as well as the storing data from all four channels to hard disk. Logged data is compatible with standard spreadsheet programs such as Microsoft’s Excel. The four channels include two high pressure side transducers (one from each cylinder) whose output ranges from 0 to 5000 psi. A third pressure transducer (range from 0 to 1000 psi) is used to monitor the “common” low pressure side of each cylinder. A fourth sensor has been added to the test fixture which monitors the ram position. The sensor is attached to the ram which drives the cylinders, and is used to accurately determine the bottom of the stroke. A fifth sensor is used to monitor the hydraulic fluid temperature but is not part of the high speed data logging system.

Several experiments were conducted to determine the appropriate sampling frequency and record length. We found that sampling at a frequency of 250 samples per second per channel provided excellent signal fidelity and manageable record lengths. We selected record lengths of 5000 point (5 seconds of continuous data). This allowed us to visualize and store approximately four strokes of the ram in each record. A protocol was established such that the logged files were labeled according to the measured hydraulic fluid temperature. These file also labeled with a time and date stamp.

Operationally, the output from the four sensors was visualized continuously on the monitor. At approximately 10 minute intervals, the data logging was triggered and the data stored for post processing. Typical test data is show below:
Continuing Field Trials

On April 3rd, 1997, a fifth test was run at Sunstrom using the new data logging system and the updated Aerodraulic test fixture. The primary enhancements to the Aerodraulic test fixture were: 1) increased the capacity of the accumulator from 1/4 gallon to 1/2 gallon; 2) Increased cylinder thermal capacity system by mounting the cylinders in a heat sink; and 3) Increased cylinder return speed accomplished by removing the flow control valve. The new development which was to be tested in test # 5 was the evaluation of the design of the orifice pattern on the inner cylinder sleeve which is used to control the pressure in the cylinder as a function of ram speed and stroke position.

The results of the April 3rd trials were mixed. A primary goal of this work is to produce a cylinder load (high pressure channel) which is relatively independent of the stroke displacement over a 7 inch stroke length. As can be seen in the above figure this was not accomplished. Subsequent analysis of the orifice pattern revealed that this pattern was incorrectly machined for the test conditions used in this trial. On the positive side, our analysis of the pressure response which we would calculate from the actual measured pattern on these cylinders compares favorably with that which we measured. This has led to the formulation of improved design tools for the orifice pattern. We have also implemented improved inspection procedures to measure the orifice pattern prior to completing the assembly of the cylinders. Two different orifice patterns are being fabricated and will be evaluated in the next trials.
Other results of trial # 5 were quite favorable. The energy input for this test was 80 %
greater than the previous tests, however the heat sink limited the maximum equilibrium
temperature to 180 ° F, comparable to that observed on previous tests.
We confirmed the dependence of return speed on line resistance and found that it can be
increased by removing the flow control valve. Fluctuations on the low pressure side were
reduced by a factor of two by increasing the capacity of the accumulator.

**Plan for Next Quarter**

1. Continue trials to evaluate the orifice pattern design
2. Design “boot” which encases the cylinder rod
3. Design and fabricate a “boot” attachment system
4. Assemble complete cylinder/boot Aerodraulic unit
5. Conduct evaluation trials
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