

Diesel exhaust fluid consumption in off-road logging machines

Cameron Rittich, BSF

Introduction

With machine operating costs rising annually, getting the most from a capital-intensive logging operation is critical for every fleet manager. Emerging technologies, such as the Tier 4 emission requirements for engines in off-road machinery, pose new challenges for contractors with the introduction of diesel exhaust fluid (DEF). This brief report will help managers better understand the range of DEF consumption values possible for newly purchased machines that have Tier 4 final emissions packages.



Figure 1. Access port for DEF, located below footstep of Tigercat 630E skidder.

Methodology and site conditions

FPIinnovations staff observed four machines operating in the woods and filling their tanks at the end of the work shifts with diesel and DEF. The test machines were all 2016 models, and consisted of two Komatsu 895 forwarders, a Tigercat 630E grapple skidder (fill port location shown in Figure 1), and a Tigercat 845D feller-buncher. All were equipped with Tier 4 final emissions packages that require DEF in order to function, with power outputs ranging from 193 to 210 kW (Figure 2). The forwarders and feller-buncher were tested in the winter, with temperatures as low as -5°C (well above the freeze temperature of DEF); and the grapple skidder was tested in the spring, with temperatures as low as 10°C.



Figure 2. Left to right: Komatsu 895 forwarder, Tigercat 630E grapple skidder, and 845D feller-buncher used in the test.

Fuel consumption was measured using a calibrated mechanical meter that was accurate to within $\pm 1\%$. The DEF used was measured gravimetrically and mass converted to volume using the manufacturer's stated density. The DEF consumption (%) represents the ratio of the volume of DEF used to the volume of diesel fuel consumed.

Results

When comparing the daily variation in DEF consumption for the machines, the forwarders had minor daily variation, the feller-buncher had large variations ranging from 3.4% to 9.3%, and the grapple skidder's daily variation fell between that of the other two machine types. In general, the DEF consumption for these off-road logging machines is up to twice that of trucks.

Table 1. DEF consumption for four logging machines

Type	Forwarder	Forwarder	Skidder	Feller-buncher
Model year	2016	2016	2016	2016
Make	Komatsu	Komatsu	Tigercat	Tigercat
Model	895	895	630E	845D
Total machine hours	9400	1500	511	2550
Hours of machine observation	55.0	56.5	47.4	23.5
Total fuel consumption (L)	908	705	811	922
Fuel consumption rate (L/h)	16.5	12.5	17.1	39.2
Total DEF consumption (L)	32.3	30.0	59.5	59.4
DEF consumption rate (L/h)	0.59	0.53	1.26	2.53
DEF/fuel (%)	3.6	4.3	7.3	6.4

Key findings

Machines equipped with Tier 4 final emissions packages, which consume DEF, are becoming increasingly more common in forestry operations, and it is expected that they will eventually become commonplace. However, the speed of the phase-in process in the industry depends on each manufacturer' own product phase-in process.

Operators will typically be adding two or more 10 L jugs of DEF per shift, as shown in Figure 3. Therefore, some consideration will need to be given to the storage and distribution of the fluid, which can freeze at -11°C.

As the engine manufacturers improve the selective catalytic reduction (SCR) process, which improves engine performance and efficiency, users can expect marginally better fuel economy. As the Tier 4 emissions-equipped machines are implemented and meet the demanding requirements of end-users, we can expect some durability problems.

Given the challenges faced by the trucking industry in its implementation of the U.S. Environmental Protection Agency's 2010 emission standards (the trucking sector's equivalent to Tier 4 final), we can expect some minor initial problems. However, these are likely to be short-lived if past experiences are used to improve future emission system components. For these reasons, it may be advisable to purchase machines equipped with Tier 4 interim emissions systems (no SCR and DEF) if available.



Figure 3. 10 L jug of DEF fluid.