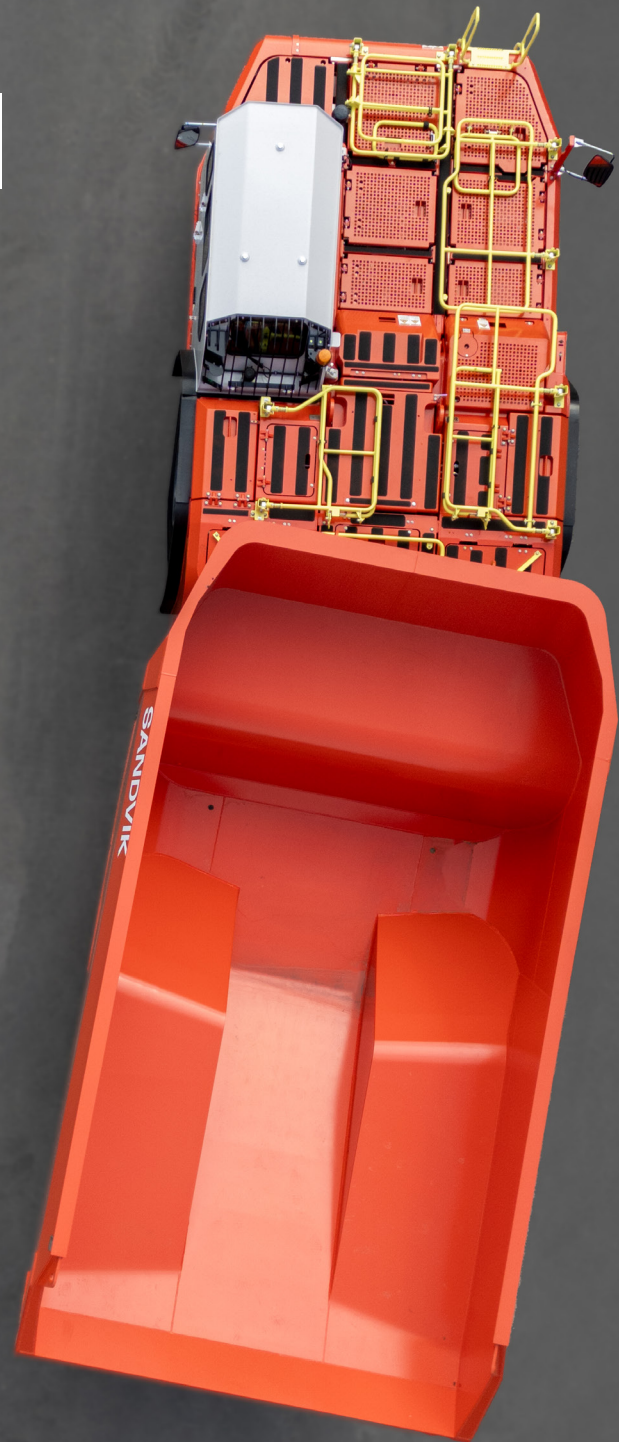


# Load & Haul Stage V engine technology



# Proven Stage V engine technology for underground mining

At Sandvik, we are continuously developing our loaders and trucks. We are committed to offering low-emission equipment with state-of-the-art power sources for underground mines.

During the years that have passed, equipment and engine technology have taken huge leaps in reducing particulate emis-

sions. With our expertise and collaborative networks, we are delivering a Stage V engine by Volvo Penta for loaders and trucks, in which the engine and equipment work as one.

Achieved through continuous research and development and tens of thousands of operating hours in active underground

mines around the world, the technology meets or exceeds the stringent demands of the harsh environment and its applicable requirements.

Stage V engines are optionally available for selected Sandvik loaders and trucks in areas where ultra-low sulfur fuel and low-ash engine oil is available.



# Reduced emissions

## Regulation development for non-road diesel engines, power range 130–560 kW

The most significant benefit of the Stage V engine is the reduced amount of particulate matter in the diesel exhaust, which helps improve air quality underground. The Stage V engine delivers the best in class ventilation rates with the goal being to lower ventilation costs.

### Passive regeneration

Reduction of diesel particles in Stage V engines with power range 130–560 kW is based on having Diesel Particulate Filter (DPF) technology as part of the engine's after-treatment system. Stage V engines from Volvo Penta utilize passive DPF regeneration which takes place during normal equipment operation. The

exhaust temperature is maintained at an optimum level at all times while the filter is regenerated. Passive regeneration is most efficient in a temperature range of 250–450 °C, which usually matches with the normal engine work cycle. This means that in normal operating conditions, there is no need to stop the equipment or manually start the regeneration. These actions are aimed to minimize equipment downtime.

### Selective catalytic reduction

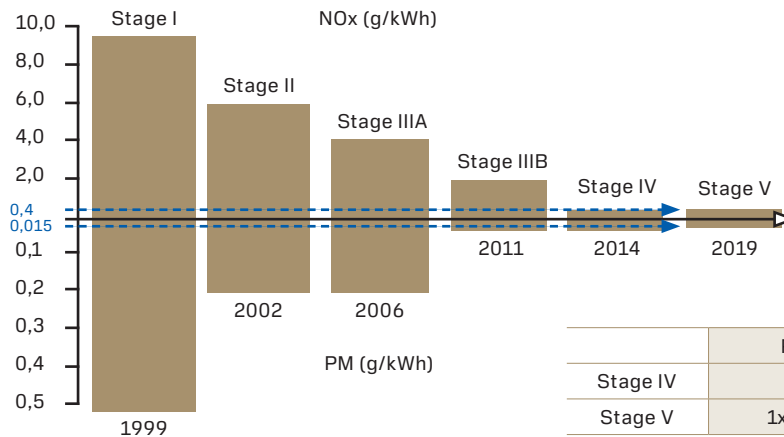
The exhaust after treatment contains a Selective Catalytic Reduction system (SCR), which uses diesel exhaust fluid to reduce emissions of nitrogen oxide. The SCR, with the DPF, reduces emissions without sacrificing performance or fuel efficiency.

## HVO100, renewable fuel for minimal emissions

To achieve minimal emissions, all Sandvik loaders and trucks with Stage V engines are compatible with HVO100, hydrotreated vegetable oil based fuel. HVO100 is a stable, high-quality fuel, meeting EN 15940 standard and it can lower fossil CO<sub>2</sub> emissions by up to 90%, depending on the feedstock. HVO100 is treated as diesel fuel and it works in exactly the same way in terms of service and installation. It can be used alone or blended, and doesn't require any additional service or maintenance tasks.

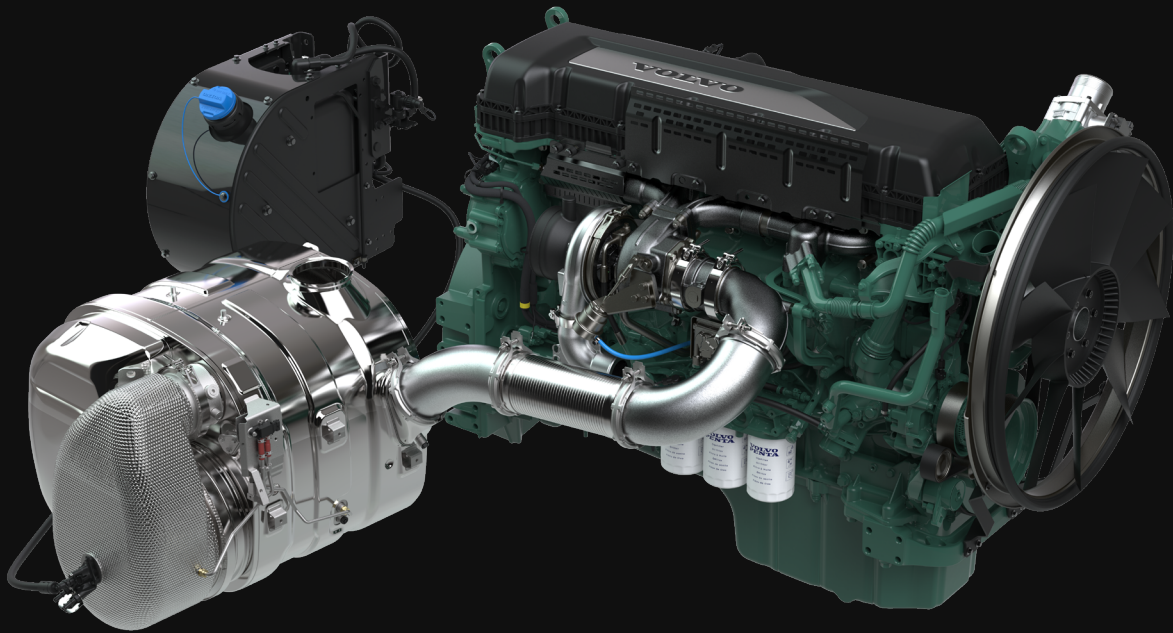
# 25

times less particle mass than in Stage II engine emissions



	PN	PM (g/kWh)	NOx (g/kWh)
Stage IV	-	0,025	0,40
Stage V	1x10 <sup>12</sup>	0,015	0,40

# Designed for underground performance



Developed in collaboration with Volvo Penta, the Stage V engine and Sandvik equipment work together to maintain productivity and reliability in the most challenging environments. Both the engine and the equipment come with proven track records from previous design solutions for underground use. Without any compromise between

the latest engine technology or the performance level of the equipment, the Stage V engine provides the same power output as the Stage IV / Tier 4f. Increased wiring protection, including a braided armour wiring harness, improves reliability. Further, all electrical hardware is specially designed for demanding conditions with corrosion, heat and water

resistance. The exhaust aftertreatment system design fits perfectly in place in the equipment frame, allowing us to keep the main dimensions and weights unchanged.

During the equipment lifetime, engines are available from Sandvik Parts & Service aftermarket support.



# High availability

## 1000

times fewer particles per  $\text{cm}^3$  than in Stage II engine emissions

Up to

## 3%

reduced fuel consumption compared to lower Stages\*

\*Test results are to be considered as results reached under certain controlled test conditions. These test results should not be treated as specifications and Sandvik does not guarantee, warranty or represent the outcome of test results in any or all circumstances.

### **Modulating engine brake**

Volvo Penta Stage V engines <560 kW are equipped with a modulating engine brake. This enables the operator to adjust the braking power for better downhill speed control. Additionally, it minimizes brake and transmission overheating and brake wear. The modulating engine brake and passive regeneration contribute to high uptime.

### **Reduced oil consumption**

With Volvo Penta Stage V, the engine oil change interval is tailored in Sandvik applications to match underground mining conditions, and stretched

from previous 250 to 500 hours. This decreases oil consumption and increases equipment availability.

### **Reduced fuel consumption**

The Stage V loaders and trucks are capable of operating with up to 3% reduced fuel consumption compared to the lower Stages, reducing total costs of ownership. The fuel and DEF (diesel exhaust fluid) tanks enable continuous operation for a full working shift without the need to stop and refuel. An optionally available Wiggins fast-filling system reduces fueling time by up to 80 % and eliminates fuel and oil spills.

# Built-in fire safety

To mitigate fire risks relating to high temperatures, Sandvik loaders and trucks are carefully designed, specifically keeping in mind tough underground mining conditions.

## **Our built-in fire prevention solutions include:**

- Hot and cold side design for the engine area
- Separation of main hydraulics from the hot engine area
- Double-wall exhaust pipe and shielding on the exhaust system
- Turbocharger covers
- Overcurrent protection and covering on electrics
- Fire-resistant materials and components
- Circuit breakers in the operator's compartment

In addition to careful design, correct equipment use and maintenance practices have crucial importance for fire safety.



# Protect your equipment with Eclipse®

To further reduce the risks associated with fire, the Eclipse® Fire Suppression System (FSS) works as an ideal backup. Eclipse® FSS from Sandvik can be factory-installed and is a sustainable choice, as it is the world's first fluorine-free fire suppression liquid for mobile equipment.

## Safety first

Statistics from mobile equipment fires reveal the following critical steps for successfully suppressing devastating fires without reliance on operator intervention:

### 1. Automatic detection and activation

Early control of a fire is critical, as most large fires start out small and unnoticed

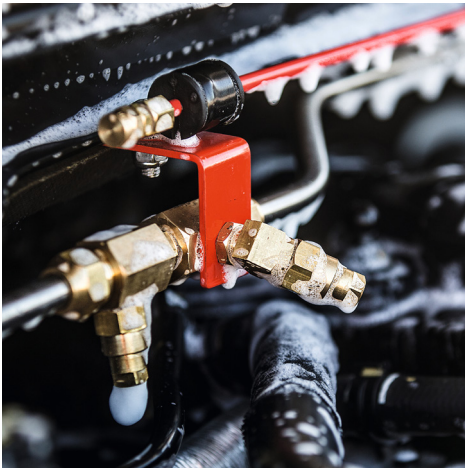
### 2. Automatic engine shutdown

Isolation of equipment power is key to interrupting the fuel supply feeding the fire

### 3. Extended discharge time

Liquid-agent fire suppression seals in flammable vapours and cools superheated surfaces to prevent re-ignition

All Eclipse® FSS feature fully automated activation and engine shutdown as standard features.





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[Rocktechnology.sandvik](https://rocktechnology.sandvik.com)

# Toro<sup>®</sup> LH410

Safer.

Stronger.

Smarter.



# Technical specification

## Toro® LH410

Toro® LH410 is an underground loader with 10 000 kg payload capacity. It is compact in size, but yet it features advanced technical solutions, common with Sandvik large i-series loaders.

The advanced Toro® LH410 loader is equipped with Sandvik Intelligent Control System and 7" touch screen display as standard, monitoring equipment productivity and health, and enabling multiple smart solutions. The numerous available options include e.g. a state of the art Stage V Volvo engine, sidetipping and ejector buckets, Integrated Weighing System (IWS), traction control, operator speed assist, and full AutoMine® loading capability.

Toro® LH410 delivers best in class performance in productivity with its high ramp speeds and fast bucket filling. To make truck loading easy, the loader offers superior lift height compared to any other loader of the same size class.

Toro® LH410 is a matching pair for threepass loading with the TH430 dump truck.



Capacities	
Maximum tramming capacity	10 000 kg
Break out force, lift	20 390 kg
Break out force, tilt	19 340 kg
Standard bucket	4.0 m <sup>3</sup>

Speeds forward & reverse (Level/loaded) With Volvo TAD11140VE engine	
1st gear	5.5 km/h
2nd gear	10.2 km/h
3rd gear	17.5 km/h
4th gear	31.7 km/h

Bucket motion times	
Raising time	6.7 sec
Lowering time	4.3 sec
Dumping time	2.7 sec

Operating weights *	
Total operating weight	28 500 kg
Front axle	12 850 kg
Rear axle	15 650 kg

Loaded weights *	
Total loaded weight	38 500 kg
Front axle	28 250 kg
Rear axle	10 250 kg

\* Unit weight depends on selected options

Operational conditions and limits	
Environmental temperature	From -20°C to +50°C
Standard operating altitude	With engine Volvo TAD1140VE from -1500 m to +3000 m at 25°C without rated power derate

Requirements and compliance	
Compliance with 2006/95/EC Low voltage directive	
Compliance with 2004/108/EC Electromagnetic compatibility directive	
Compliance with 2006/42/EC Machinery directive (Equipment for EU area, achieved with relevant options)	
Design based on EN 1889-1. Machines for underground mines. Mobile machines working underground. Safety. Part 1: Rubber tyred vehicles.	
Design based on MDG 15. Guideline for mobile and transportable equipment for use in mines. (Equipment for Australia, achieved with relevant options)	
Electrical system based on IEC 60204-1. Safety of machinery – Electrical equipment of machines – Part 1: General requirements	
Contains fluorinated greenhouse gases (closed cabin option) Refrigerant R134a under pressure max 38 bar/550 PSI: Filled weight: 2,0 kg CO <sub>2</sub> e: 2,860 tons GWP: 1430 Information based on the F Gas Regulation (EU) No 517/2016	

Engine	
Diesel engine	Volvo TAD1140VE
Output	235 kW @ 2100 rpm
Torque	1568 Nm @ 1300 rpm
Number of cylinders	In-line 6
Displacement	10.84 l
Cooling system	Liquid cooled and piston pump driven cooler fan
Combustion principle	4-stroke, direct injection, turbo with intercooler
Air Filtration	Two stage filtration, dry type
Electric system	24 V
Emissions	Tier 2, Euro Stage II
Ventilation rate	CANMET 8,07 m <sup>3</sup> /s MSHA 16,000 CFM
MSHA	16,000 CFM
Particulate index	MSHA 5,500 CFM
Compatible with paraffinic diesel fuel (EN 15940)	Yes
Exhaust system	Catalytic purifier and muffler with Proventia thermal insulation system exhaust pipe
Average fuel consumption at 40% load	26 l/h
Fuel tank refill capacity	280 l
Converter	
Dana C5472	With lock-up

Transmission	
Power shift transmission with modulation	Dana transmission with automatic gear shift control, four gears forward and reverse

Axles	
Front axle, spring applied hydraulic operated brakes. Fixed.	Kessler D102, limited slip differential
Rear axle, spring applied hydraulic operated brakes. Oscillating ± 8°.	Kessler D102, limited slip differential

Tires	
Tire size (Tires are application approved. Brand and type subject to availability.)	18,00x25 L5S 28 ply

Cabin (Cabin option replaces the standard canopy)	
ROPS certification according to EN ISO 3471	
FOPS certification according to EN ISO 3449	
Sealed, noise suppressed and over pressurized cabin with air conditioning and heating	
Sound absorbent material to reduce noise	
Laminated glass windows	
Cabin mounted on rubber mounts to the frame to reduce vibrations	
Air conditioning unit located outside the cabin to reduce noise inside the cabin	
Cyclone pre-filter for A/C device	
Adjustable joysticks	
No high pressure hoses in the operator's compartment	
Inclinometers to indicate operating angle	
Emergency exit	
Floor washable with water to reduce dust	
Three-point contact access system with replaceable and colour coded handles and steps	
12 V output	
Remote circuit breaker switch	

Canopy (Standard)	
ROPS certification according to EN ISO 3471	
FOPS certification according to EN ISO 3449	
Adjustable joysticks	
No high pressure hoses in the operator's compartment	
Inclinometers to indicate operating angle	
Emergency exit	
Floor washable with water to reduce dust	
Three-point contact access system with replaceable and colour coded handles and steps	
12 V output	
Remote circuit breaker switch	

<b>Operator's seat</b>	
Low frequency suspension	
Height adjustment	
Adjustment according to the operator's weight	
Padded and adjustable arm rests	
Two-point seat belt	
Fore-aft isolation (with cabin option)	
Adjustable lumbar support (with cabin option)	
Selectable damping (with cabin option)	
<b>Control system, dashboard and displays</b>	
Sandvik Intelligent Control system	
Critical warnings and alarms displayed as text and with light	
7" color display with touch screen functionality, adjustable contrast and brightness	
Illuminated switches on instrument panel	
My Sandvik Digital Services Knowledge Box™ on-board hardware	
Supports 3G, 4G, LTE and WLAN data transfer	
<b>Illumination</b>	
<p>Illuminance <math>E_{av}</math> with 4 pieces of LED lights at a distance of 20 m in front of the loader:</p>	<p>Low beam (28 W): 4 lights  <math>E_{av}</math> : 14.04 lx            High beam (50W): 2 lights  <math>E_{av}</math> : 14.76 lx</p>
<p>Illuminance <math>E_{av}</math> with 4 pieces of LED at a distance of 20 m behind the loader:</p>	<p>Reverse (28W): 3 lights  <math>E_{av}</math> : 25.62 lx</p>
<p>Toro® LH410 is compliant with South African Mine health and safety act 29 of 1996, because average light intensity in the direction of travel is more than 10 lux at a distance of 20 m.</p>	
<b>Rear and front frame</b>	
High strength structure with optimized material thicknesses. Reduced own weight for higher overall hauling capacity and long structural lifetime. Welded steel construction.	
Central hinge with adjustable upper bearing	
Rear tanks are bolted to frame, hydraulic tank and cabin base are both bolted and welded to frame	
Automatic central lubrication	
<b>Hydraulics</b>	
Door interlock for brakes and boom, bucket, and steering hydraulics	
Oil cooler for hydraulic and transmission oil, capability up to 52°C ambient temperature	
ORFS fittings	
MSHA approved hoses	
Hydraulic oil tank capacity 240 l	
Sight glass for oil level, 2 pcs	

<b>Steering hydraulics</b>	
Full hydraulic, centre-point articulation, power steering with two double acting cylinders. Steering lock. Steering controlled by electric joystick	
Steering main valve	Open circuit type
Steering hydraulic cylinders	125 mm, 2 pcs
Steering pump	Piston type, LS Controlled
Steering and servo hydraulic pumps	Piston type
<b>Bucket hydraulics</b>	
The oil flow from steering hydraulic pump is directed to bucket hydraulics when steering is not used.	Joystick bucket and boom control (electric), equipped with piston pump that delivers oil to the bucket hydraulic main valve.
Boom system	Z-link
Lift cylinders	160 mm, 2 pcs
Dump cylinder	200 mm, 1 pc
Main valve	Open circuit type
Pump for bucket hydraulics	Piston type, LS controlled
<b>Brakes</b>	
Service brakes are spring applied; hydraulically operated multidisc wet brakes on all wheels. Two independent circuits: one for the front and one for the rear axle. Service brakes also function as an emergency and parking brake. Brake system performance complies with requirements of EN ISO 3450, AS2958.1 and SABS 1589.	
Neutral brake	
Automatic brake activation system, ABA	
Electrically driven emergency brake release pump	
Brake oil tank capacity 75 l	
<b>Electrical equipment</b>	
Alternator	24 V, 150 A
Batteries	2 x 12V, 145 Ah
Starter	24 V, 5,5 kW
Driving lights	LED lights: 4 pcs in front 4 pcs in rear 4 pcs in cabin
Working lights	LED light, 1 pc under boom
Parking, brake and indicator (blinkers) lights	LED lights: 2 pcs in front 2 pcs in rear
Control system with 7" color display, 5 modules, inbuilt system diagnostics	
Reverse alarm	
Flashing beacon	

**Fire safety**

Portable fire extinguisher, 12 kg

Hot side – cold side design

Isolation of combustibles and ignition sources

Heat insulation on exhaust manifold, turbo, and isolated exhaust pipe

**Energy isolation**

Lockable main switch, ground level access

Emergency stop push buttons according to EN ISO 13850:  
1 pc in cabin and 2 pcs in rear

Pressure release in the expansion tank cap

Automatic discharge for pressure accumulators (brake system and pilot circuit)

Frame articulation locking device

Mechanical boom locking device

Wheel chocks and brackets

**Optional engine**

Diesel engine Volvo TAD882VE

Output 210kW @ 2200 rpm

Engine brake Yes, modulating engine brake

Emissions Euro Stage V (CE)

Ventilation rate CANMET T 4.67 m<sup>3</sup>/s,  
MSHA 9,500 CFM

Particulate index MSHA 500 CFM

Average estimated fuel consumption at  
40% load 21 l/h

Compatible with paraffinic diesel fuel  
(EN 15940) Yes

**Documentation**

Operator's Manual English and other EU languages

Maintenance Manual English and other EU languages

Parts Manual English

Service and Repair Manual English, Russian

ToolMan 2 x USB stick in pdf format,  
includes all the manuals

Decals English, Finnish, Swedish, Spanish,  
Russian, French, Polish, Portuguese,  
Turkish, German, Norwegian, Estonian,  
Chinese

**Options**

ANSUL Twin fire suppression system with checkfire  
(mandatory with RRC) (CE)

ANSUL Twin fire suppression system without checkfire (CE)

Arctic package 120V (preheater for hydr. oil tank and engine block)

Arctic package 230V (preheater for hydr. oil tank and engine block)

AutoMine® Loading Onboard Package

AutoMine® Loading Readiness

Battery isolation switch

Boom suspension (ride control)

CE Declaration of conformity

Cover grills for lamps

Direct feed for beacon

Disabled 3rd / 4th gear

Door latch and seat belt monitoring system

Driving direction lights (red / green)

Eclipse™ Fire suppression system with auto shutdown, Sustain or Extreme agent  
delivered separately (CE)

Electric loader towing kit

Electrical filling pump for hydraulic oil

Emergency steering (CE)

Harsh condition package

Integrated weighing system for loaders (IWS)

Jump start

Line of sight radio remote control, CAN, complete

Line of sight radio remote control, CAN, complete, with video camera

Monitoring camera system

Proximity Detection System Interface

Radio remote control interface, analogue

Recorder for monitoring camera system

Retrieval hook (hydraulic brake release by pulling the hook)

Safety rails

Spare rim 13.00-25/2.5 (for tyres 18.00 R25)

Starter isolator

Traction control

Tyre Pressure Monitoring System

Wiggins quick filling set for fuel and oils

Wiggins quick filling set for fuel

Available buckets			
Type	Volume SAE heaped (2:1) *	Width	Material broken density with fill factor 100%
<b>G.E.T. (standard)</b>	4.0 m <sup>3</sup>	2588 mm	2500 kg/m <sup>3</sup>
G.E.T.	4.6 m <sup>3</sup>	2588 mm	2100 kg/m <sup>3</sup>
G.E.T.	5.0 m <sup>3</sup>	2588 mm	1900 kg/m <sup>3</sup>
G.E.T.	5.4 m <sup>3</sup>	2588 mm	1700 kg/m <sup>3</sup>
G.E.T. Half Arrow	4.6 m <sup>3</sup>	2700 mm	2000 kg/m <sup>3</sup>
G.E.T. Half Arrow	5.4 m <sup>3</sup>	2700 mm	1700 kg/m <sup>3</sup>
Bare Lip	4.0 m <sup>3</sup>	2550 mm	2600 kg/m <sup>3</sup>
Bare Lip	4.6 m <sup>3</sup>	2550 mm	2200 kg/m <sup>3</sup>
Bare Lip	5.0 m <sup>3</sup>	2550 mm	2000 kg/m <sup>3</sup>
Bare Lip	5.4 m <sup>3</sup>	2550 mm	1800 kg/m <sup>3</sup>
Ejector bucket Bare Lip	4.6 m <sup>3</sup>	2770 mm	1900 kg/m <sup>3</sup>
Side tipping bucket	4.6 m <sup>3</sup>	2830 mm (total width) 2550 mm (lip width)	1800 kg/m <sup>3</sup>

Note: Depending on the bucket size and type, the actual payload may deviate from the nominal payload.

**Grade performance****Volvo TAD1140VE, EU Stage II, Tier 2 (3% rolling resistance)****Empty**

Percent grade	0.0	2.0	4.0	6.0	8.0	10.0	12.5	14.3	17.0
Ratio					1:12	1:10	1:8	1:7	
1st gear (km/h)	5.5	5.5	5.5	5.5	5.4	5.4	5.4	5.4	5.4
2nd gear (km/h)	10.2	10.2	10.1	10.0	10.0	9.9	9.9	9.8	9.8
3rd gear (km/h)	17.6	17.4	17.3	17.1	16.9	16.3	14.2	13.1	9.5
4th gear (km/h)	31.9	31.3	30.8	25.7	21.6				

**Loaded**

Percent grade	0.0	2.0	4.0	6.0	8.0	10.0	12.5	14.3	17.0
Ratio					1:12	1:10	1:8	1:7	
1st gear (km/h)	5.5	5.5	5.5	5.4	5.4	5.4	5.4	5.3	5.3
2nd gear (km/h)	10.2	10.1	10.0	10.0	9.9	9.8	9.7	9.1	8.1
3rd gear (km/h)	17.5	17.3	17.1	16.9	15.0	13.1			
4th gear (km/h)	31.7	30.9	25.5						

**Volvo TAD882VE, EU Stage V (3% rolling resistance)****Empty**

Percent grade	0.0	2.0	4.0	6.0	8.0	10.0	12.5	14.3	17.0
Ratio					1:12	1:10	1:8	1:7	1:6
1st gear (km/h)	6.0	5.9	5.9	5.9	5.8	5.8	5.8	5.7	5.7
2nd gear (km/h)	11.0	10.9	10.8	10.7	10.6	10.4	10.3	10.2	9.4
3rd gear (km/h)	18.8	18.5	18.1	17.8	16.7	14.8	11.7		
4th gear (km/h)	33.6	32.5	27.3						

**Loaded**

Percent grade	0.0	2.0	4.0	6.0	8.0	10.0	12.5	14.3	17.0
Ratio					1:12	1:10	1:8	1:7	1:6
1st gear (km/h)	5.9	5.9	5.9	5.8	5.8	5.7	5.7	5.6	5.6
2nd gear (km/h)	11.0	10.8	10.6	10.5	10.3	10.0	8.9	8.2	
3rd gear (km/h)	18.6	18.1	17.7	15.2	12.9				
4th gear (km/h)	33.0	27.5							

Dimensions				
Volume SAE heaped 2:1 (m <sup>3</sup> ) *	4.0 (standard)	4.6	5.0	5.4
Max material broken density with fill factor 100% (kg/m <sup>3</sup> )	2500	2100	1900	1700
Lip plate type	GET	GET	GET	GET
L1 (mm)	9742	9830	9869	9961
L2 (mm)	3052	3140	3179	3271
L3 (mm)	1298	1427	1469	1569
L4 (mm)	2811	2968	3023	3155
L5 (mm)	2447	2531	2569	2660
H1 (mm)	1622	1752	1792	1887
H2 (mm)	2319	2233	2196	2109
H3 (mm)	3431	3455	3452	3445
H4 (mm)	5083	5216	5257	5353
H5 (mm)	5463	5541	5610	5704
W1 (mm)	2588	2588	2588	2588
R1 (mm)	3244	3244	3244	3244
R2 (mm)	6509	66550	6568	6606
T1 (mm)	4215	4256	4274	4312
T2 (mm)	3445	3485	3504	3542

Dimensions						
Volume SAE heaped 2:1 (m <sup>3</sup> ) *	4.0	4.6	5.0	5.4	4.6	5.4
Max material broken density with fill factor 100% (kg/m <sup>3</sup> )	2600	2200	2000	1800	2000	1700
Lip plate type	Bare Lip	Bare Lip	Bare Lip	Bare Lip	Half Arrow	Half Arrow
L1 (mm)	9711	9800	9848	9921	9855	10016
L2 (mm)	3021	3110	3158	3231	3165	3326
L3 (mm)	1280	1437	1488	1567	1415	1910
L4 (mm)	2797	2954	3022	3126	2973	3209
L5 (mm)	2417	2501	2547	2619	2556	2715
H1 (mm)	1635	1763	1812	1887	1738	1910
H2 (mm)	2326	2263	2219	2149	2208	2055
H3 (mm)	3458	3482	3479	3473	3427	3418
H4 (mm)	5092	5226	5276	5353	5203	5377
H5 (mm)	5462	5541	5610	5698	5541	5698
W1 (mm)	2550	2550	2550	2550	2700	2700
R1 (mm)	3244	3244	3244	3244	3244	3244
R2 (mm)	6439	6482	6504	6538	6625	6680
T1 (mm)	4145	4188	4210	4244	4331	4387
T2 (mm)	3375	3418	3439	3473	3560	3616

\* According to ISO 7546

**Standard dimensions (with standard bucket)**  
 in the drawing, necessary changing dimensions in a table.

