Genset with heat recovery system

(Engine cooling water/heating water, 2nd stage LT mixture cooling water, without exhaust gas exchanger)

AE 16V4000L62

1 Ratings and Emissions

For operation on	**NATURAL GAS**					
Methane number	**MZ ≥ 70**					
Low heat value (LHV)	**Hu = 8,0-11,5 kWh/m_n^3**					
Heating water temperature	**80 / 70 °C**					
Genset with synchronous generator for generating	**3Ph, 50Hz**					
Gas mixture cooler, intern (1st stage HT)	**integrated**					
Gas mixture cooler, extern (2nd stage LT)	**40 °C**					
No_x	**< 500**			**< 250**		mg/m_n^3

1.1 Continuous Operating Data in Grid Parallel Mode

Generator voltage	400	415	6300	10500	11000	V
Electrical output of generator (no overload capacity)	**1562**		**1549**	**1546**	**1554**	kW_{el}
Thermal output (Engine cooling / lube oil / 1st stage HT mixture cooler)	**829**			**872**		kW_{th}
Thermal output (2nd stage LT mixture cooling)	**111**			**118**		kW_{th}
Total energy input	**3745**			**3857**		kW

1.2 Part Load Data in Grid Parallel Mode (75%)

Generator voltage	400	415	6300	10500	11000	V
Electrical output of generator	**1171**		**1160**	**1157**	**1168**	kW_{el}
Thermal output (Engine cooling / lube oil / 1st stage HT mixture cooler)	**622**			**648**		kW_{th}
Thermal output (2nd stage LT mixture cooling)	**81**			**85**		kW_{th}
Total energy input	**2882**			**2959**		kW

1.3 Part Load Data in Grid Parallel Mode (50%)

Generator voltage	400	415	6300	10500	11000	V
Electrical output of generator	**778**		**767**	**766**	**772**	kW_{el}
Thermal output (Engine cooling / lube oil / 1st stage HT mixture cooler)	**445**			**455**		kW_{th}
Thermal output (2nd stage LT mixture cooling)	**52**			**55**		kW_{th}
Total energy input	**2025**			**2069**		kW

1.4 Continuous Operating Data Insolated Mode

Generator voltage	400	415	6300	10500	11000	V
Electrical output of generator (is only valid for MZ ≥ 90)	**1405**		**1394**	**1391**	**1398**	kW_{el}

8% tolerance for thermal outputs and 5% for total energy input listed. Performance data in accordance with ISO 3046. All data apply to grid parallel operation. Data for site operating conditions other than those mentioned, available on demand. Max. reactive power in kVA, resp. nominal current acc. to nominal output of the generator.

1.5 Pollutant Emissions

Emission values related to dry exhaust gas with 5% O_2. (For exhaust gas volume flow see 3.5)

NO_x, stated as NO_2	**< 500**		**< 250**	mg/m_n^3
CO, without catalyst		**< 1000**		mg/m_n^3
CO, with catalyst (optional, delivered loose)		**< 300**		mg/m_n^3

2 Design Principles / Scope of Supply

- Engine and flange-mounted alternator (SAE 00 housing) are connected via a torsionally resilient coupling and resiliently mounted to a rigid, welded steel base frame.
- Standby heater
- Lube oil pump for draining the oil sump (incl. two solenoid valves).
- The base frame is installed on vibration dampers

2.1 Engine plus Accessories

Otto-Gas-Engine		**MTU 16V4000L62**		
Cyl. arrangement, no. of cyl.		V 16		
Bore / stroke		170 / 210		mm
Volume		76,27		Litre
Speed		1500		1/min
Mean piston speed		10,5		m/s
Compression ratio		12,9:1		
Mean effective pressure		16,8		bar
Standard power acc. to ISO 3046, (no overload capacity)*		**1600**		kW_{mech}
Specific full-load consumption (tolerance 5%)	2,34		2,41	kWh/ kWh
Gas consumption (based on LHV=10kWh/m^3)	374,5		385,7	m^3/h
Lube oil consumption (not guaranteed, at rated load and after 1000Oh)		0,3		g/kWh_{mech}

* Overload must reliably be avoided by means of suitable external control systems (e.g. electronic output power control).

Basic Engine

- Monobloc grey cast crankcase with inspection ports, flywheel housing SAE 00, flywheel 21“ cast iron oil pan
- Forged crankshaft
- Forged connecting rods
- Four-valve, individual cylinder heads with central pre-chamber armoured valves with „Rotocap“ rotators
- Light-metal solid-skirt pistons with oil cooling duct, piston cooling via oil spray nozzles

Mixture Formation

- Air intake via dry-type engine-mounted air filters
- Venturi type air-gas mixer with gas supply via electronically controlled gas metering valve

Turbocharging

- Turbocharger for gas-air mixture compression
- Two-stage mixture cooling
- Throttles between mixture coolers and intake manifold

Exhaust System

- Dry-type, insulated exhaust manifolds in the engine Vee

Lube Oil System

- Lube oil circulation pump with safety valve for forced-feed lubrication and piston cooling
- Engine mounted heat exchanger
- Lube oil filters with replaceable filter elements
- Engine-mounted device for automatic oil level control
- Oil dipstick
- Closed crankcase venting system with oil separator connected to mixture piping before turbo charger
- Connections for oil refill and oil draining

Cooling System (2-circuit)

- High temperature circuit for lube oil cooling, 1st stage of mixture cooling and engine jacket
- Connections with counter-flanges for external cooling- or heat recovery system
- Integrated cooling preheating unit

Starting System
- Electric starter (2x 9 kW, 24 VDC)

Ignition System
- Microprocessor-controlled high-voltage spark-ignition system with low voltage distribution, no moving parts, no wear
- Automatic control for ignition energy adjustment
- Variable timing control
- Timing sensors at camshaft and crankshaft
- One ignition coil per cylinder
- Industrial spark plugs

2.2 Generator

Self-regulating, brushless revolving-field synchronous generator with built-in exciter, voltage and cos φ regulator, designed to VDE 0530, radio interference class N, low-harmonic design.

Generatorspannung	400	415	6300	10500	11000	V
Rating (F)	1935		2148	2168	1920	kVA
Insulation class	H		F	F	F	
Temperature-rise rating	F		B	B	B	
Cos φ*	1,0 -0,8		1,0 -0,9	1,0 -0,9	1,0 -0,8	
Frequency			50			Hz
Speed			1500			1/min
Efficiency (100% load) at cos φ 1	97,6		96,8	96,6	97,1	%
Stator connection			Star			
Max. ambient temperature.			40			°C
Type of protection			IP 23			

*) Cos-phi must be over the whole power range in the defined range. Only inductive reactive power admissible (over-erected).

In case of nominal mains voltage variations by ± 2%, an automatic voltage adjustment must be used.

2.3 Heat Exchanger System

heat recovery system (to extract heat from cooling water circuit and 2nd stage LT of mixture cooler)

Engine cooling circuit (HT)
- Plate heat exchanger engine cooling-/heating water
- Cooling water pump
- Thermostat controlled mixture valve
- Expansion vessel
- Pressure and level monitoring cooling water
- Overpressure valve

Mixture cooling water circuit (2nd stage, LT)
- Pump for 2nd stage mixture cooler
- Control valve
- Expansion vessel (max. water volume note) with pressure and level monitoring
- max. Δp for recooler and pipes notes
- Overpressure valve

Values for cooling / heating water are based on water without antifrost and corrosions additives.
Admissible antifrost and corrosions additives see operating media. Values in brackets [ ]* refer to 35% Glycol.

Engine Cooling (engine block with lube oil and 1st stage HT mixture cooling)

Thermal output (8% tolerance)	**829**			**872**		kW
Cooling water temperature, in- / outlet			78 / 90			°C
Cooling water volume flow	61	[66]		65	[70]	m³/h
Pressure loss	2,0	[2,3]		2,0	[2,3]	bar
System pressure permitted max.			6,0			bar
Standby heater, min.			40			°C

Mixture Cooling (2nd stage LT)

Data see 3.3

Plate Heat Exchanger

Thermal output (8% tolerance)	**829**			**872**		kW
Cooling water temperature, in- / outlet			90 / 78			°C
Heating water temperature, in- / outlet			70 / 80			°C

2.4 Gas Supply

Gas regulation lines delivered loose, components approved per Directive for Gas Components 90/356/EWG

Gas Regulation Line

- Gas filter
- two solenoid valves (or double solenoid valve)
- Low pressure regulator
- valve leakage monitor
- flexible stainless steel hose

2.5 Engine Management (MIS)

General

- Control cabinet is mounted directly to the genset
- Connection to control cabinet (e.g. MMC-4000) with CanOpen and discrete signals (digital and analog) via a multipolar engine cable (max. 25 m). There is an assignment diagram for the engine cable and a signal list specifically for the CanOpen interface.
- The engine is controlled by discrete signals. The engine management requests various auxiliary drives (e.g. pumps, gas valves, etc.) and expects corresponding feedback within certain timeframes. The CanOpen interface serves solely for the exchange of information. No specifications can be issued via the interface (read only!).
- Internal bus communication via CAN.

ECU7

- Speed governing
- Air / Fuel ratio control via engine characteristic map
- Engine start / stop sequence
- Emergency stop sequence
- Engine monitoring (temperatures, pressures, speed, etc.)

EMU7

- Single exhaust temperature monitoring (cylinderhead)

SAM

- Providing CANopen interface
- Lube oil make up
- Monitoring of minimum load

Ignition

- Electronic ignition system
- Ignition time setting
- Speed monitoring

Knocking monitoring AKR

- Acoustic knocking monitoring system
- Individual ignition timing adjustment per cylinder

3 Technical Data Design / Operation

3.1 Operating Media

The binding specifications for cooling water, fuel, lube oil, exhaust condensate and heating water are stipulated in the relevant MTU operating media regulations.

3.2 Filling Quantities

Lube oil – quantity (first filling)	285	Liter
Lube oil – quantity (consecutive oil changes)	250	Liter
Engine cooling water, HT (engine and heat recovery	330	Liter
Heating water	40	Liter
Mixture cooling water, LT	32	Liter

3.3 Heat Generation

Heating water return temperature upstream of genset, min / max	60 / 70		°C
Heating water volume flow, standard	75	79	m^3/h
Max. permissible working pressure (cooling water heat exchanger)	16		bar
Pressure loss at standard flow rate (between the connecting flanges)	0,5		bar

Mixture Cooling (2nd stage LT)

Thermal output (8% tolerance)	**111**	**118**	kW
Mixture cooling water volume flow (8% tolerance)	26	26	m^3/h
Inlet temperature mixture cooling water max.	40		°C
Max. permissible pressure loss outside the heat recovery system	0,5		bar
System pressure permitted max.	6,0		bar
Information for dimensioning of expansion vessel for max. water siphon	300		Liter
Note information pressure control valve.			

3.4 Combustion Air / Ventilation

Heat radiated from the genset (engine and generator without adjoining pipes)	101	103	kW
Engine room ventilation			
Minimum intake air volume flow for engine room cooling. (The engine room ventilation has to be calculated and adjusted according to the requirements for gaseous fuels valid at the installation site)	22705	23324	m^3/h
Ventilation air volume flow	15871	16184	m^3/h
Combustion air volume flow	6269	6550	m_n^3/h
Intake air temperature min. / max. (for other temperatures the limit values must be adapted after consultation)	15		°C
Temperature difference intake / ventilation max.	< 20		K
max. permissible intake negative pressure at inlet air filter	3		mbar

3.5 Exhaust Gas (Exhaust gas heat exchanger not included in scope of supply, optional)

Thermal output by 120°C (8% tolerance)	871	902	kW
Exhaust temperature (turbocharger outlet)	453	450	°C
Exhaust gas mass flow, dry	7826	8182	kg/h
Exhaust gas mass flow, moist	8412	8785	kg/h
Exhaust gas volume flow, dry (0 °C, 1013 mbar)	5916	6188	m_n^3/h
Exhaust gas volume flow, moist (0 °C, 1013 mbar)	6603	6896	m_n^3/h
Permissible back-pressure downstream of engine min. / max.	30 / 50		mbar

In multi-genset systems, separate exhaust piping for each genset is recommended.
If a common exhaust header system is installed, exhaust flow back into any non-operationing gensets must be avoided by use of a 100% gas-tight exhaust shut-off flap.

In the range of partial load the exhaustive temperature rises up to 550°C. In case of use of catalyzers, due to the exothermic reaction the exhaustive temperature may increase up to 600°C.

3.6 Sound Levels

Engine surface noise emitted by the genset
(distance 1 m, free field measurement, Tolerance +5 dB for single 1/3-octave band, +2 db(A) for total A-weighted level)

Frequency (Hz)	Sound pressure levels (dB)	
12,5		
16		
20		
25	68,3	68,1
31,5	68,8	68,6
40	72,1	72,4
50	66,8	67,2
63	73,6	74,1
80	74,1	74,5
100	84,0	83,7
125	80,6	80,4
160	81,3	81,3
200	81,6	81,5
250	81,8	81,9
315	85,0	84,2
400	91,5	91,7
500	85,8	85,7
630	84,8	85,0
800	84,6	84,7
1000	83,5	83,4
1250	82,3	82,2
1600	81,0	80,6
2000	81,4	81,1
2500	82,2	82,0
3150	82,0	82,0
4000	82,8	82,8
5000	84,3	83,9
6300	94,8	96,3
8000	85,6	88,3
10k	82,5	82,7

	Lin dB	dB (A)	Lin dB	dB (A)
Sum of sound pressure levels (dB)	99,3	98	100,1	98,9
Sound power levels dB (A)		117,4		118,3

undampened Exhaust noise
(distance of 1 m from outlet, Tolerance +5 dB for single 1/3-octave band, +3 db(A) for total A-weighted level)

Frequency (Hz)	Sound pressure levels (dB)	
12,5		
16		
20		
25	90,8	90,0
31,5	85,9	86,4
40	98,3	98,7
50	89,7	91,1
63	107,2	107,1
80	116,4	116,4
100	117,2	117,6
125	110,5	110,5
160	107,1	107,3
200	105,2	105,6
250	103,6	104,1
315	102,2	102,6
400	100,7	100,7
500	96,9	97,7
630	94,7	95,5
800	93,0	94,3
1000	92,5	94,0
1250	91,9	93,2
1600	91,2	91,9
2000	91,3	91,7
2500	91,5	92,1
3150	89,2	89,9
4000	87,9	90,4
5000	79,7	81,5
6300	75,1	75,4
8000	67,9	66,3
10k	62,9	61,3

	Lin dB	dB (A)	Lin dB	dB (A)
Sum of sound pressure levels (dB)	121,1	106,5	121,3	107
Sound power levels dB (A)		118,7		119,2

3.7 Connections

Unless stated otherwise, the connecting flanges are to DIN 2501.
Nominal diameters and pressures are as follows:

Safety gas line *	DN80 / PN16	
Exhaust gas outlet (expansion joint)	DN300 / PN6	
Heating water in- / outlet	DN100 / PN16	
Mixture cooling water in- / outlet	DN50 / PN16	
Safety pressure valve outlet (CWsystem HT)	Socket R 2 1/2"	
Safety pressure valve outlet (MCWsystem LT)	Socket R 1 1/2"	
Lube oil flow and return: Tube connection to DIN 3861	d = 22	

*) Dimension depending on gas pressure and gas quality

3.8 Paints, Dimensions and Weights of the Genset

Engine, Generator and Frame	RAL 9006	
Length	6800	mm
Width	1800	mm
Height	2600	mm
Genset (dry weight)	13000	kg
Genset (service weight)	13600	kg
Heat recovery system (dry weight)	1250	kg
Heat recovery system (service weight)	1400	kg

For binding dimensions please refer to drawing.

Data are subject to change without notice in the interest of further development.