FPInnovations
INFO NOTE
March 2017- no. 16
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Hydraulic tune-up to improve feller buncher energy intensity

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Introduction

With the cost of fuel being a major factor in the operation of off-road machines, getting the most for your money is in the interest of the cost-conscious machine owner. This brief report will demonstrate the possible improvements in machine function and energy intensity (or litres per unit of production) made possible by performing a hydraulic tune-up on a feller buncher. Feller bunchers are one of the more complex machines in the forest, with many hydraulic circuits, high duty cycle, and high energy intensity. Energy intensity, being the litres of fuel consumed to produce a stem suitable for skidding and processing, is the standard to which machine improvements are judged.

Methodology and site conditions

A diagnostic data logging tool compatible with the logging equipment's J1939 CAN bus port was used to access ECM data to determine the fuel consumption over the baseline period of observation. Productivity was determined by counting stems produced and then scaling the logs. The baseline study, prior to any machine improvements, occurred in southwestern BC in October 2016 and the final performance improvements were measured during a follow-up study in December 2016. The test conditions for the follow-up study were 20°C cooler than the baseline conditions. A fully warmed up machine was used for both test conditions, which should negate some of the effect of the colder environment on hydraulic and other lubricating fluids. Two factors, the effects of which were not measured, were not accounted for. These were the effects of cold ambient air upon improved engine efficiency as well as the use in December of winterized diesel blend with lower energy content and its effect on decreased engine efficiency (~3% according to Cummins[1]).

The tests were conducted in different forest stands of predominantly pine and spruce and were of similar age with average slopes of 25%. The test of the machine after the hydraulic tune-up was performed in 20 cm of light snow, but the lack of travel distance between trees and good machine mobility on the moderate slopes is a good indication that snow was not a significant impediment to productivity in this instance.

[1] https://cumminsengines.com/uploads/docs/cummins_secrets_of_better_fuel_economy.pdf

Figure 1. 2011 Tigercat 870C2 feller buncher cutting a large spruce tree.

The test machine was a model year 2011 Tigercat 870C2 feller buncher equipped with a 224 kW Tier 3 emissions engine with 10 163 operating hours, as shown in Figure 1. The machine needed several repairs that were performed during two separate service calls from the on-site mechanic.

The following items were adjusted to factory specifications during the hydraulic tune-up:

- Set port reliefs on main control valve;
- Set load sense pressure on main control valve;
- Adjust margin pressure on pump controller;
- Check saw pressure and cycle time;
- Check attachment pump pressure;
- Check track drive shift points (beginning of regulation) and reset track pressures;
- Check swing motor cross-over relief settings.

Items replaced during the two machine service calls:

- One load sense valve;
- Turbocharger (was found to be weak 6 weeks after baseline study, not judged to be a significant factor in baseline test performance);
- Two spool valves;
- Cartridge filters.

The hydraulic fluid was still serviceable and therefore not changed. One of the main tools for accomplishing a hydraulic tune-up is a high-quality mechanical pressure gauge, as shown in the figure below. In addition, a knowledgeable mechanic is key to success.

Figure 2. Hydraulic pressure gauge used for adjusting margin pressure and checking relief valve operation.

Results

The total cost for all servicing was approximately $10 000, not including the cost of the turbocharger or travel time to and from the jobsite. Given the boost in productivity and lower energy intensity, as seen in Table 1, the investment in machine maintenance can be paid back in less than 200 hours[2].

Table 1. Improved energy intensity from hydraulic tune-up

Hydraulic tune-up	m^3/stem	Litre/hr	m^3/hr	Litre/m^3
Before tune-up	0.50	49.1	90.6	0.54
After tune-up	0.48	42.5	99.3	0.43
Percent difference		-13%	10%	-20%

As can be seen from the results, the feller benchers' production picked up and fuel consumption decreased. When both of those occur, the effect on energy intensity is significant. The operator reported the machine was better at multi-tasking – moving the boom while travelling. As well, the machine was more responsive and less frustrating to operate.

Implementation

Spending funds on seemingly optional maintenance, when the machine is still functional, can be a difficult decision. This test demonstrates that complex machines, like this feller buncher, can experience drift in operational parameters that can significantly affect machine performance. For some operations, a machine with 10 000 operating hours is due for replacement and for others, replacement is not economically feasible. Extending the useful life of an older machine is therefore the best course of action. Recovering lost machine efficiency by performing a hydraulic tune-up is a good business practice and should be considered for all older machines that are still required to perform at high utilization levels, such as the feller buncher.

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[2] Assuming machine payment rate of $5/$m^3$ and $1.00/litre fuel cost.