

# Technical Data

## 4000 Series

## 4006-23TRS2

### Landfill / biogas supplemental data sheet

#### Basic technical data

Number of cylinders .....	6
Cylinder arrangement .....	vertical, In line
Cycle .....	4 stroke, spark ignition
Induction system .....	turbocharged mixture cooled
Compression ratio .....	12 : 1 nominal
Bore .....	160 mm
Stroke .....	190 mm
Cubic capacity .....	22,92 litres
Direction of rotation .....	anti-clockwise viewed on flywheel
Firing order .....	1, 5, 3, 6, 2, 4
Cylinder 1 .....	furthest from flywheel
Total weight of electro unit (engine only)	
-estimated total weight (dry) .....	2420 kg
-estimated total weight (wet) .....	2652 kg

#### Overall dimensions

mm (in)	Height	Length	Width
<b>Cogeneration unit</b>			
Natural gas	1671	2242	1400
Bio gas	1787	2242	1418
<b>Electro unit</b>			
Natural gas	1671	2242	1633
Bio gas	1787	2242	1633

#### Moment of inertia (GD<sup>2</sup>)

-engine .....	4.12 kgm <sup>2</sup>
-flywheel .....	5.92 kgm <sup>2</sup>
Cyclic irregularity for engine/flywheel @ baseload	
4006-23TRS2 - 393 kW @ 1500 rev/min .....	1:110

#### General installation

Designation	Units	Continuous baseload rating			
		Methane content			
		70%	60%	50%	40%
Gross engine power	kWm	393	393	393	373
Brake mean effective pressure	kPa	1371.7	1371.7	1371.7	1301.9
Combustion air flow	m <sup>3</sup> /min	29.7	27.1	26.8	25.7
Exhaust gas temperature (max) turbo charger exit	°C	485	505	508	512
Exhaust gas flow (max)	m <sup>3</sup> /min	78.9	121.4	144.9	170.2
Boost pressure ratio	-				
Overall electrical efficiency	%	38.3	37.9	37.6	36.7
Mean piston speed	m/s	9,5			
Charge coolant flow	l/sec	6,7			
Typical gross Gen Set electrical output (25 °C, 100 kPA, cos φ 1)	kWe	375	375	375	356
Assumed alternator efficiency	%	95.4	95.4	95.4	95.4

**Continuous baseload rating:** Power available for continuous full load operation. No overload available.

#### Ratings

This is defined in ISO3046 / 1 (BS5514 /1 - 1982)

Electrical ratings are based on stated alternator efficiency and are for guidance only. For "Load Acceptance" figures, refer to Stafford Applications Engineering Department.

#### Operating point

Engine speed .....	1500 rev/min
Ignition timing .....	30° BTDC
Inlet manifold mixture temperature .....	< 50 °C
Cooling water exit temperature .....	< 96 °C
Exhaust emission .....	according to TA-Luft (NOx)

#### Performance

Steady state speed stability at constant load .....

± 0,25%  
**Note:** All data based on operation to ISO 3046/1, BS 5514 and DIN 6271 standard reference conditions

#### Test conditions

-air temperature .....	25 °C
-barometric pressure .....	100 kPa
-relative humidity .....	30%
If the engine is to operate in ambient conditions other than test conditions suitable adjustments may be necessary for any change in inlet air temperature or barometric pressure.	

## Energy balance

### 4006-23TRS2 @ 70% Methane - 30% CO<sub>2</sub>

#### Fuel data

Lower calorific value .....	25.150 kJ/Sm <sup>3</sup> (22.973 kJ/kg)
Density .....	1.094 kg/Sm <sup>3</sup>
Stoichiometric air requirement .....	7.85 kJ/kg

#### Energy balance

Designation	Units	Power rating		
		100%	75%	50%
Energy in fuel	kWt	979	758	536
Energy in power output (Net)	kWm	393	295	197
Energy in exhaust	kWt	301	240	174
Energy to coolant and oil	kWt	162	145	123
Energy to charge cooler	kWt	57	31	12
Sum of useable heat	kWt	401	337	263
Sum of useable energy	kWt	794	632	460
Energy to radiation	kWt	65	47	29

#### Mass flow data

Designation	Units	Power rating		
		100%	75%	50%
Combustion air	kg/h	2086	1616	1142
Fuel	kg/h	77.1	59.8	42.2
Exhaust gas (wet)	kg/h	2163	1676	1184

#### Volume flow data (100 kPa)

Designation	Units	Power rating		
		100%	75%	50%
Combustion air (25°C)	m <sup>3</sup> /h	1784	1382	977
Fuel @ 15 °C	Sm <sup>3</sup> /h	101.5	78.6	55.6
Exhaust gas (temperature turbo exit)	m <sup>3</sup> /h	4731	3723	2679
Exhaust gas (temperature 120 °C)	m <sup>3</sup> /h	2453	1900	1343
Exhaust gas (temperature 0 °C)	Nm <sup>3</sup> /h	1704	1320	933

#### Exhaust data

Designation	Units	Power rating		
		100%	75%	50%
Exhaust gas temperature	°C	485	497	511
Specific heat exhaust gas	kJ/kg.K	1.090	1.092	1.092
Oxygen content in exhaust gas	%	9.03		
Nominal excess air factor (Lambda)	λ	1.69		

## 4006-23TRS2 @ 60% Methane - 40% CO<sub>2</sub>

### Fuel data

Lower calorific value..	21.543 kJ/Sm <sup>3</sup> (17.657 kJ/kg)
Density ..	1.22 kg/Sm <sup>3</sup>
Stoichiometric air requirement ..	6.09 kJ/kg

### Energy balance

Designation	Units	Power rating		
		100%	75%	50%
Energy in fuel	kWt	988	765	540
Energy in power output (Net)	kWm	393	295	197
Energy in exhaust	kWt	309	247	181
Energy to coolant and oil	kWt	162	145	123
Energy to charge cooler	kWt	57	31	12
Sum of useable heat	kWt	410	344	270
Sum of useable energy	kWt	803	638	466
Energy to radiation	kWt	67	48	28

### Mass flow data

Designation	Units	Power rating		
		100%	75%	50%
Combustion air	m <sup>3</sup>	1901	1471	1038
Fuel	kg/h	201.5	156.0	110.1
Exhaust gas (wet)	kg/h	2102	1627	1148

### Volume flow data (100 kPa)

Designation	Units	Power rating		
		100%	75%	50%
Combustion air (25°C)	m <sup>3</sup> /h	1626	1259	888
Fuel @ 15 °C	Sm <sup>3</sup> /h	165.2	127.9	90.2
Exhaust gas (temperature turbo exit)	m <sup>3</sup> /h	7284	5726	4112
Exhaust gas (temperature 120 °C)	m <sup>3</sup> /h	3680	2848	2010
Exhaust gas (temperature 0 °C)	Nm <sup>3</sup> /h	2556	1979	1396

### Exhaust data

Designation	Units	Power rating		
		100%	75%	50%
Exhaust gas temperature	°C	505	517	531
Specific heat exhaust gas	kJ/kg.K	1.103	1.107	1.120
Oxygen content in exhaust gas	%	7.89	7.89	7.89
Nominal excess air factor (Lambda)	λ	1.55	1.55	1.55

## 4006-23TRS2 @ 50% Methane - 50% CO<sub>2</sub>

### Fuel data

Lower calorific value .....	17.965 kJ/Sm <sup>3</sup> (13.347 kJ/kg)
Density .....	1.35 kg/Sm <sup>3</sup>
Stoichiometric air requirement .....	4.60 kJ/kg

### Energy balance

Designation	Units	Power rating		
		100%	75%	50%
Energy in fuel	kWt	998	773	545
Energy in power output (Net)	kWm	393	295	197
Energy in exhaust	kWt	319	254	186
Energy to coolant and oil	kWt	162	145	123
Energy to charge cooler	kWt	57	31	12
Sum of useable heat	kWt	418	350	274
Sum of useable energy	kWt	811	645	471
Energy to radiation	kWt	67	48	28

### Mass flow data

Designation	Units	Power rating		
		100%	75%	50%
Combustion air	kg/h	1881	1456	1028
Fuel	kg/h	269.2	208.4	147.0
Exhaust gas (wet)	kg/h	2151	1665	1175

### Volume flow data (100 kPa)

Designation	Units	Power rating		
		100%	75%	50%
Combustion air (25°C)	m <sup>3</sup> /h	1609	1246	879
Fuel @ 15 °C	Sm <sup>3</sup> /h	200.0	154.8	109.2
Exhaust gas (temperature turbo exit)	m <sup>3</sup> /h	8695	6834	4907
Exhaust gas (temperature 120 °C)	m <sup>3</sup> /h	4375	3387	2390
Exhaust gas (temperature 0 °C)	Nm <sup>3</sup> /h	3039	2353	1660

### Exhaust data

Designation	Units	Power rating		
		100%	75%	50%
Exhaust gas temperature	°C	508	520	534
Specific heat exhaust gas	kJ/kg.K	1.104	1.108	1.120
Oxygen content in exhaust gas	%	7.62		
Nominal excess air factor (Lambda)	λ	1.52		

## 4006-23TRS2 @ 40% Methane - 60% CO<sub>2</sub> - 5% de-rate required

### Fuel data

Lower calorific value..	14.768 kJ/Sm <sup>3</sup> (10.033 kJ/kg)
Density ..	1.47 kg/Sm <sup>3</sup>
Stoichiometric air requirement ..	3.45 kJ/kg

### Energy balance

Designation	Units	Power rating		
		100%	75%	50%
Energy in fuel	kWt	970	753	531
Energy in power output (Net)	kWm	373	280	187
Energy in exhaust	kWt	322	257	188
Energy to coolant and oil	kWt	159	142	120
Energy to charge cooler	kWt	52	27	10
Sum of useable heat	kWt	418	350	273
Sum of useable energy	kWt	791	630	459
Energy to radiation	kWt	65	47	28

### Mass flow data

Designation	Units	Power rating		
		100%	75%	50%
Combustion air	kg/h	1800	1398	986
Fuel	kg/h	348.1	270.3	190.7
Exhaust gas (wet)	kg/h	2148	1668	1177

### Volume flow data (100 kPa)

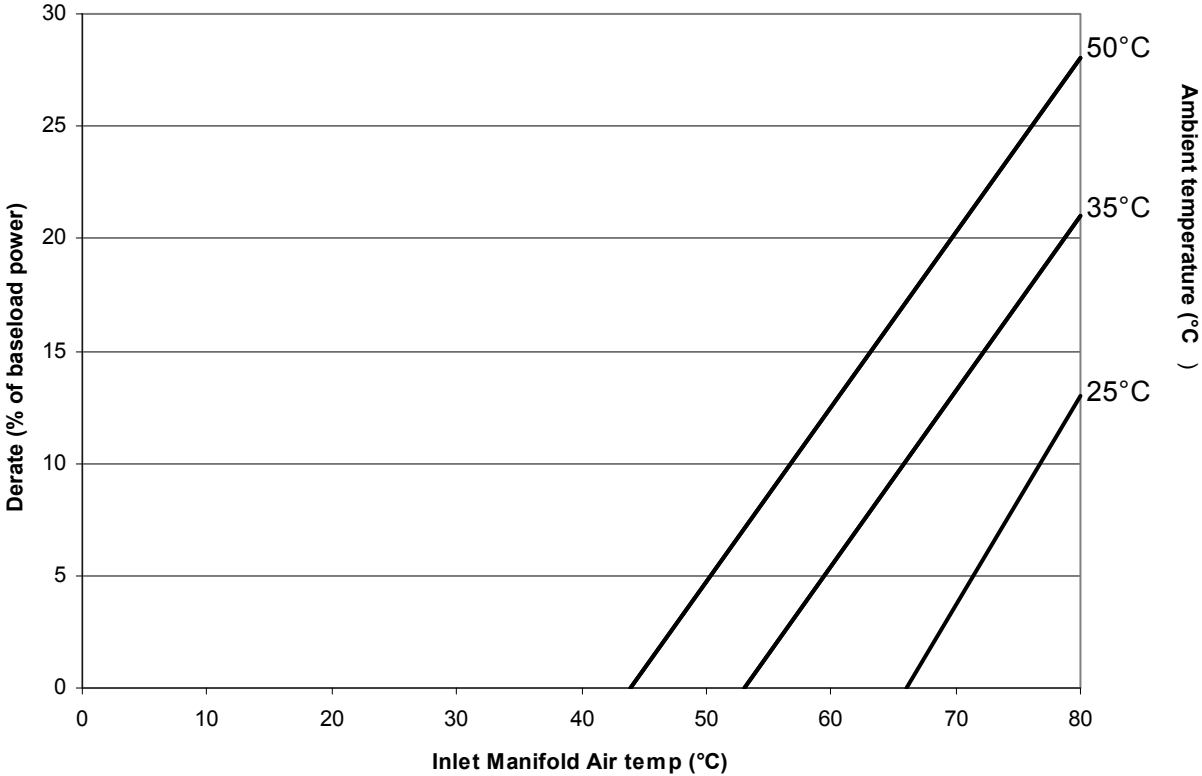
Designation	Units	Power rating		
		100%	75%	50%
Combustion air (25°C)	m <sup>3</sup> /h	1540	1196	844
Fuel @ 15 °C	Sm <sup>3</sup> /h	236.5	183.6	129.6
Exhaust gas (temperature turbo exit)	m <sup>3</sup> /h	10210	8043	5778
Exhaust gas (temperature 120 °C)	m <sup>3</sup> /h	5109	3967	2799
Exhaust gas (temperature 0 °C)	Nm <sup>3</sup> /h	3549	2755	1944

### Exhaust data

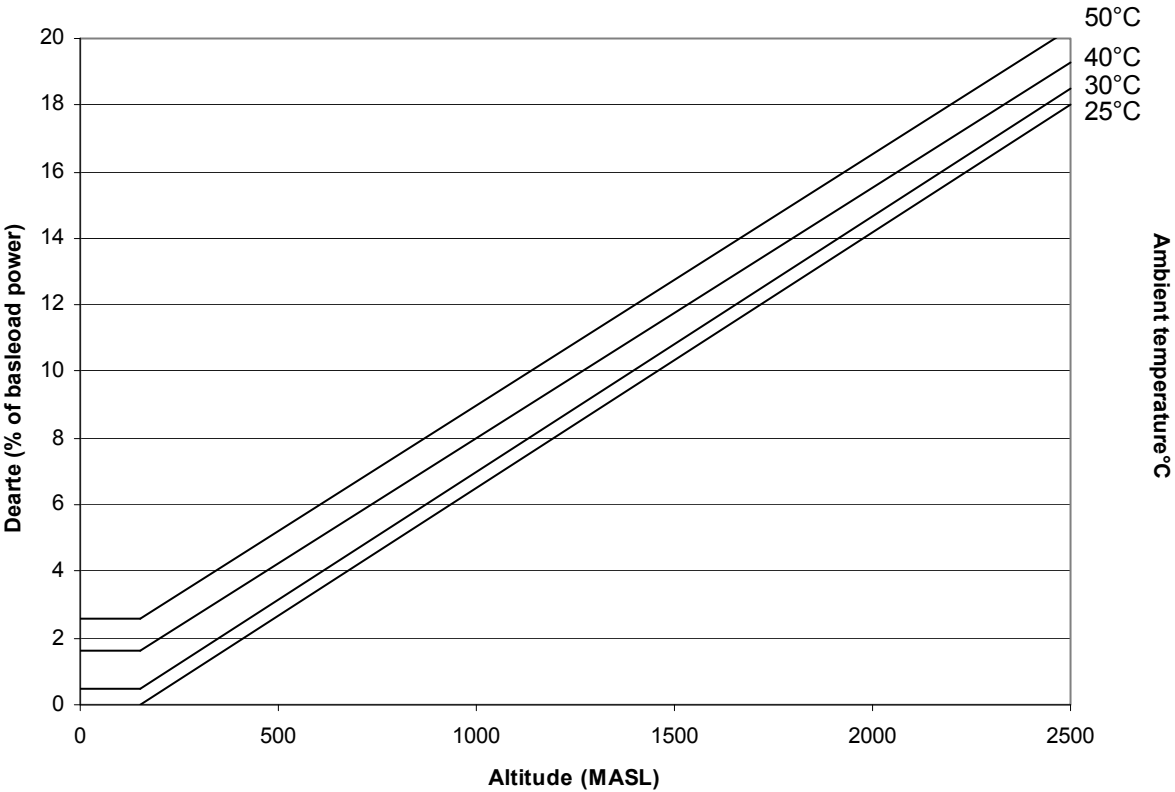
Designation	Units	Power rating		
		100%	75%	50%
Exhaust gas temperature	°C	512	524	538
Specific heat exhaust gas	kJ/kg.K	1.106	1.110	1.120
Oxygen content in exhaust gas	%	7.43		
Nominal excess air factor (Lambda)	λ	1.50		

**Derate tables**

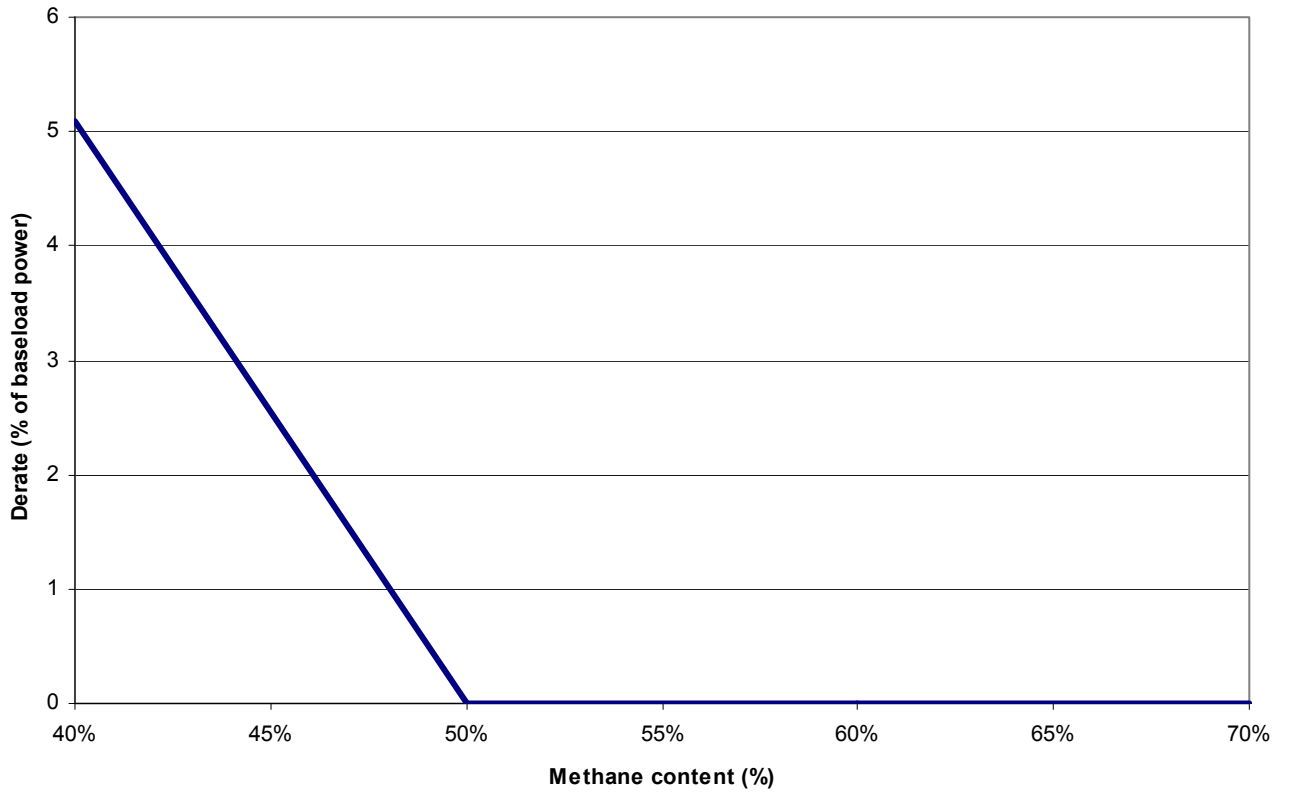
**4006-23TRS2 Inlet manifold Air Temperature & Ambient derate**



**4006-23TRS2 Altitude and ambient derate**

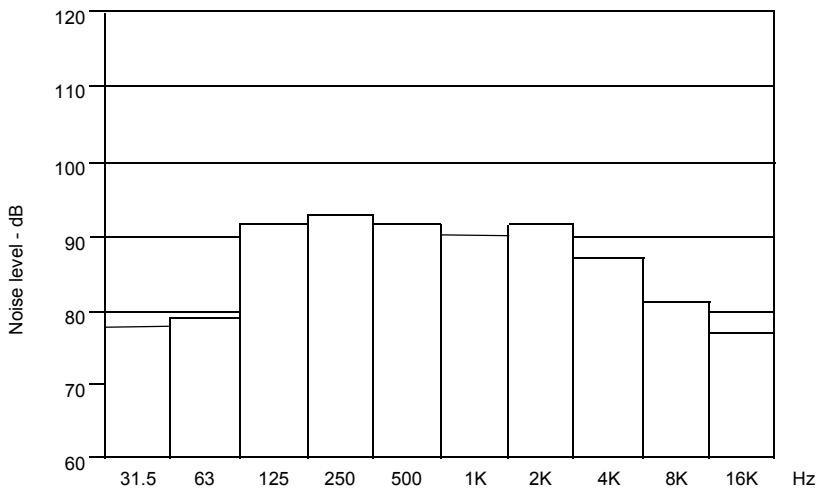
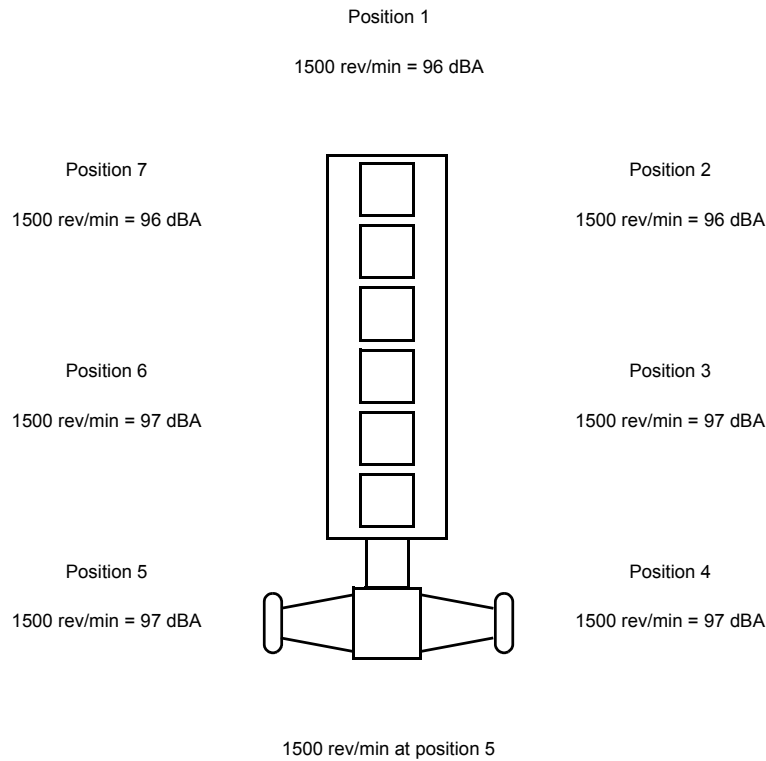


4006-23TRS2 Methane Content Derate



**Noise levels**

The figures for total noise levels are typical for an engine running at the continuous baseload power rating in a semi-reverberant environment and measured at a distance of one metre from the periphery of the engine (sound pressure level re:  $-20 \times 10^{-6}$  pa). Ambient noise level at rated speed (1500 rev/min) ... 70 dBA



**Engine mounting**

Maximum additional load applied to flywheel due to all rotating components ... 650 kg  
The information given in this Technical Data Sheet is for guidance only. For ratings other than those shown, contact Perkins Engines Company Limited.

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