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Innovative Chain Lubrication System for Harvesters

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Introduction

This report presents the results of trials conducted on an innovative chain lubrication system developed by STL Lubrifiants Inc. The Envirosys system was designed to replace conventional chain oil with a bio-degradable grease-based lubricant. A prototype of this system was installed on a Direct single-grip harvester belonging to J. Lavoie, a contractor. Performances were monitored jointly by the contractor and FPInnovations, Feric division.

Trials

During 2007, two series of trials were conducted near Girardville in the Lac-Saint-Jean region. The duration of the trials was as follows:

- Winter period – from January to March 2007 (9 weeks)
- Summer period – from July to October 2007 (17 weeks)

The operator began the series of tests by alternating between the conventional chain oil and the grease. However, after trying the grease and finding that it had a positive impact on the saw, he was somewhat reluctant to finish the number of tests with the oil. For that reason, the breakdown of tests was as follows:

- Winter period: oil: 3 weeks; grease: 6 weeks
- Summer period: oil: 4 weeks; grease: 13 weeks

Figure 1 shows the installation of the grease-based lubrication system in the machine.

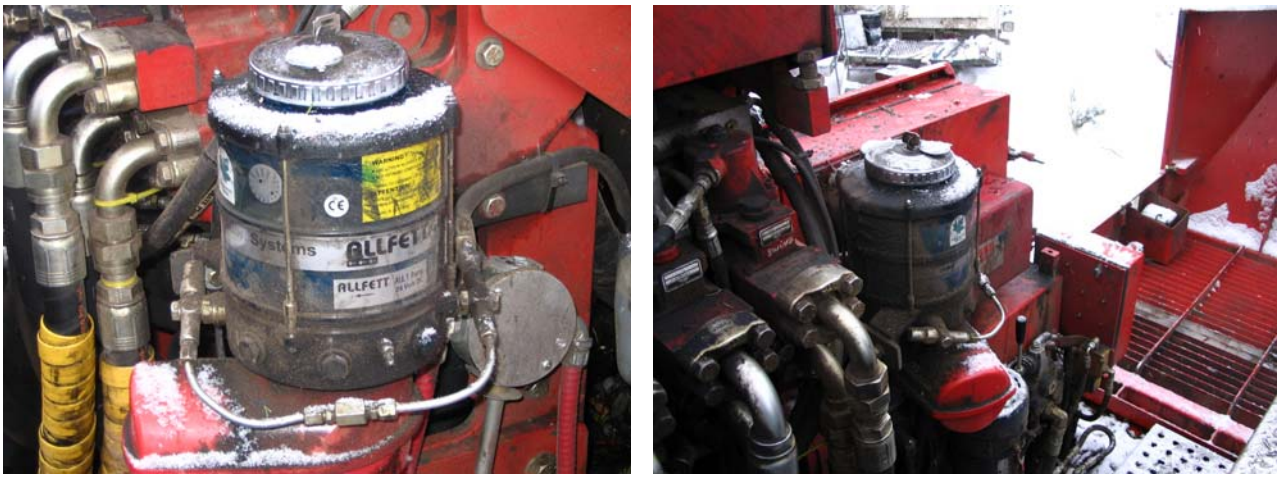

Figure 1. Grease pump and reservoir (*left*); location of pump in machine (*right*)

Oil and grease consumption data were reported on a weekly basis by the contractor along with total production data (stems and logs). The contractor also reported the number of chains and chain guides used with the two types of lubricant.

The single-grip harvester was equipped with a MultiDat device (see Figure 2) to record the machine's uptime (in operation) and downtime. The harvester operator also used the MultiDat to report causes of downtime when they were related to the lubrication system or chain/chain guide assembly.

Figure 2. MultiDat® device

Lubricant consumption

Table 1 shows the quantities of lubricant used per 1000 logs produced, according to the time of year and type of lubricant used during the tests. Grease quantities were also converted into an oil equivalent using an oil content factor of 0.92 in the grease.

Table 1: Quantity of lubricants used

Season	Winter	Summer
Oil (L/1000 logs)	3.226	4.513
Grease (400-g tube/1000 logs)	0.738	1.344
Grease (L oil equiv./1000 logs)	0.262	0.495
Ratio: oil/grease (oil equiv.)	11.9	9.1

The grease-based system made it possible to considerably reduce the quantity of lubricant used per production unit. This reduction, expressed in equivalent litres of oil, was roughly 12 to 1 in winter and 9 to 1 in summer. For instance, for an average daily production of 4000 logs, the quantity of lubricant dispersed into the atmosphere by the conventional system ranged from 13 to 18 litres of oil, whereas the Envirosys system dispersed the equivalent of 1 to 2 litres of oil. Since part of these particles are known to settle on the machine, especially on the windshield, operators not only reported lower clean-up costs when they used the grease-based system, but also better visibility, thus reducing the risk of accidents.

Among other advantages noted by the operator was that significantly less time was wasted adding lubricant to the system, resulting in the harvester stopping less often.

Durability of chains/chain guides

The quality of lubrication can have an impact on the service life of chains and chain guides (heating, stretching, breaking). Table 2 presents the use of these components by season and type of lubricant.

Table 2. Consumption of chains and chain guides by season and lubricant

Season	Winter		Summer	
Lubricant	**Grease**	**Oil**	**Grease**	**Oil**
Chains (failures/1000 logs)	0.20	0.23	0.41	0.36
Chain guides (failures/1000 logs)	0.70	0.73	0.80	0.86

Despite that in three of the four situations considered, the number of failures per 1000 logs was higher when oil was used as the lubricant, the differences reported are not significant because of the variation noted in the weekly failure rate.

Results would possibly have been more significant if, as initially set out in trial protocol, the chains and chain guides had been kept separate according to the type of lubrication. However, the contractor did not follow this procedure.

Mechanical reliability of system

Several criteria can be used to estimate the reliability of a system prone to failures. The following criteria were chosen:

- The MTBF (mean time between failure) = (total uptime) / (number of failures). This is the average time separating the start of two consecutive failures, while the system is in operation;
- The MTTF (mean time to failure) = (total uptime – total failure time) / (number of failures). This is the average time during which the system is in operation prior to the failure;
- The MTTR (mean time to repair) = (total failure time) / (number of failures). This is the average duration of the failure.

Table 3 presents these three reliability indicators for the two trial periods.

Table 3. Reliability of the system (lubrication, chains, chain guides) according to type of lubricant and season

Saison	**Winter**		**Summer**	
Lubricant	**Grease**	**Oil**	**Grease**	**Oil**
MTBF (h)	3.13	2.37	6.26	5.54
MTTF (h)	3.03	2.28	6.19	5.46
MTTR (min)	5.9	5.6	4.2	4.4

The variations in reliability according to the type of lubricant show that the use of grease makes it possible to increase the operating time between two consecutive failures by close to 30% in winter and 13% in summer. This suggests fewer weekly failures on average when grease is used. Assuming that a typical work week is 75 hours of uptime, the average number of failures in winter goes from 32 to 24, and in summer from 17 to 13. The average gains in work time are therefore 45 minutes/week in winter and roughly 15 minutes/week in summer.

Conclusion

The use of grease-based lubricants appears to increase the average uptime before a failure occurs, which translates into fewer times the machine is stopped on average during a week, therefore resulting in more available productive hours. In addition, since savings in oil are significant and a lot less ends up in the environment, the system is much more eco-friendly when you consider that oil from hydrocarbons is being replaced by a biodegradable grease. Using grease also helps reduce the costs and inconveniences of cleaning a machine's external components, which are normally contaminated by oil.

However, the financial benefits associated with lower lubricant consumption are lessened by a higher cost for the lubricant used in the Envirosys system trial (biodegradable vegetable grease).

Results for the service life of components (chains, chain guides) could perhaps have been more significant if, as initially set out in the trial protocol for a more in-depth analysis, the components had been kept separated and identified by type of lubricant. However, because of the conditions in which the trials were conducted, this procedure was not followed.

To obtain declarations or comments from other users of the Envirosys biodegradable grease lubricant system, please contact:

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