DLG Test Report 7410

revised version 09/2023

Afton Chemical Limited, Bracknell

HiTEC® 47000 Multifunctional Diesel Performance Additive

www.DLG-Test.de

Overview

The DLG QUALITY SEAL for operating equipment and consumables encompasses products, which are subjected to extensive testing of their value-determining and advertised characteristics.

The tested criteria and the requirements to be fulfilled are specified by independent commissions and are designed – over and above legal requirements – to prove the product's fitness for purpose, its advertised characteristics and practical requirements.

QUALITY SEAL · DLG · WWW.DLG.ORG

CLEAN-UP
CONTINUOUS MONITORING
✓ Fuel efficiency
✓ Power recovery
✓ Productivity
✓ AdBlue®/DEF consumption
✓ CO_2 reduction
DLG Certificate 7410

Testing contents and requirements are developed further by the responsible specialist departments of the DLG e.V. in line with the applicable legislation, as well as with technical and scientific progress.

Successful testing is concluded with the assignment of the DLG QUALITY SEAL. The approved products are then published.

In the course of the development of diesel engines, fuel injection systems have become more and more complex, the injection pressures higher and the injection nozzle holes in the injectors are smaller, more precise and more sensitive to dirt and deposits.

These deposits affect the fuel spray pattern and subsequent combustion becomes less effective. This reduces engine performance and can also lead to a deterioration in exhaust gas behavior and, in the worst case, to engine damage.

A well-controlled industry 'Test Fuel' consistent with fuel used in the industry standard CEC F-098 injector coking test was used to provide an efficient and reproducible method of creating injector deposits.

Injector coking deposits in market fuel arise from a range of contaminants and oxidation products that occur in fuel manufacturing, shipping, and storage. Dissolved zinc from sources such as galvanized fuel tanks or the release of tiny particles from brass connections combined with oxidation products from bio-diesel can accelerate deposit formation in the nozzle holes in a very short time.

With the HiTEC® 47000 diesel fuel additive deposits on the injector nozzle holes are broken down and new deposits are prevented, reversing the effects on combustion and restoring vehicle performance.

Other criteria were not tested.

Assessment in brief

In the series of tests carried out, both the targeted coking of the injectors by the test fuel and the cleaning effect of HiTEC® 47000 diesel fuel additive could be demonstrated. The performance of the machine measured at the beginning of the series of measurements was reached again after cleaning with HiTEC® 47000.

Table 1:
Overview of results

DLG QUALITY PROFILE			Cleaning effect confirmed
Fuel Efficiency	up to 3.9 % better / 1.8 % ave	(PTO testing)	✓
Power Recovery	up to 11.4 % / 9 % ave	(PTO testing)	✓
Productivity	up to 13.1 %	(PowerMix testing)	✓
AdBlue®/DEF consumption	up to 12.2 % less	(Powermix full load cycle)	✓
CO_2 reduction	-1.8 % average	(PTO)	✓
	-7.0 % per hectare	(Powermix full load cycle)	✓
Running Costs	up to 6.9 % / 1.1€/ha less	(Powermix full load cycle)	✓

* Evaluation range: requirements fulfilled (✓) / requirements not fulfilled (✗)

The product

Manufacturer

Afton Chemical Limited
London Road, RG12 2UW Bracknell
England

Contact:
Telephone +44 1344 356609
jon.pilbeam@aftonchemical.com
www.aftonchemical.com

Product:
Multifunctional Diesel Performance Additive

Description and technical data

HiTEC® 47000 diesel performance additive is formulated with Afton's Greenclean™ detergent technology, developed for performance in industry tests CEC XUD-9, DW-10, IDID and real-world vehicle fuel economy and performance, ensuring injectors are kept clean and free from deposits.

HiTEC® 47000 was dosed into the Test fuel at a concentration of 134 ppm v/v.

The base test fuel was a diesel supplied by Haltermann Carless GmbH. It contained 5 % bio-diesel and was blended specifically so the test fuel was able to meet the following market diesel specifications:

- EN590
- ASTM D975
- CEC RF-79-07
- CEC RF-06-08

The Test Vehicle

- John Deere 6R 215 DIRECTDRIVE
- 6.8 l engine with 6 cylinders
- 237 hp (174 kW) max power (ECE-R120) and 22 hp (16 kW) IPM
- Transmission: DIRECTDRIVE
- Emission Stage V

The John Deere 6R 215 tractor is often used in contract work. Typical areas of application for this machine include transport and light agriculture through heavy cultivation. Good and comfortable handling is desired throughout.

The method

All the measurements were carried out using DLG's dedicated off-road/agricultural chassis dyno (Figure 2 and 3). Our chassis dyno ranks among the world's highest-capacity test stands for measuring vehicle performance, emissions and fuel consumption. Here, tests are conducted on tractors, machinery and other commercial vehicles.

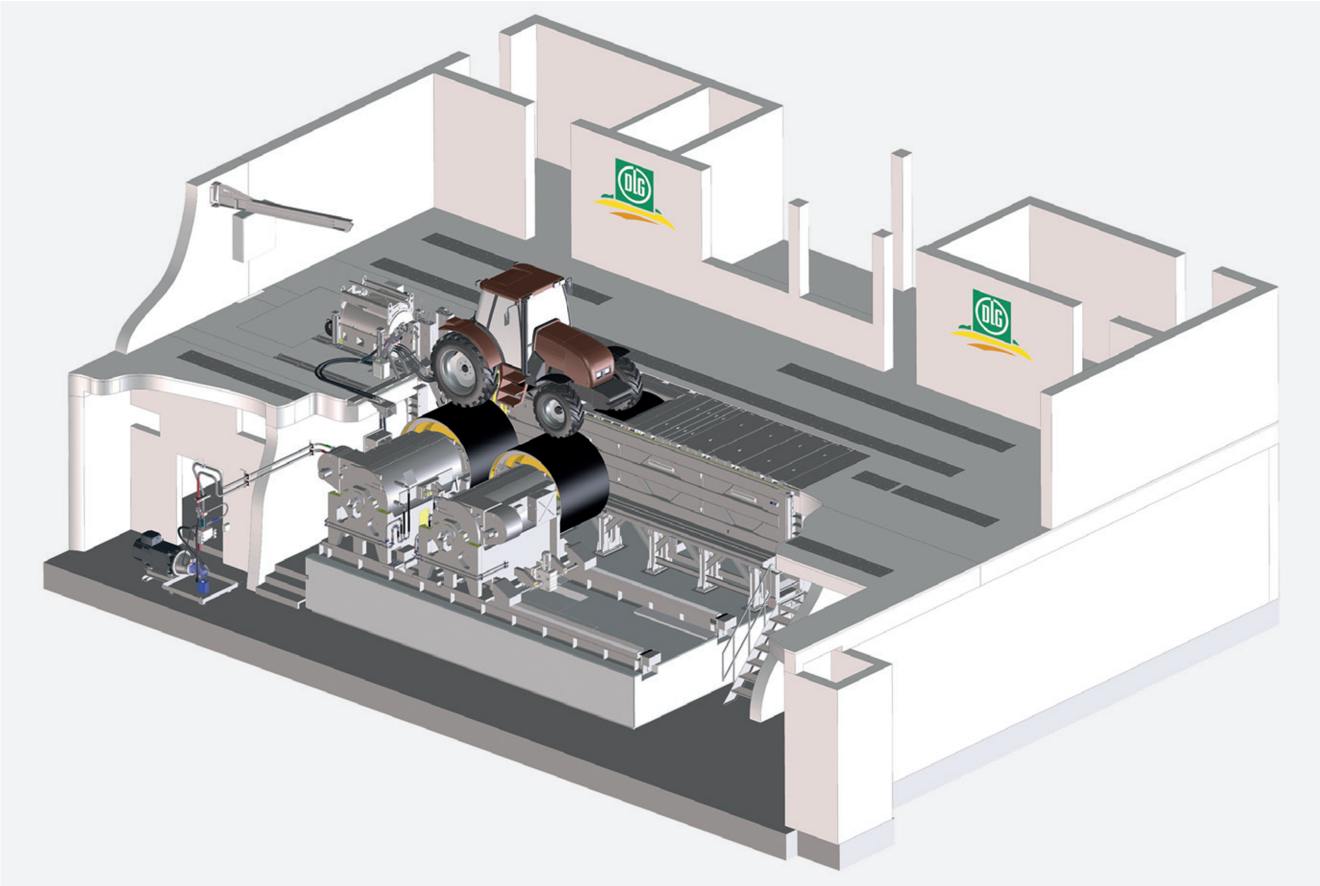

Figure 2:
Schematic representation of DLG Chassis Dyno

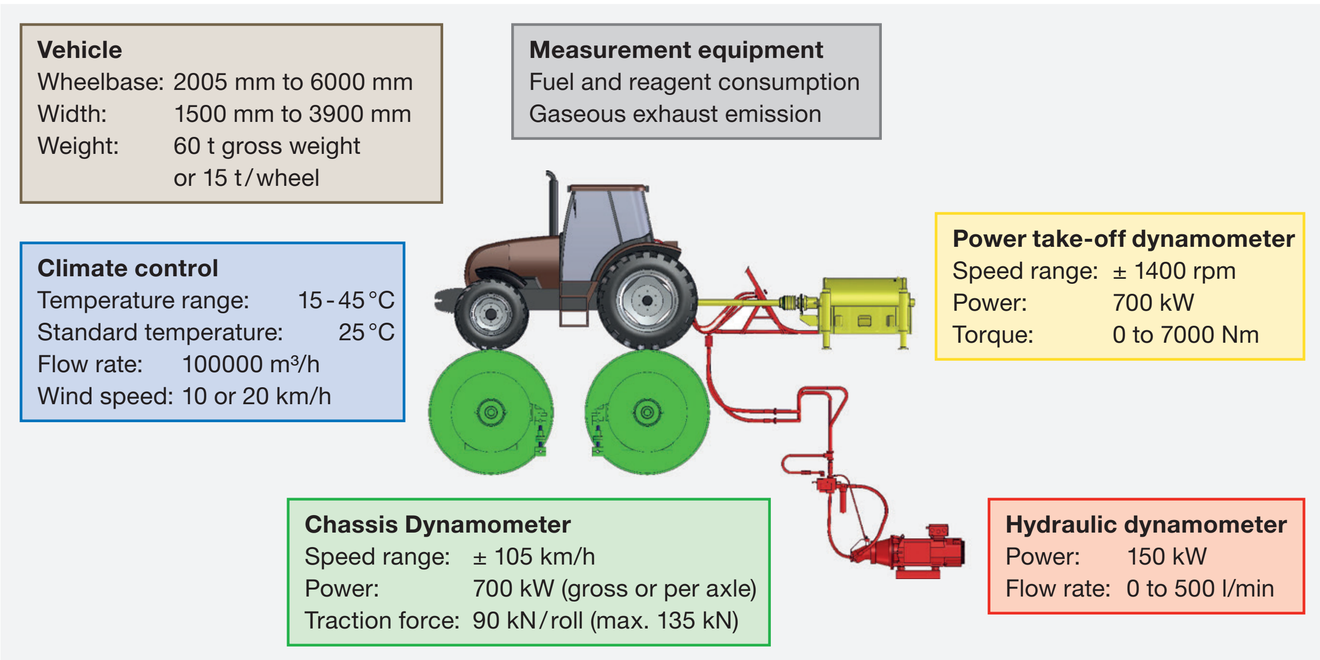

Figure 3:
Schematic representation of DLG Chassis Dyno Measurement Types

Overview of Test Method – Definition

- ‘Dirty-Up’ was done with engine at full load and engine speed of 1900 rpm running on test fuel and zinc without diesel fuel additive.
- ‘Clean-Up’ was done with engine at full load and engine speed of 1900 rpm running on test fuel and zinc with 134 ppm v/v of HiTEC® 47000 diesel fuel additive.

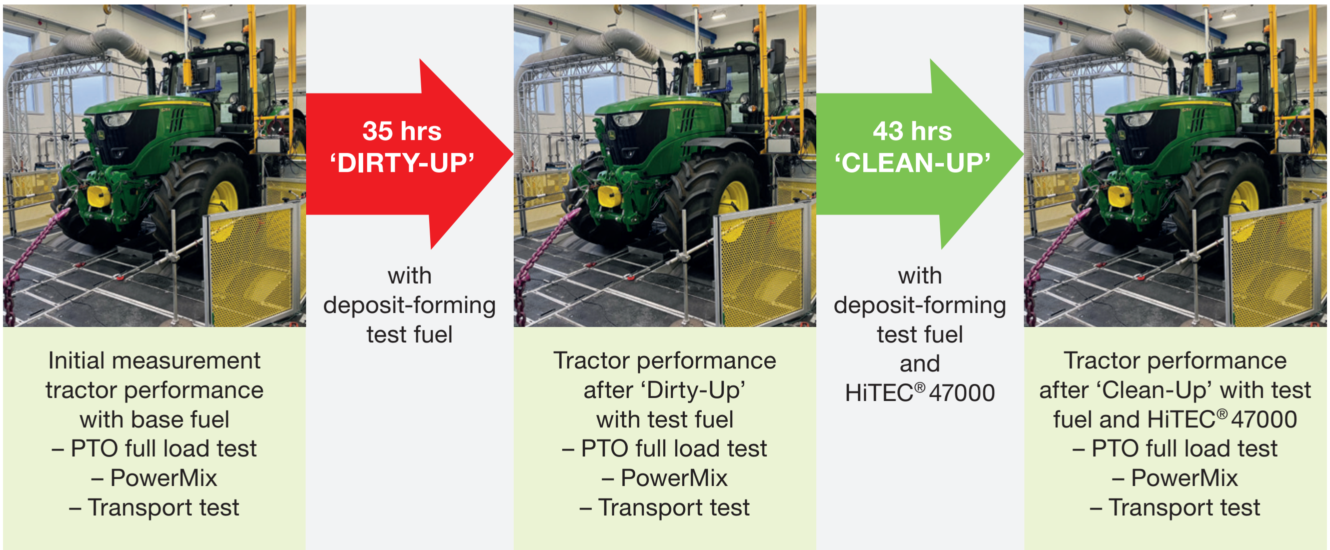

Figure 4:
Overview of the test method

Tractor Performance Measurement

The effect of deposit forming test fuel was examined with 3 different test methods in order to show a relation to use beyond the test bench results.

1. POWER AND FUEL CONSUMPTION MEASUREMENT at full engine load using the Power Take Off (PTO) shaft

a) PTO attachments give tractors more versatility and in some cases the PTO is used alone – for example

- Post hole diggers allow owners to dig holes for fence posts, posts for a deck, a pole barn or even plant trees.
- Water pumps are used for dredging ponds and irrigating crops on a farm.
- Wood chipping

b) When measuring the power at the PTO shaft, the entire speed range from rated speed (2100 rpm) down to low idle (900 rpm) was covered.

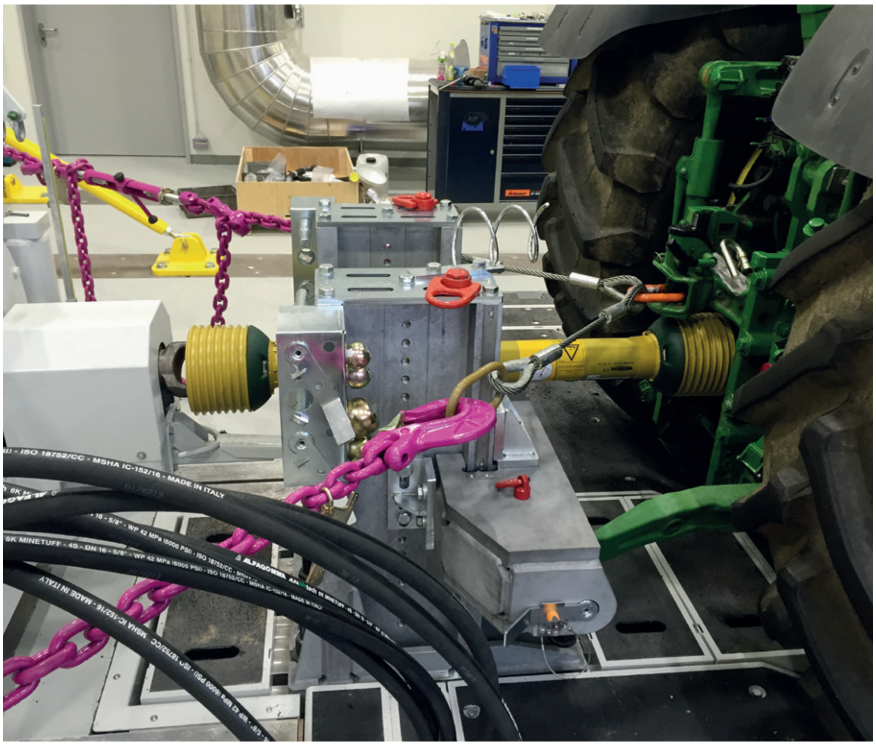

Figure 5:
PTO measurement

2. DLG POWERMIX

The test cycles performed on the roller dynamometer are based on actual load cycles measured in the field, which over the years have been developed into a practical test recognized by the tractor industry.

For the measurements of the field work based on the DLG PowerMix, the focus was on typical work with high power requirements on the PTO shaft, rotary harrow and mower. Pure traction cycles without PTO were not run-in order to minimize the influence of the tires under high tensile loads.

Table 2:
PowerMix Cycles during test

Load type	Name of cycle			Driving speed [km/h]	PTO speed [min^{-1}]
Drawbar work + PTO work	power harrow	100 %	Z3K	6	900
	power harrow	70 %	Z4K	6	900
	power harrow	40 %	Z5K	6	900
	mowing	100 %	Z3M	16	900
	mowing	70 %	Z4M	16	900
	mowing	40 %	Z5M	16	900

3. DLG TRANSPORT TESTS

a) Simulating the tractor driving on the road whilst towing a trailer.

b) Trips with high trailer loads were used.

Figure 6:
PowerMix and transport on chassis dyno

Detailed account of the test results

Table 3:
Summary PTO Test – %-Change after Clean-Up with HiTEC® 47000 diesel fuel additive at 134 ppm v/v [1]

Measurement	PTO Power	PTO Torque	Brake Specific Fuel Consumption	AdBlue® Specific Fuel Consumption
Units	kW	Nm	g/kWh	g/kWh
Average from 900 rpm to 2100 rpm	+10 %	+10 %	-1.8 %	-1.3 %
Maximum	+12.5 % at 1300 rpm	+12.5 % at 1300 rpm	-3.9 % at 1300 rpm	-19.5 % at 1300 rpm

The results of the performance measurement can be seen in figures 7 and 8.

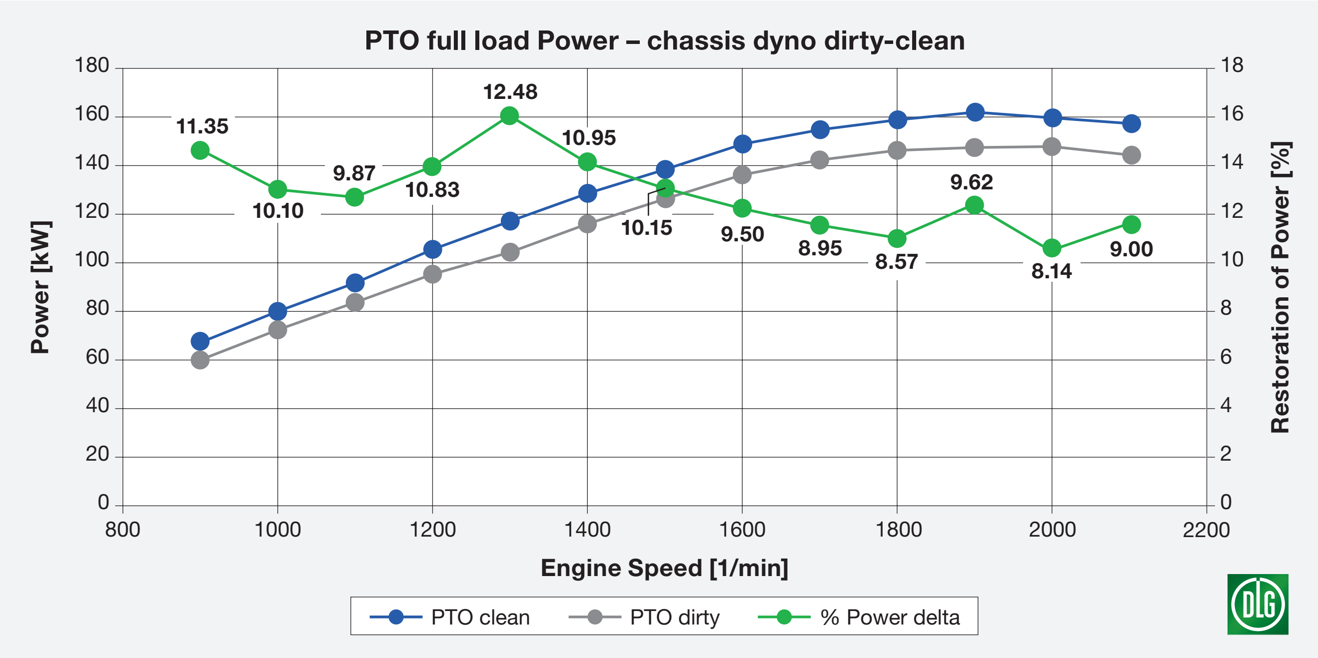

Figure 7:
PTO performance initial / after test fuel used / after clean up with additive HiTEC® 47000

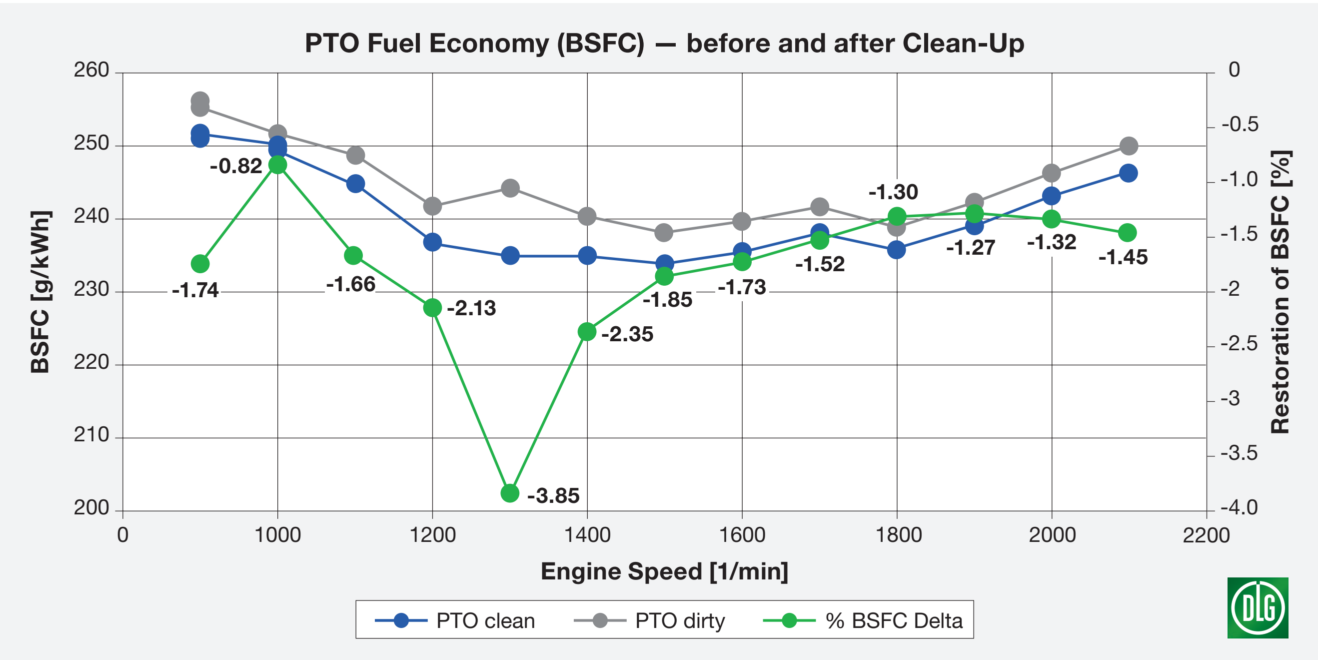

Figure 8:
Increased PTO performance after clean up with additive HiTEC® 47000

[1] value corrected

PowerMix Test – Power and Productivity Increase

Table 4:
Summary of Tractor Productivity Improvement

Measurement	Cycle [2] power	Area performance	Consumption per hectare		Consumption costs* per hectare
			Diesel	AdBlue®/DEF	
	[kW]	[ha/h]	[l/ha]	[l/ha]	[€/ha]
Maximum (Z3K cycle power harrow)	+5.3 %	+13.1 %	-7.0 %	-2 %	-6.9 %
Maximum (Z3M cycle mowing)	+4.2 %	+7.2 %	-3.5 %	-12.2 %	-3.7 %

* calculated with: fuel costs 1,75 €/l; AdBlue 1,1 €/l

The cycles carried out with rotary harrow and mower confirm the results of the performance measurement on the PTO shaft.

The increases in performance after Clean-Up with HiTEC® 47000 diesel fuel additive allow the tractor to increase its productivity compared to the vehicle with injectors in the 'Dirty' state.

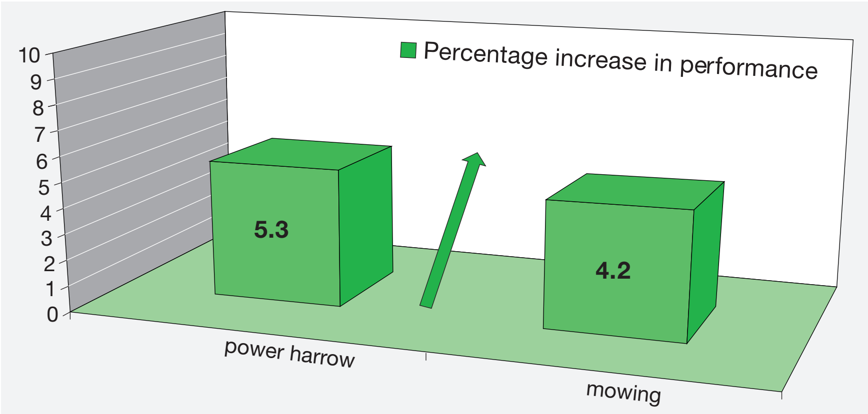

Figure 9:
Percentage increase of power after clean up with additive

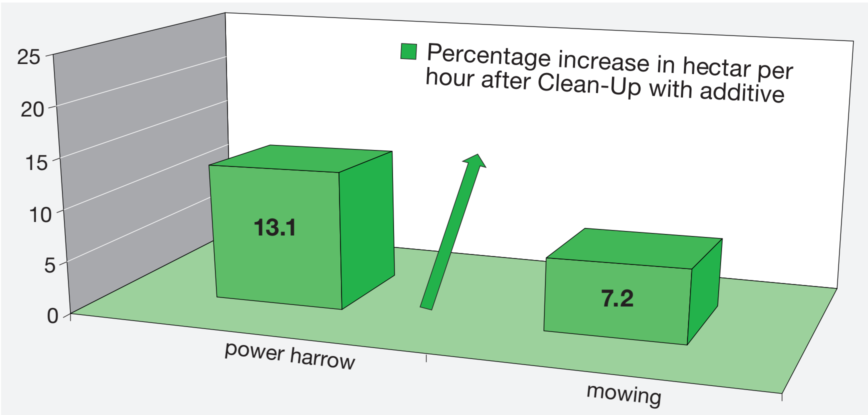

Figure 10:
Percentage increase of hectare per hour after clean up with additive

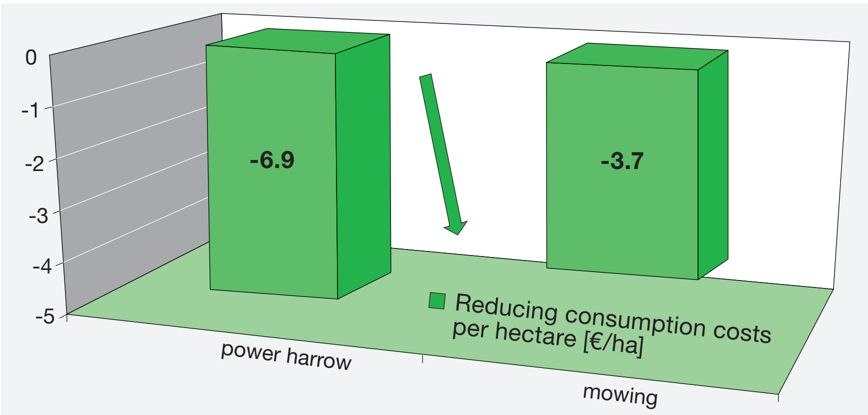

Figure 11:
Reducing consumption costs per hectare with additive

[2] Designation precised

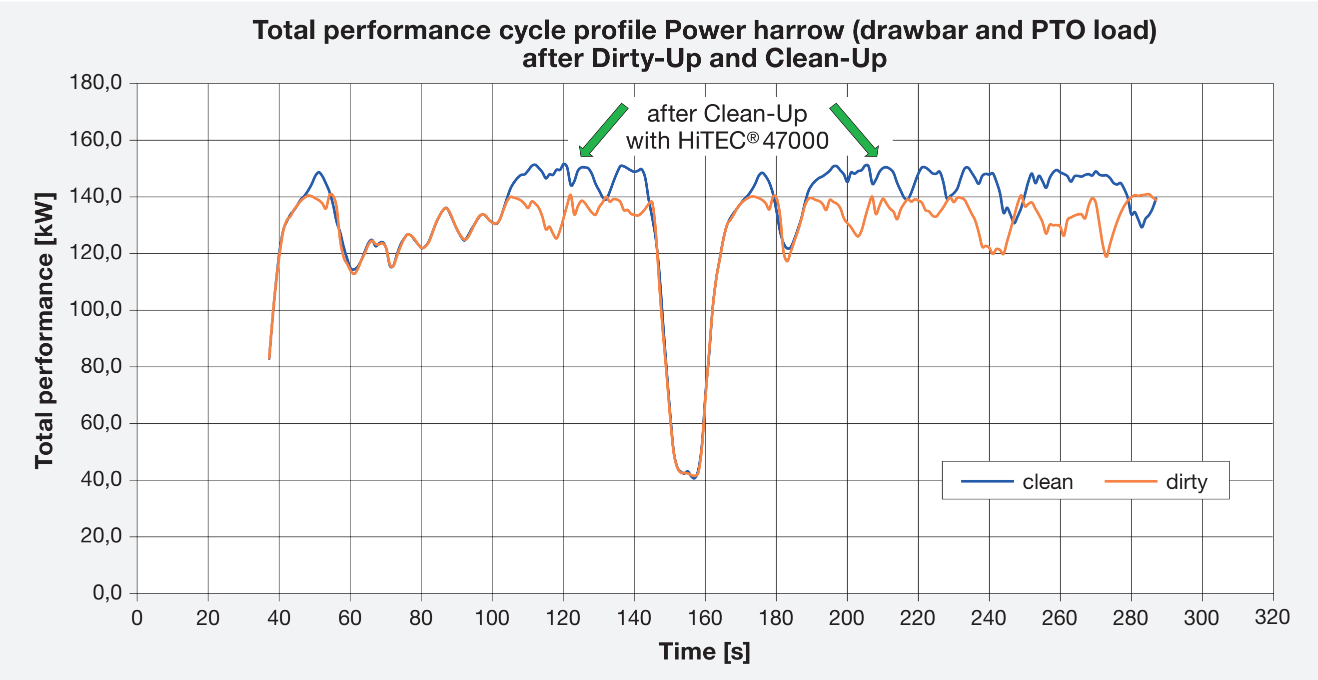

Figure 12:
Cycle history power harrow before and after clean up with HiTEC® 47000 diesel fuel additive

Transport Test

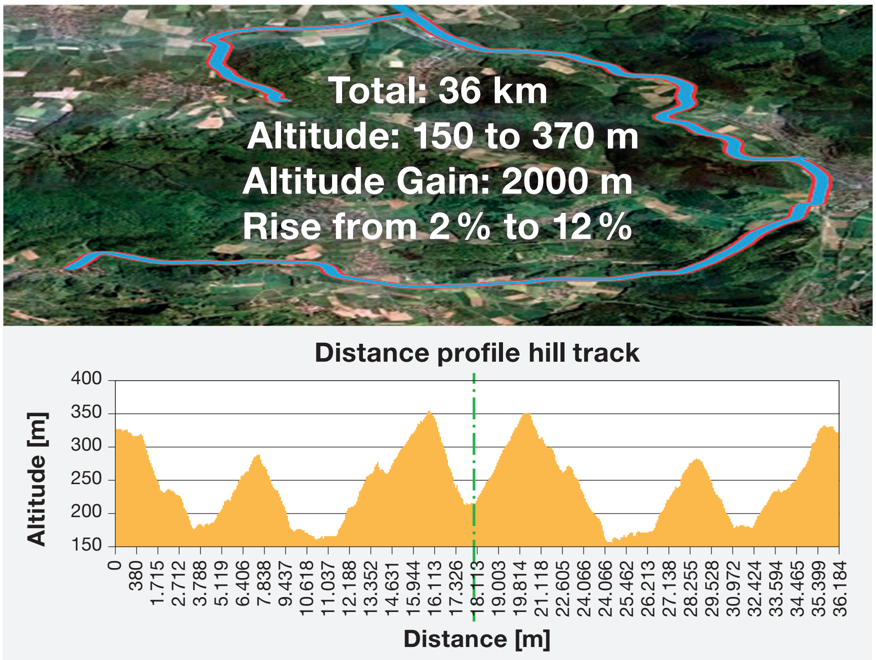

Figure 13:
Transport cycle – dynamic measurement of hill sections 1 to 6

During the transport test, the main focus was on transport work with a high load, where the maximum available performance was required

The measuring results are continuously recorded, however only the results of six partial drives are used for the evaluation. These are highlighted in green in figure 14.

These partial drives have different characteristic properties, and therefore requirements for the engine-gearbox coordination.

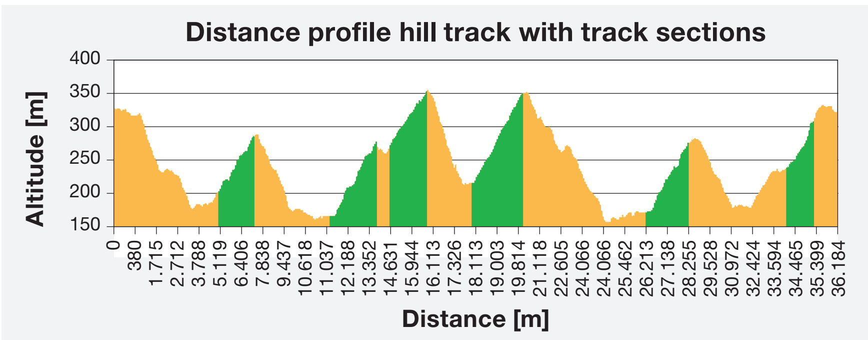

Figure 14:
Distance profile hill track with track sections

Summary of Tractor Productivity Improvement during Transport Cycles

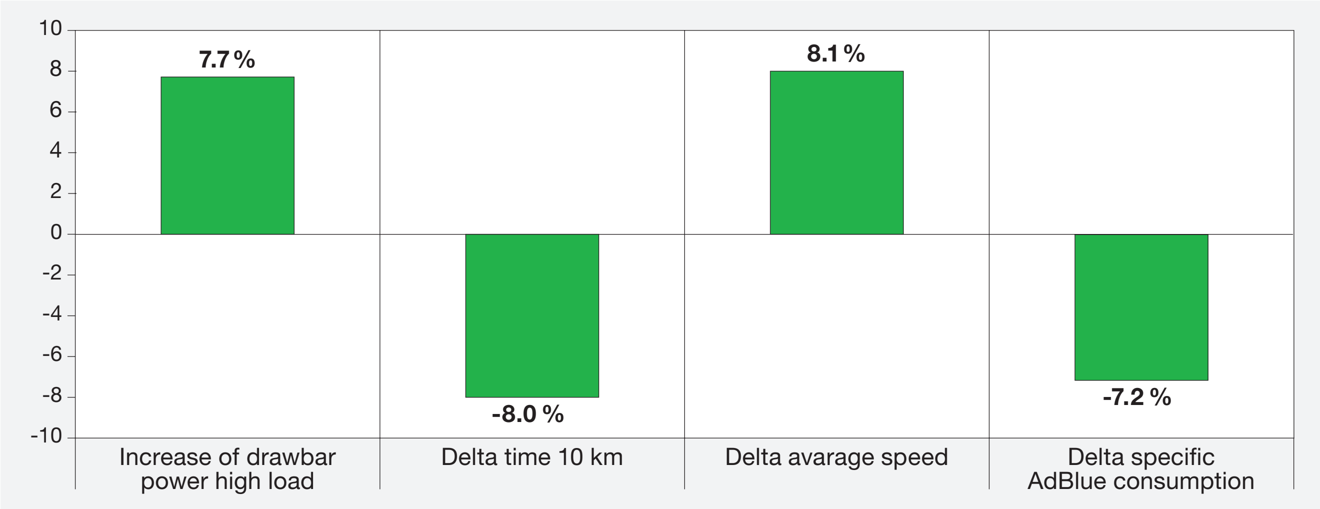

Figure 15:
Improvement in transport test high load after clean up with HiTEC® 47000 diesel fuel additive

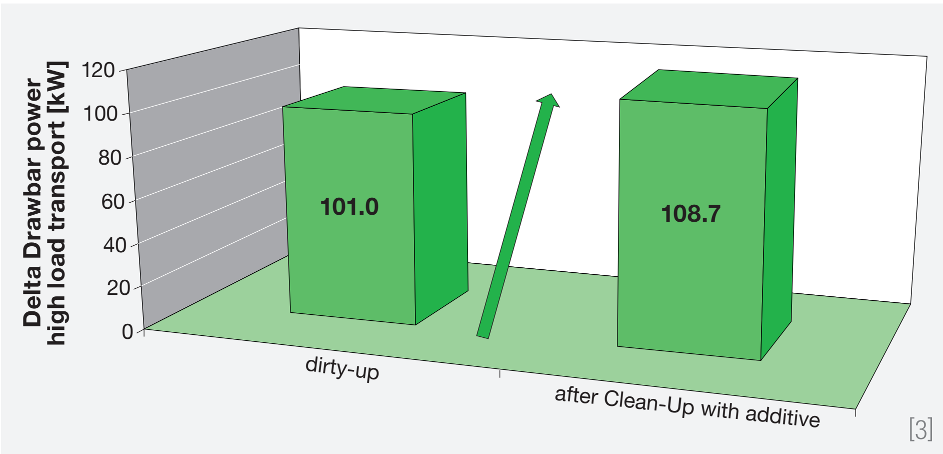

Figure 16:
Increased drawbar power after clean up with additive

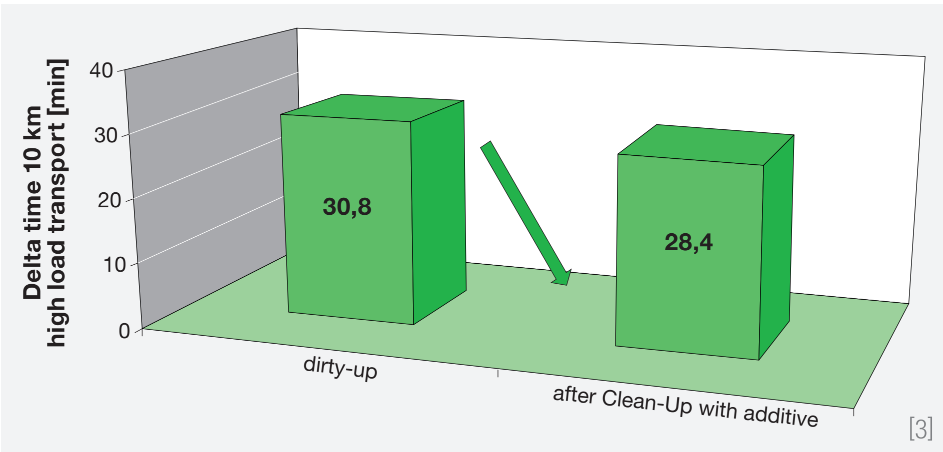

Figure 17:
Decreased time for 10 km transport under high load after clean up with additive HiTEC® 47000

[3] Designation precised

Summary

Table 4:
Final Summary – Table of significant claims

	Afton H47000
Fuel Efficiency	up to 3.9 % better / 1.8 % ave (PTO testing)
Power Recovery	up to 11.4 % / 9 % ave (PTO testing)
Productivity	up to 13.1 % (PowerMix testing)
AdBlue®/DEF consumption	up to 12.2 % less (Powermix full load cycle)
CO_2 reduction	-1.8 % average (PTO)
	-7.0 % per hectare (Powermix full load cycle)
Running Costs	up to 6.9 % / 1.1€/ha less (Powermix full load cycle)

The test has shown that the additive HiTEC® 47000 from Afton Chemical Limited can completely remove injector deposits created with a fuel meeting CEC RF79-07 reference fuel specification

The performance of the machine was fully restored after 43 operating hours with HiTEC® 47000 diesel fuel additive showing significant

- Increase in engine power and torque at full load measured through the tractors Power-Take-Off (PTO) device
- Reduction in fuel consumption at full load measured through the tractors Power-Take-Off (PTO) device
- Reduction in AdBlue®/DEF consumption at full load measured through the tractors Power-Take-Off (PTO) device
- Increase in productivity parameters during the PowerMix cycle for harrowing and mowing
- Increase in productivity parameters during the Transportation cycles
- Reduction in CO_2 at full load, measured through the tractor Power-Take-Off (PTO) device and during the PowerMix cycle for harrowing and mowing

Fuel Properties

Property / ANALYSES	Unit	CEC RF79-07	EN590	ASTM D975 No 2-D Limit	Haltermann Tractor Test Fuel
Distillation % (v/v) recovered at 250 °C	% (v/v)		< 65		33.7
Distillation % (v/v) recovered at 350 °C	% (v/v)		≥ 85		95.6
Distillation 50 % (v/v) recovered at	°C	> 245			274.7
Distillation 90 % (v/v) recovered at	°C			min 282 max 338	327.4
Distillation 95 % (v/v) recovered at	°C	345 - 350	≤ 360		346
API Gravity at 60°F	n/a			n/a	0.8365
Appearance	n/a	na		clear and bright	
Aromaticity				35	27.3
Aromatics poly (2+3)	% wt	3 - 6 %			3.8
Ash content	% (m/m)	< 0.01	≤ 0.01	≤ 0.01	< 0.001
Carbon residue (on 10 % distillation residue)	% (m/m)	< 0.2	≤ 0.3	0.15 max (1D) 0.35 max (2D)	< 0.1
Cetane index	n/a		≥ 46	40	54.1
Cetane number		52 - 54	≥ 51	≥ 40	52.8
CFPP	°C	< -5	≤ +5 … ≤ -44	operability: report	-19
Cloud point	°C		≤ -10 … ≤ -34	report	-19
Conductivity	pS/m	na		25, min	90.9
Copper strip corrosion (3 h at 50 °C)	rating	1	Class 1	No 3	1A
Density at 15 °C	kg/m³	833 - 837	820 … 845 ≥ 800		836
FAME content	% (v/v)	na	≤ 7	≤ 5	4.9
FBP	°C	< 370			361.7
Flash point	°C	> 62	> 55	38 - 52	82.5
Lubricity, wear scar diameter WSD at 60 °C	µm	< 400	≤ 460	≤ 520	180
Manganese content	% (v/v)	– –		≤ 35	< 1
Oxidation stability	g/m³	< 0.025	≤ 25		< 1
Rancimat	h	na	≥ 20		35.2
Specific gravity at 60 °F	n/a			n/a	0.8365
Strong acid number	mg KOH/g	< .002			< 0.02
Sulfur content	mg/kg	< 10	≤ 10	15 max	< 3
Total contamination	mg/kg		≤ 24		< 12
Viscosity at 40 °C	mm²/s	2.3 - 3.3	min 2 … 4.5 max 1.2 … 4	min 1.3-2.4 max 1.9-4.1	2.627
Water and sediment	% volume	na		0.05 max	< 0.01
Water content	% (m/m)	< 0.02	≤ 0.02	< 0.05 % water and sediment	0.003

Haltermann Carless Deutschland GmbH
Quality Assurance
Schlengendeich 17
21107 Hamburg
Deutschland

Certificate of Analysis

Diesel, CEC Legislative Fuel RF-06-08 B5 (EU-V Cert.) BULK

Analyzed for: Haltermann Carless Deutschland GmbH, Sales
Schlengendeich 17, 21107 Hamburg

Material-No. (GMID): 283507
SAP Batch No.: 0000050133
Date of Analysis: 21.03.2022

Sample No : 3000023976
Batch No : 44
Project No :

Parameter	Method	Unit	Limits Min.	Limits Max.	Result
Cetane Number (CFR) *[1]	DIN EN ISO 5165:2018-04		52,0	54,0	**52,8**
Density at 15°C *[2]	DIN EN ISO 3675:1999-11	kg/m3	833,0	837,0	**836,0**
Density at 15°C	DIN EN ISO 12185:1997-11	kg/m3			**836,0**
Specific Gravity @ 15/15 degC	DIN EN ISO 12185:1997-11				**0,8365**
Distillation IBP *[4]	DIN EN ISO 3405:2019-09	°C			**197,7**
Dist. 50% v/v *[4]	DIN EN ISO 3405:2019-09	°C	245,0		**274,7**
Dist. 90% v/v *[4]	DIN EN ISO 3405:2019-09	°C			**327,4**
Dist. 95% v/v *[4]	DIN EN ISO 3405:2019-09	°C	345,0	350,0	**346,0**
Distillation FBP *[4]	DIN EN ISO 3405:2019-09	°C		370,0	**361,7**
Flash Point	DIN EN ISO 2719:2021-06	°C	55,0		**82,5**
CFPP	DIN EN 116:2018-04	°C		-5	**-19,0**
Cloud Point	ISO 3015:2019-04	°C			**-19,0**
Viscosity at 40°C *[4]	DIN EN ISO 3104:2021-01	mm2/s	2,300	3,300	**2,627**
Aromatics, Poly (2+3)	DIN EN 12916:2019-08	%(m/m)	2,0	6,0	**3,8**
Aromatics, Total	DIN EN 12916:2019-08	%(m/m)			**27,3**
Aromatics, Mono	DIN EN 12916:2019-08	%(m/m)			**23,5**
Aromatics, Di	DIN EN 12916:2019-08	%(m/m)			**3,7**
Aromatics, Tri+	DIN EN 12916:2019-08	%(m/m)			**0,1**
Sulfur	DIN EN ISO 20846:2019-12	mg/kg		10,0	**< 3,0**
Corrosion - Copper	DIN EN ISO 2160:1999-04			max. 1	**1A**
Carbon Residue	DIN EN ISO 10370:2015-03	% w		0,20	**< 0,10**
Ash Content *[1]	DIN EN ISO 6245:2003-01	%(m/m)		0,010	**< 0,001**
Water *[1]	DIN EN ISO 12937:2002-03	%(m/m)		0,020	**0,003**
Water & Sediment	ASTM D2709	%(V/V)		0,02	**< 0,01**
Strong Acid Number	ASTM D974:2021	mg KOH/g			**< 0,02**
Oxidation Stabilit	DIN EN ISO 12205:1996-01	g/m3		25	**< 1**
Oxidation Stability *[3]	DIN EN 15751:2014-06	Hour	20,0		**35,2**

Haltermann Carless Deutschland GmbH
District Court Hamburg Commercial Register B118570
USt-ID / VAT-ID: DE815285855
Management Board: Henrik Krüpper (Chairmanship),
Dr. Harald Dialer, Peter Stubbe

Haltermann Carless Deutschland GmbH
Quality Assurance
Schlengendeich 17
21107 Hamburg
Deutschland

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Schlengendeich 17, 21107 Hamburg

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Sample No : 3000023976
Batch No : 44
Project No :

Parameter	Method	Unit	Limits		Result
			Min.	Max.	
Oxidation Stabilit	DIN EN 15751:2014-06	Hour	20,0		**35,2**
HFRR (WSD)	DIN EN ISO 12156-1:2019-09	µm		400	**180**
FAME	DIN EN 14078:2014-09	%(V/V)	4,5	5,5	**4,9**
Oxygen	HH-HM-028	%(m/m)			**0,56**
Hydrogen *[2]	HH-HM-028	%(m/m)			**13,43**
Carbon *[2]	HH-HM-028	%(m/m)			**86,01**
C:H Ratio (H=1) *[2]	HH-HM-028				**6,41**
H:C Ratio (C=1) *[2]	HH-HM-028				**0,156**
Net Heating Value *[2]	HH-HM-027	MJ/kg			**42,849**
Net Heating Value *[2]	HH-HM-027	Btu/lb			**18422**
Pour Point	ASTM D6892:2003	°C			**-27**
Additional measurements from Sample 3000028364 / 09.06.2022					
Conductivity	ASTM D2624:2021	pS/m			**90,9**
Aluminium *[1]	ICP-OES	mg/l			**< 0,10**
Barium *[1]	ICP-OES	mg/l			**< 0,10**
Boron *[1]	ICP-OES	mg/l			**< 0,10**
Cadmium *[1]	ICP-OES	mg/l			**< 0,10**
Calcium *[1]	ICP-OES	mg/l			**< 0,10**
Chromium *[1]	ICP-OES	mg/l			**< 0,10**
Copper *[1]	ICP-OES	mg/l			**< 0,10**
Iron *[1]	ICP-OES	mg/l			**< 0,10**
Lead *[1]	ICP-OES	mg/l			**< 0,10**
Magnesium *[1]	ICP-OES	mg/l			**< 0,10**
Manganese *[1]	ICP-OES	mg/l			**< 0,10**
Molybdenum *[1]	ICP-OES	mg/l			**< 0,10**
Nickel *[1]	ICP-OES	mg/l			**< 0,10**
Phosphorus *[1]	ICP-OES	mg/l			**< 0,10**

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Schlengendeich 17, 21107 Hamburg

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SAP Batch No.: 0000050133
Date of Analysis: 21.03.2022

Sample No : 3000023976
Batch No : 44
Project No :

Parameter	Method	Unit	Limits Min.	Limits Max.	Result
Potassium *[1]	ICP-OES	mg/l			**< 0,10**
Silicon *[1]	ICP-OES	mg/l			**< 0,10**
Silver *[1]	ICP-OES	mg/l			**< 0,10**
Sodium *[1]	ICP-OES	mg/l			**< 0,10**
Tin *[1]	ICP-OES	mg/l			**< 0,10**
Titanium *[1]	ICP-OES	mg/l			**< 0,10**
Vanadium *[1]	ICP-OES	mg/l			**< 0,10**
Zinc *[1]	ICP-OES	mg/l			**< 0,10**

*[1]: tested by subcontractor
*[2]: not accredited
*[3]: modified, not accredited
*[4]: autom. Measured

Technical Services & Development PF
Ron Widera
Development Chemist
Tel. +49 40 33318 144
Email: rwidera@h-c-s-group.com

The analyses were conducted in our DIN EN ISO/IEC 17025 accredited laboratory. The Test results refer exclusively to the mentioned objects. Samples analyzed as received. The test report may not be reproduced even in part without the written consent of testing laboratory. The certificate is electronically generated and valid without signature.

Haltermann Carless Deutschland GmbH
District Court Hamburg Commercial Register B118570
USt-ID / VAT-ID: DE815285855
Management Board: Henrik Krüpper (Chairmanship),
Dr. Harald Dialer, Peter Stubbe

More information

Testing agency

DLG TestService GmbH,
Gross-Umstadt location, Germany

The tests are conducted on behalf of DLG e.V.

DLG test framework

DLG APPROVED "DLG-PowerMix 2.0"

Department

Tractors, machines & utility vehicles

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DLG – the open network and professional voice

Founded in 1885 by the German engineer Max Eyth, DLG (Deutsche Landwirtschafts-Gesellschaft – German Agricultural Society) is an expert organisation in the fields of agriculture, agribusiness and the food sector. Its mission is to promote progress through the transfer of knowledge, quality standards and technology. As such, DLG is an open network and acts as the professional voice of the agricultural, agribusiness and food sectors.

As one of the leading organisations in the agricultural and food market, DLG organises international trade fairs and events in the specialist areas of crop production, animal husbandry, machinery and equipment for farming and forestry work as well as energy supply and food technology. DLG's quality tests for food, agricultural equipment and farm inputs are highly acclaimed around the world.

For more than 130 years, our mission has also been to promote dialogue between academia, farmers and the general public across disciplines and national borders. As an open and independent organisation, our network of experts collaborate with farmers, academics, consultants, policymakers and specialists in administration in the development of future-proof solutions for the challenges facing the agriculture and the food industry.

Leaders in the testing of agricultural equipment and input products

The DLG Test Center Technology and Farm Inputs and its test methods, test profiles and quality seals hold a leading position in testing and certifying equipment and inputs for the agricultural industry. Our test methods and test profiles are developed by an independent and impartial commission to simulate in-field applications of the products. All tests are carried out using state-of-the-art measuring and test methods applying also international standards.

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