B&W MEGTEC Reference P064357 rev5
(changes marked in yellow)

EPSILON® Regenerative Thermal Oxidizer and Scrubber for HCl

Pharmaceutical Ingredients

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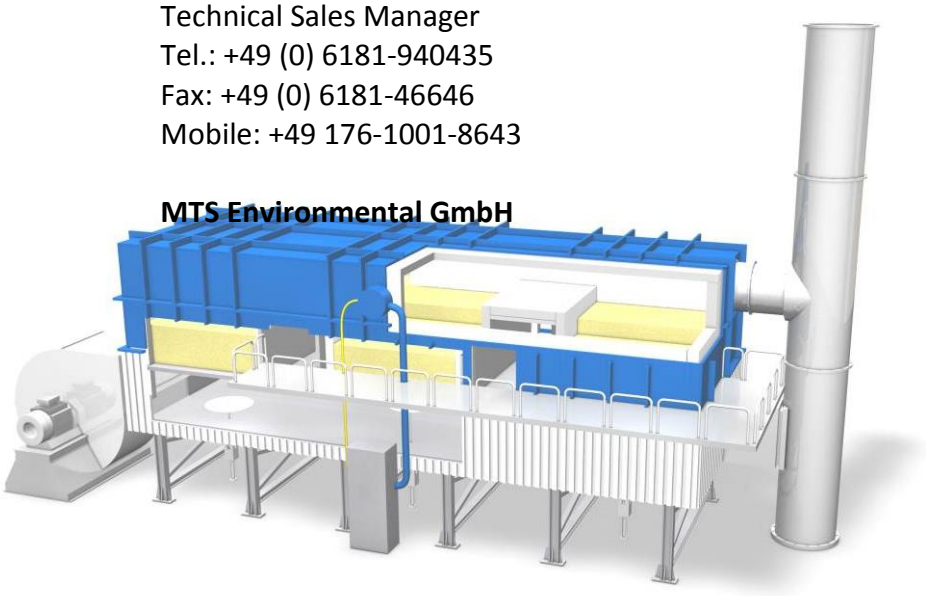
MTS Environmental GmbH



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2. EPSILON® – DESCRIPTION

The Epsilon® consists of two, three or five separate towers (A-B/C/D-E) that are filled with ceramic heat-exchange media. The towers are connected via a combustion chamber.

The Epsilon® is preheated up to operating temperature, whereupon the associated exhaust fan guides the solvent laden process air into the first heat-exchange tower (A). Within the tower the process air passes through the already warm ceramic heat-exchange media causing the solvent-rich process air to oxidise (refer figure 1). During this oxidation process energy is released in the form of heat and in turn transfers the energy to the ceramic heat exchange media surrounding it. After the process air passes through the ceramic heat-exchange media it enters the combustion chamber. A minimum combustion chamber temperature is maintained, whereupon the remaining pollutants within the process air are burnt and oxidised. After this oxidation process the hot process air leaves the unit by passing through the second heat exchange tower (B) and in turn transfers heat to the ceramic heat exchange media within. The exhaust air stream leaves the unit with a temperature that is above that of the inlet temperature (delta T is approx. 40°C). During the heat transfer and oxidation process, the third tower (C) is purged to free it of any solvent residue. At low process solvent concentrations, the use of a third tower is often not required to achieve the emission limits.

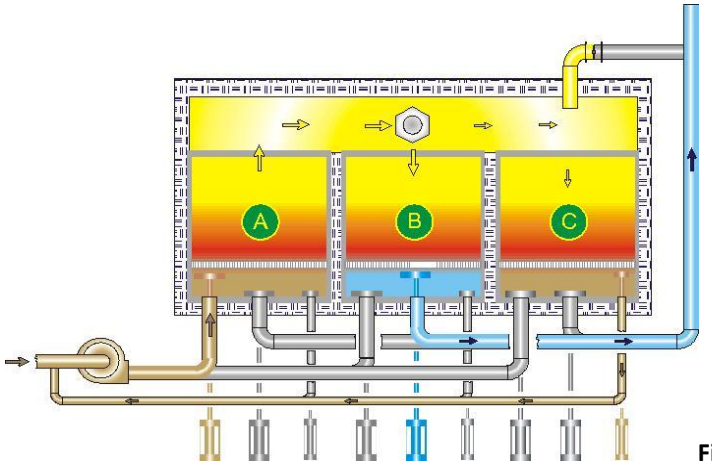


Figure 1

In order to maintain thermal equilibrium within the unit, the inlet, outlet and purge towers are cycled periodically. This is achieved by redirecting the air into the other towers via the actuation of the inlet and outlet valves located at the base of the towers. After valve actuation, the process air enters the unit through heat exchange tower (B) and adsorbs the heat which was stored in the previous cycle. The pollutants within the process air are similarly oxidised in the tower and in the combustion chamber whereupon the exhaust air exits the unit via the third tower (C), whilst transferring energy in the form of heat to the ceramic heat-exchange media located in that tower (figure 2).

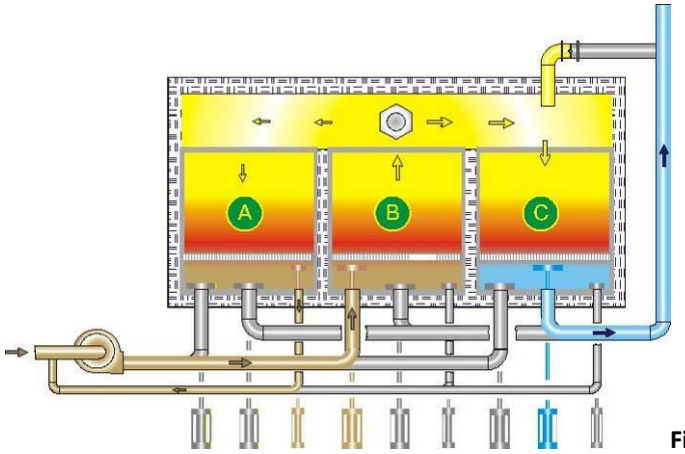


Figure 2

The first tower (A) is purged during the previous cycle period to remove the un-oxidised exhaust air allowing the tower to be used for the outlet process air path

A further changeover of the valves results in the process air entering through the third tower (C) and leaving the unit through the first tower (A), during which time the second tower (B) is purged (figure 3). This continuous cycling of the towers (A-B-C) is undertaken to maintain the thermal equilibrium of the unit.

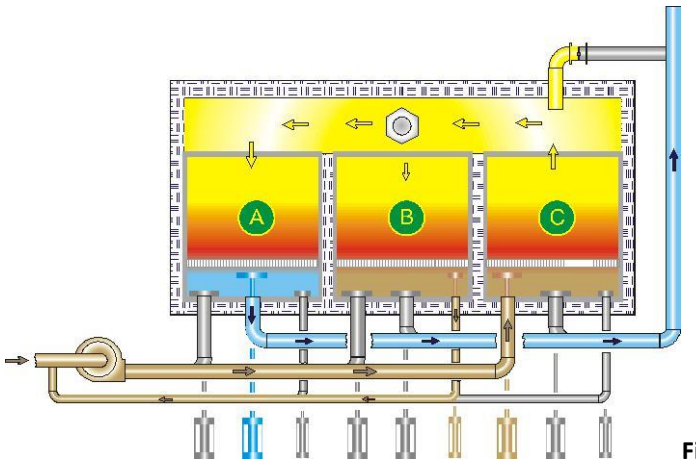


Figure 3

In the case that the VOC-loading (or solvent concentration) of the process air is higher than the energy needed to maintain the combustion chamber temperature required for oxidation, a hot-side-bypass opens and releases a portion of the hot clean exhaust air directly to the exhaust stack.

The process described above results in low emissions, stable duct pressure conditions, a very good heat recovery, low energy consumptions, compact design, reliable and robust operation. The Epsilon® unit can treat VOC-loadings up to a maximum of 25%/20% Lower Explosion Limit (LEL), according to aromatic content.

With a two can unit, destruction efficiencies of up to 98.5 % will be achieved. For higher destruction efficiencies (depending on the inlet concentration and required emission limits) the purge chamber can be considered to minimize the switching peak and to maintain exhaust concentrations below the emission limits.

3. SRUBBER – DESCRIPTION

The unit for waste gas cleaning mainly consists of a packed bed column for separation of HCl, which is equipped with a quench for cooling the hot gas from the RTO.

The hot waste gas from the RTO is led into the quench / spray tower, were it is cooled down to the saturation temperature of appr. 60 °C. A partial removal of the HCl takes place in the quench simultaneously.

The quench mainly consist of a flushing ring in PTFE and two spraying levels for cooling and saturating the hot flue gas with circulation solution.

The inside wall of the quench will be wetted and cooled through a flushing ring disposed on the head of the quench. Stick of salt and dust above the nozzles can be prevented.

Extreme material stress on the quench-surface (hot /cold or dry/wet) will not appear. The flushing ring achieves by tangential flanges with plastic-nozzles a continuous distribution of the flushing- and cooling water. Separate nozzles are connected to an emergency water system.

The flue gas passes the flushing ring and will be cooled down to saturation temperature with circulation water over nozzles in two cooling levels. In the first level there are also separate nozzles connected to the emergency system.

Behind the quench the saturated gas is fed into the lower part of the scrubbing column and streams through to the top of it. For cleaning the waste gas washing water will be pumped around in a circle line, distributed on the top of the column and streams in counter current flow to the gas through the packed bed.

The washing solution from the sump of the column is pumped by help of two chemicals standard pumps as well as to the quench and to the liquid distributor of the scrubber.

For an effective chemisorption of gaseous HCl, NaOH (35 %) will be dosed in the circulation solution in dependence of the measured pH-value. The addition is effected in the suction side of the pumps. The pH-parameter is set to a value of app. 7. The loaded salt solution is discharged out of the process in dependence of conductivity by a regulating valve. Liquid loss in the quench by gas saturation and the bleed of salt solution will added level controlled with softened water.

The cleaned gas passes a 3-stage mist and aerosol eliminator on the top of the column.

Scrubber equipment consists of:

- ✓ Quench section in PTFE with spray nozzles as spray tower in FRP
- ✓ Packed bed scrubber in RFP with chemical protection layer, sump and mist separator,
- ✓ 2 chemical liquid pumps as described before, Brand Wernert or similar
- ✓ Dosing station with pH control, necessary controls for temperature, pressure drops and flow measurement

4. MECHANICAL AND ELECTRICAL INSTALLATION (TYPICAL)

SMALL TO MEDIUM

Feature	Benefit
Predominantly pre-assembled	Minimised onsite mechanical installation and time
	No onsite welding as shipped in one piece
	Manufactured in a QA controlled environment
	No requirement for onsite painting
	No onsite insulating of main body
	Typical mechanical installation time <1 week
Media pre-filling	Minimised onsite mechanical installation and time
Extensively pre-wired	Minimised onsite electrical installation and time

5. INSTALLED PICTURES

Epsilon RTO including HCl scrubber and VOC control and dilution system (FTAs)

6. DESIGN FEATURES

The EPSILON® has been designed with ease of maintenance uppermost in mind:

Internal Poppet Valve View during Construction, Access Doors to Left

Feature	Benefit
Low Leakage Design <0.1%	Meets stringent emission values year on year without emission degradation
No sealing air required	Lower operation costs
Metal to metal valve seats	Longevity of sealing and no annual replacement of hardened or contaminated seals, saving costs and labour
Cushioned actuator operation	Minimisation of noise levels in operation, valve actuation noise issues are removed
Flexible and rotating disc action	Self-cleaning valve seats for continued performance in arduous environments
Optional poppet shaft gaiters	Protection from condensates
Purging of linear bearings with actuator exhaust air	Effective sealing and cooling of linear bearings
Optional individual valve access doors	Ease of valve set up and adjustment in arduous vent stream applications
Integrated inlet and outlet plenums	Minimisation of cold bridges and condensation zones

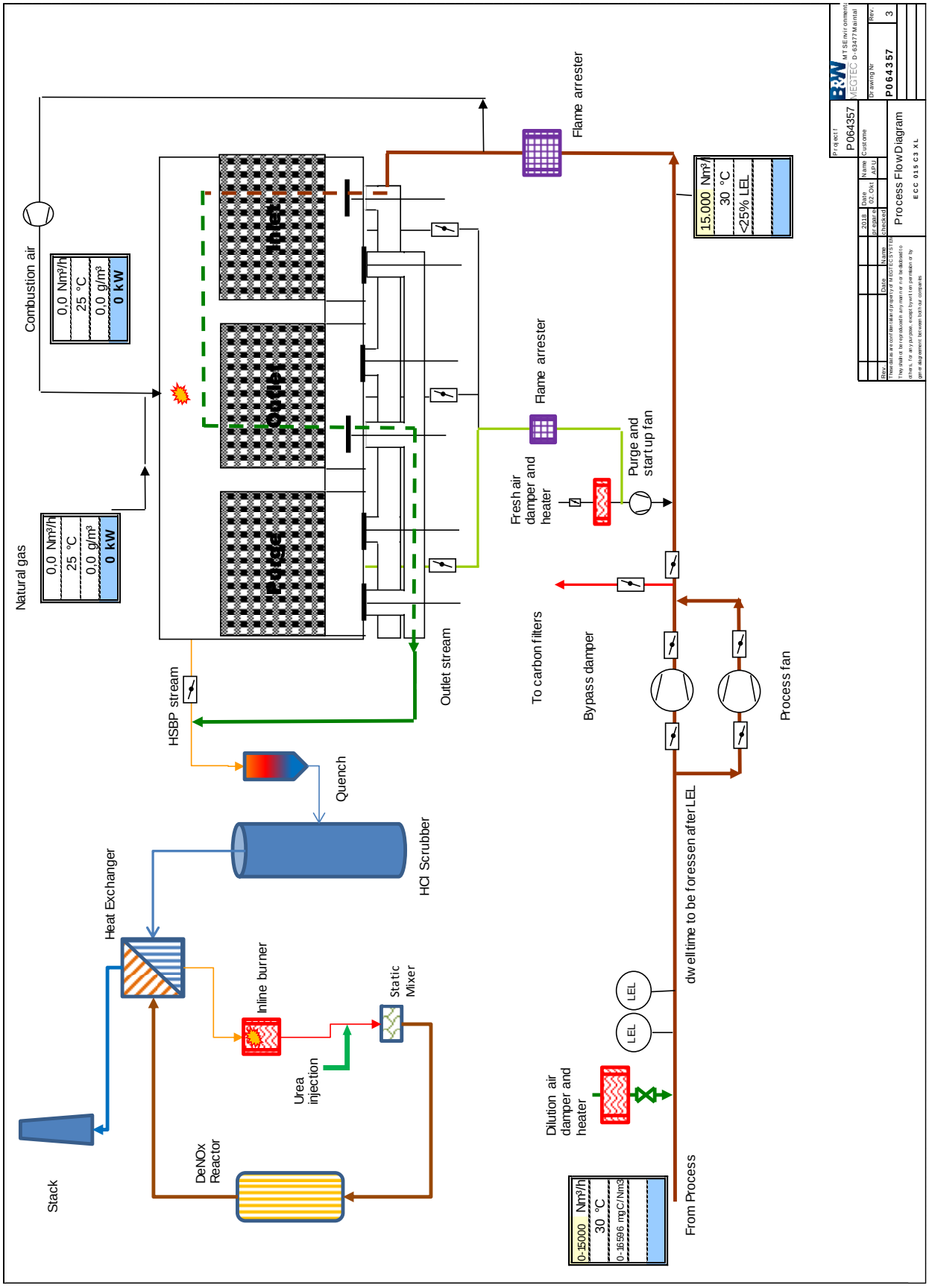
Feature	Benefit
Poppet actuators below unit	Ease of access and servicing, adjustment and maintenance
Vertical Actuation	No turning moments on valves shafts and bearings for reduced wear and longevity
Actuators below unit	Weather protected environment
Serviceability	Ease of maintenance and set up

Feature	Benefit
Pneumatic connections below unit	Ease of Access and Servicing, adjustment and maintenance
Enlarged pipework header used	No reservoir required and no annual certification needs in most regions

Feature	Benefit
Floor mounted gas train	Ease of access at low level
Modular gas train design	Delivered pre-assembled and tested for ease of installation and in a weather protection cabinet

Feature	Benefit
Individual poppet valve door access	Ease on maintenance in arduous vent flow applications

7. PROCESS FLOW DIAGRAM



8. DESIGN BASIS

The following design parameters have been used*:

Design Basis			
Process Type	Hydrocarbons, alcohols, ketones, amines, acetates, halogenated hydrocarbons		
Maximum Process Flow	15.000 Nm³/h		
Minimum Process Flow	0 Nm³/h		
Process Suction Pressure Required	-5 mbar (TBC)		
Process Gas Temperature	30 °C		
VOC Concentration, max	Dichloromethane max	mg/Nm3	13835
	Dimethylformamide max	mg/Nm3	802
	Methanol max	mg/Nm3	688
	Methanol + Ethanol max	mg/Nm3	1,327
	Hexane max	mg/Nm3	13
	Heptane max	mg/Nm3	4,274
	Hexane + Heptane max	mg/Nm3	479
	Acetone max	mg/Nm3	478
	Methyl-butyl ether max	mg/Nm3	292
	Various (MEK, BMK) max	mg/Nm3	3,102
	Total VOC	mg/Nm3	**16.595,7**
VOC Lower Heating Value	32.000 kJ/kg		
Dust Concentration, Max. (Burnable)	<10 mg/Nm³		
Dust Concentration, Max. (Unburnable)	<1 mg/Nm3		
H2S or SO2 conc.	< 1 mg/m³		
Relative Humidity	100 %, no droplets		
Noise Level Requirement, Max.	80 dB(A) @ 1m (FFC)		

*The design criteria should be reviewed and confirmed by the customer.

9. EPSILON® TECHNICAL SPECIFICATIONS

RTO Technical Specifications	
Maximum RTO Volume flow	15.000 Nm³/h (Including dilution air)
Minimum RTO Volume flow	3.000 Nm³/h
Dilution Control Required	yes
Maximum VOC Concentration*	15 g/m³
RTO inlet temperature	30 °C
The combustion temperature and dwell time are set at 850 °C and 1 second. In order to treat the maximum flow of 15.000 Nm3/h at 850 °C the RTO will be approx. 2 m higher than the standard one. L x W X H (excluding ducts and fan)	7,4 x 2,7 x 6.5 m
Main Electrical Supply	400V, 3 Ph, 50Hz
Electrical Supply for Cabinet Power	220V, 1 Ph, 50Hz
Total Electrical Power **	324 kVA
Process Fan Power	2 x 110 kW
Combustion Blower Power	3 kW
Fuel Type	NG
Gas Connected Supply	550 kW

Gas Pressure	300 mbar
Compressed Air	3-5 m^3/h @ 6 barg, clean & dry up to -40°C
Weight of Epsilon® Body	30.000 kg Approximately

* Always < 25% LEL or < 20% LEL if more than 25% of aromatic solvents are present.

** including 2 x fans and double pump groups

10. ENERGY DATA

ECC 015 C3 94% TE

Exhaust Flow Nm^3/h	VOC mg/m^3	Gas kW	Fan kW
15.000			
	1.000	166	55
	2.000	29	55
	3.000	0	55
	5.000	0	55
	10.000	0	55
12.000			
	1.000	116	29
	2.000	21	29
	3.000	0	29
	5.000	0	29
	10.000	0	29
8,000			
	0	145	11
	1.000	72	11
	1.500	35	11
	2.000	10	11
	3.000	0	11
	5.000	0	11
	10.000	0	11
3.000 (Standby)	0	60	3

START-UP ENERGY

RTO STOP Duration (Hours)	Gas kWh	Elec kWh	Duration (minutes)
8	130	<1	21
16	200	1	33
24	250	2	42
48	350	3	58
Cold Start-up	1000	9	180

ENERGY DATA ASSUMPTIONS

Criteria	Assumption
At self-sustained operation the burner will be	shut off
Lower heating value of VOCs	32.000 kJ/Kg (estimated)
Assumed process air inlet temperature	30 °C
Assumed job site elevation	Sea level
Ambient Air Temperature	20 °C
Assumed suction pressure for duct losses	- 10 mbar
Assumed pressure drop allowance for other systems	68 mbar for Flame arresters/ quench/scrubber/ducts/Heat Exchanger/ DeNOx/Static mixers/stack.

11. RTO SCOPE

The Epsilon® RTO system proposed is based upon the supply of the following systems (subject to confirmation):

Enclosure	ECC 015 C3
Manufacturer	MTS Environmental GmbH
Colour	Basalt Grey, RAL 7012 (where painted)
Main Housing Description	Internally insulated energy recovery columns containing heat exchange media and connected by an integral thermally insulated combustion chamber
Number of Regenerative Columns	3
Chamber Separation	Each regenerative tower will be separated by an air gap in the main body
Residence Time at full Flow	1 s @ 850°C
Combustion Chamber Thermocouples	3 x thermocouples…2 x for averaging combustion chamber temperature for burner control, 1 x as high temperature limit switch.
Main Body Steel Shell Construction	stainless steel 1.4307, 304L for combustion chamber towers Duplex 1.4462 for lower part as cold face support and outlet channel
Body Pressure Rating	80 mbar
Main Body Insulation	Ceramic fiber modules up to 250 mm
Cold Face Support	1.4462 steel cold face support. Stainless steel extended metal
Design Operating Temperature	850 - 900 °C
Maximum Operating Temperature	980-1100°C depending on solvent load and type
Exterior Coating	No coating of the stainless steel parts. Support steel hot galvanized. Carbon steel parts will be coated acc. to DIN EN ISO 12944-C3-K, with 2 layers (total 80 µm) epoxy based primer, and 1 layer (40 µm) epoxy based or poly-urethane based top-coat.
External insulation	Add. Cladding with corrugated sheets for increase of wall temperature and minimize risk of condensation Corrugated sheets are protected by powder-coated layer
Integrated Dampers	Integrated dampers for flow distribution purge
Purging air fan	For purging the third can with fresh air. The air will be taken from the fresh air preheater.

RTO Switching Valves	
Manufacturer	MTS Environmental GmbH
Description	High efficiency pneumatic poppet valves with precision machined valve seats
Design Leakage	<0.05%
Switching Control Philosophy	Independently operable poppet valves enable variable RTO chamber switching for optimal energy usage and flexibility
Valve Sealing	Metal to metal seal, no gaskets, no purged valve seats and no purge air required

Process Backpressure Minimization	Pneumatic poppet valve system is optimized to minimize backpressure within the system during airflow direction changeover
Number	One inlet and one exhaust valve per energy recovery tower
Shafts	Stainless steel valve shafts
Bearings	Heavy duty purged bearing supports
Disc Fastening	Poppet disc fastening consisting of a hub with threaded bore for the shaft and radial coupling bolts secured with “aircraft grade” safety wire
Material	Duplex steel 1.4462 construction incl. shafts
Limit Switches	Valves equipped with external position limit switches on both ends of travel. The limit switches will be in a weather resistant enclosure
Compressed Air Reservoir	Compressed air holding reservoir header will be provided with pressure switch
Noise	Cushioned actuation to minimize noise generation
Silencers	Air from the pneumatic actuator is passed through integrated noise silencing system

Heat Exchange Media	
Material	Ceramic
Style	Structured
Maximum Operating Temperature	According to media design and application
Thermal Efficiency at Full Flow	94%
Thermocouples in each Tower	2

Burner/Gas Train	
Manufacturer	Eclipse or equivalent
Fuel	Natural Gas
Style	Nozzle gas system
Control	Electric/Mechanical modulating actuator
Turndown	20:1 maximum burner turndown ratio.
Over Temperature Protection	High temperature protection device.
Gas Valve	Modulating gas valve will be equipped with limit switch to detect minimum position.
Interlocks	Necessary interlocks to achieve safe starts and fail safe operation.
Enclosure	Gas system installed in a weatherproof cabinet. Manufacturer: Rittal or equivalent
Safeguards	Flame safeguard with self-checking ultraviolet scanner. Manufacturer: Siemens or equivalent
Design	Gas train design according DIN EN ISO 746-2

Combustion Blower	
Manufacturer	Elektror or equivalent
Motor	AC motor IP55, class F insulation
Protection	Motors with contactor and circuit breakers for thermal overload protection

System Fan	
Manufacturer	Ventapp or equivalent
Type	AC motor IP54, VFD controlled, class F insulation
Style	Forced draft flow arrangement
Noise	80 dB(A) at 1 m FFC at maximum flow
Tightness	Airtight welded connections
ATEX	Designed for ATEX zone 2 inside, no ATEX zone on the outside
Material	Stainless steel 1.4301 for parts in contact with the process gases. Fan wheel in 1.4462 .
Fan Motor Connection	Fan fixed on motor shaft, or connection with coupling if required (customer to specify before order)
Insulation	Thermally insulated (if required according to process temperature conditions)…if customer required then this should be specified before order
Temperature	Max. 100 °C (mechanical design, in case of failure of dilution air preheater) 30°C (capacity design)

System Fan Variable Frequency Drive (VFD)	
Manufacturer	Siemens or equivalent
Location	Pre wired in main electrical cabinet
Control	Negative pressure duct sensor
Purge/Idle Modes	The VFD will provide a fixed fan speed in purge and idle modes of operation based upon a fixed reference speed signal

Oxidiser Integrated Air Plenum	
Manufacturer	MTS Environmental GmbH
Function	Internal plenum for air distribution within the Epsilon® including purge duct to connecting flange
Material	1.4307
Construction	Welded, includes insulation and cladding in low level touchable areas
Codes & Standard	All ducts and flanges designed acc. to MTS standards

Fresh Air Damper	
Function	For supply of fresh air for purge, idle, stand by, heat up and cool down operation to the RTO
Material	Stainless steel 1.4301
Design	Single blade damper
Actuation	Pneumatic actuated
Limit Switches	Internal limit switches for sensing of damper position
Temperature interlock	Interlock at TT-510 to avoid condensation. Shut down the unit after 30 min (diversion to carbon filters)
Installation	To be installed by customer in customers' duct

Fresh Air Heater	
Function	Hot Water/air heat exchanger for the supply of warm fresh air for purge, idle, stand by, heat up and cool down operation to the RTO

Material	Stainless steel 1.4301
Capacity	40 kW
Design	Tube bundle
Control	Including temperature regulation
Installation	To be installed by customer in customers' duct

Electrical Cabinet	
Contents	Electrical cabinet will contain the VFD for fans and power supply for supplied equipment
Location	Electrical cabinet design for indoor installation. The electrical cabinets, all its components are designed for installation in a non-ATEX zone
Codes	Designed and tested to EN 61439-1/-2 …or UL 508A(optional)
Standards	Wiring acc. IEC 60204-1
Colour	Light grey, RAL 7035

Control System	
Manufacturer	Siemens
PLC Type	S7-315F-2DP (Failsafe PLC)
Safeties	All safety related signals controlled by fail safe PLC
Outputs	Control system will be provided with outputs suitable for alarm annunciation to the plant control system
HMI	Industrial Panel PC 677D
Data Storage	Sufficient data storage will be provided so that main operating figures can be available for 12 months.
RTO Control	Operator interface panel will monitor operation of the RTO via the following process variables: • Start/Stop of RTO • Overview of RTO process data • RTO set up screens for burner and AC Drive • Logged process history data • RTO Damper positions The above includes typically 15 screens
RTO Fault History	History screen with time/date/description
Remote Connection	Ethernet

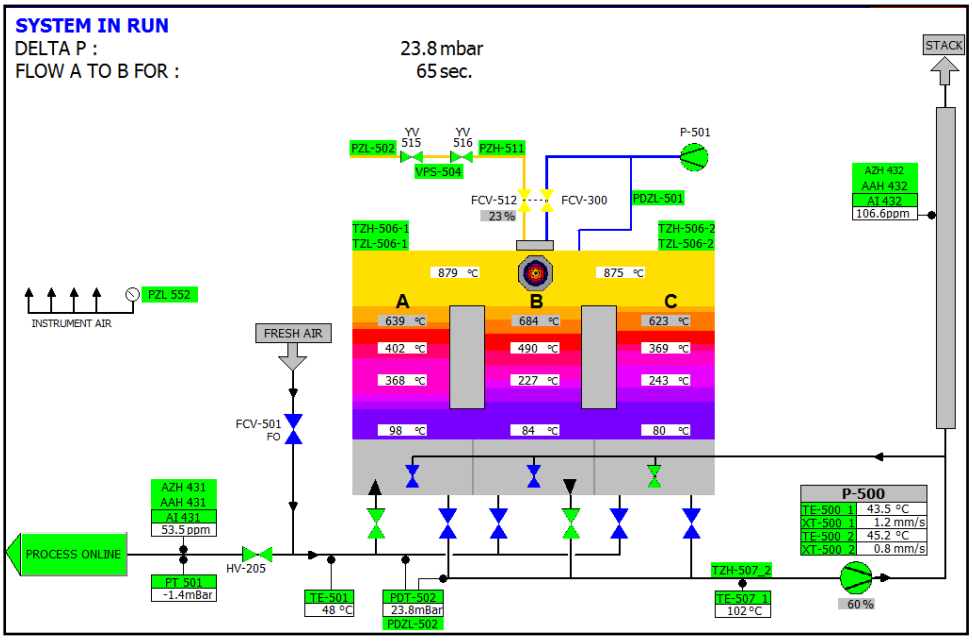
MEG@CONTROL

The control system developed by B&W MEGTEC for the EPSILON® optimises the energy consumption (gas and power) by identifying the process flow characteristics; as a result high cleaning efficiencies can be obtained with a minimum of energy usage.

High sophisticated control loops will supervise the temperatures in several locations of the ceramic media, cold face support and combustion chamber. Variable switching time for flow control ensures equalized operating conditions in all cans.

In units equipped with a Hot Side Bypass, Meg@control will operate it to regulate the temperature in the ceramic media, exhaust channel and combustion chamber providing an exceptionally safe and reliable operation under high VOC concentration conditions.

Meg@control also provides the best conditions for the operation of an optional secondary heat recovery system, which means maximum use of the excessive energy released by the VOCs oxidation.



Three Chamber Overview

13. PROJECT ENGINEERING

Engineering Scope	Included Engineering
Project Management Scope	Project Management of the B&W MEGTEC Scope as defined herein and agreed as part of this contract
Drawings	• Process & Instrumentation Diagram • General Arrangement Drawing • Foundation plan (including dimensions and loading points only) • Electrical wiring diagram • PLC and SPS – programming Drawings will be submitted for review by the client, it is assumed that Three (3) revisions will be submitted, Draft, Engineering for Approval, As Built. Drawings will be as per B&W MEGTEC standards, formats and nomenclature
Documentation	• RTO Operation Manuals and one (1) CD according to EG-Machine guidelines 2006/42/EG (2 sets: 1 in English, 1 in Portuguese) • Bought in Equipment Operation Instructions – format as per sub-vendor supplied • Additional copies can be provided on request, prices agreed according to project scope and complexity Assumes all manuals will be as per B&W MEGTEC standards, formats and nomenclature. Sub-vendor/Bought in Equipment as per their standards
Planning	• Manufacturing Schedule showing major items of equipment and milestones
HazOp Participation	• Participation in a client held HAZOP study, assumes two (2) day and two (2) person
Clarification meetings	• 2 clarification meetings including all travel cost for maximum of 4 days in total for two (2) person
Engineering support for the VCS	• To review the design of the VCS (made by others) to assure a good interaction between the VCS and RTO system. • Limited to 20 hrs of engineering in house. If meetings at site are required, the travel time and cost will be billed separately.

All documents submitted which are not for review will be submitted as part of the operating and maintenance manuals for the plant.

14. ADDITIONAL EQUIPMENT

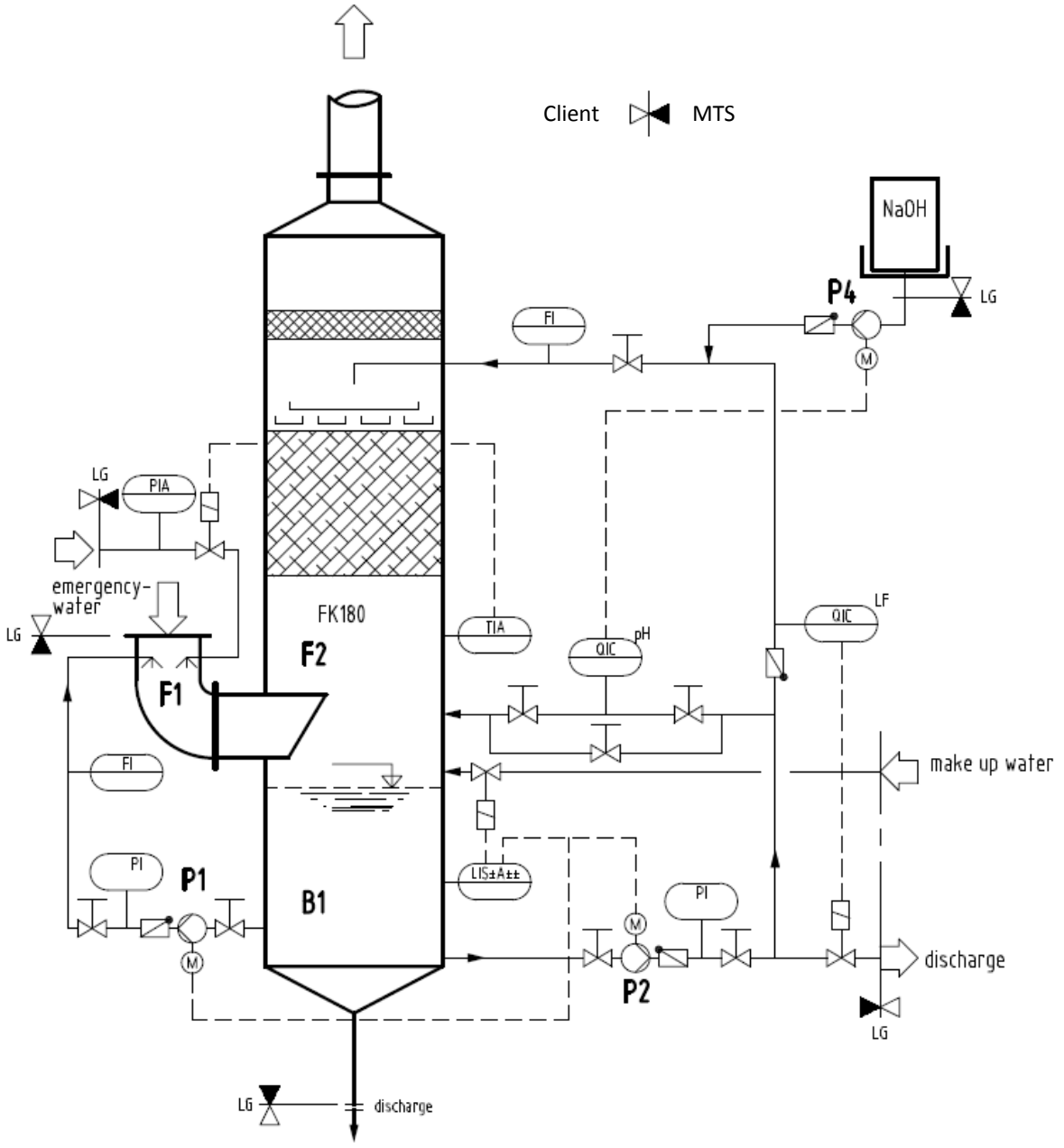
Hot Side By-Pass (HSBP)	
Function	Transfers hot purified air from the combustion chamber during high solvent loading
Control	Modulated via automatic sensing and control of the high temperature limit setpoint within the combustion chamber
Construction	Consists of an internally insulated damper
Material	Ceramic
Actuation	Pneumatic with positioner
Number	1

Mixing Box for Hot Side By-Pass	
Style	Internally insulated mixing box
Inlet	Inlet: hot gas from the HSBP and main clean exhaust air from the RTO

HCL Scrubber	
Design and description	The unit for waste gas cleaning mainly consists of a packed bed column for separation of the HCl, which is equipped with a quench for cooling the hot gas.
Material of Construction	Tower in FRP Quench section in 1.4539 with spray nozzles
Size	DN 900 quench tower; DN 1800 packed tower, Height 12m
Utilities	Caustic soda solution (35 %) Fresh water Softening Water, max. 1,2 mSiemens Emergency water app. 3 bar (g). Instrument air 5 bar (g), oil free Electric power 400 V
Circulation Pumps	Number of pumps: 2 for packed tower circulation and 2 quench (1 duty / 1 stand-by) Type: Horizontal process pump Pump Scrubber: Capacity: 50 m3/h (each) Motor: 7,5 kW Pump quench: Capacity: 20 m3/h (each) Motor: 5,5 kW Optional: Upgrade to eight (8) automatic valves for switching between duty/standby pumps. The system will automatically and periodically change from pump to pump to guarantee the redundancy. In the event of one pump failing the second one will take over automatically.
Dose pump	Dosing pumps for NaOH (1 duty / 1 stand-by) Magnetic coupling
Bleed	Ca. 1,1 m³/h with 5% salt content
Codes/Standards Used	MEGTEC standard
Instrumentation	Flow, level, pH , conductivity, temperature and differential pressure Additional level high switch (independent from LT-805)

	Additional dP measurement over the scrubber with interlock The valve XV-835 will be tested by the PLC program once per week
Storage tanks	Not included

NOTE: the temperature of the discharged water from the scrubber will depend on the process inlet conditions. During operation with high flow and VOCs load the temperature could increase and be in the range of 50-70 °C. A cooling system should be considered by the customer in the effluent if the maximum temperature allowed is 40°C



Example P&I diagram. P1, P2 and P4 will be Duty / stand-by arrangement.

FTA LEL Sensors and dilution control system	
Function	To monitor the LEL of the exhaust gases and dilute with fresh air in case necessary. If the LEL goes

	above the 25% of LEL the system will bypass the RTO and send the gases to the existing carbon filters
LEL Sensors	
Design	2 x FTA LEL analyzer as redundant system
Manufacturer	Control Instruments
Features	Analyzer for the continuous LEL monitoring based on flame temperature analysis (FTA) Direct duct mounting. Detection range: 0 - 80% LEL Response time: T60 < 2 s plus sample transport time of approx. 0,5 s/m depending on model. Automatic calibration. 220 V AC control voltage, 50 Hz IP65 electrical protection. Complete set of outputs: fault and alarm relays, 4-20mA reading output, serial RS-485 interface with Modbus protocol. Fuel gas: Pure Hydrogen, max. 40 ml/min. Tanks, piping and fittings are not included. Including 1 m sampling line
Number	2
Static mixer	
Function	To allow a mix between process gases and dilution air before reaching the FTA sensors
Manufacturer	Schuhmacher or similar
Size/Material	Static mixer in 304L;1.4307
	Pressure drop < 0,1 mbar
	>95% mixing results by turbulence
Bypass damper	
Function	Bypass to the carbon filters (existing) in cases of too high LEL and to isolate RTO from process flow.
Type	Consists of 2 independent pneumatic actuated single blade shut off dampers. Shut off damper, to isolate the process air duct. Shut of damper, to divert the process air to the atmosphere in case of high LEL.
Actuation	Pneumatic
Limit Switches	Internal limit switches for sensing of damper position.
Codes	In accordance with DIN EN 12266-1, leakage rate according to application needs.
Material	Stainless steel 1.4301
Dilution Air Damper	
Function	For supply of fresh air dilution to maintain the LEL below 25%
Material	Stainless steel 1.4301
Design	Double blade damper
Actuation	Pneumatic actuated
Inlet Filter	F5 Filter including pressure gage for visual inspection
Position sensor	Positioner
Installation	To be installed by customer in customers' duct
Dilution Air Preheater	
Design	Water/air heat exchanger for the supply of warm fresh air for dilution to the RTO

Type	Tube bundle
Material	Stainless steel
Capacity	Max 100 kW Max. 8.000 Nm3/h from 0 to 30°C
Control	Including temperature regulation
Installation	To be installed by customer in customers' duct

DeNOx System	
Function	Controlling NOx emissions by injection of urea solution and catalytic supported reduction to N2 and H2O,
Location	Downstream from the HCl scrubber. The gases will be reheated with an inline burner and a heat exchanger to reduce the energy usage.
Catalyst	Umicor DNX-LD 929 or similar
Catalyst temp operating design	200 °C, injection of the urea will be done at 300°C
Inline gas burner for process gas heating	Max. 1000 kW
Gas/Gas heat exchanger for air preheating	In stainless steel 1.4301, including thermal insulation 900 kW
NOx Reduction	From 600 mg/m³ down to <50 mg/Nm^3
NH3 Slip	Less than 10 mg/Nm^3
Housing	• Vertical flow orientation • Cosisting of one reactor with two layers of cytalyst • Internal catalyst supports and catalyst block sealing mechanisms • Permanent sampling grid and ports for testing and tuning of the injeciton grid • Transition pieces from catalyst housing to inlet and outlet gas path dimensions • Removable access door for catalyst loading and removal • Maintenance access door • Hausing material carbon steel • Instrumentation (shipped loose for field install) • Two (2) type K thermocouple • One (1) differential pressure transmitter
Urea injection	Pump skid, nozzles, ducting between RTO and SCR catalyst is included in cope of supply. Urea storage is excluded, can be offered in a later stage • Designed for 40% urea • Skid mounted, pre-piped and wired to electrical cabinet • Contains urea and compressed air flow controls, automated shut-off • Requires 80 psig compressed air at conneciton point • Turbotak dual fluid atomizing nozzles • Stainless steel injection lances

	• Static mixer to improve NH3 distribution after the injection. 15 kg/h NH3 reagent injection (diluted) Notes: The use of urea will reduce the handling risks compared to NH3, nonetheless some disadvantages are that it may create fouling of the systems downstream as reactor or heat exchanger. Additionally, corrosion issues may arise. The use of stainless steel for the heat exchanger instead carbon steel should be considered. Additional control valve for recirculation of the urea to the tank for start up operations Flow meter low alarm
Control	Controlled by continuously NOx and NH3 measurement in the stack (by others), dosing control is included by Epsilon PLC. The signals for control from the NOx and NH3 measuring device should be provided by customer to the MTS PLC.
Dimension	Catalyst housing is approx. 1,8 x 1,8 x 4 m, Catalyst amount is 3,91 m³ approx. 2,3 tons total weight

Guaranteed performance for DeNOx

The SCR catalyst volumes are designed for an NH3 slip as specified in the table above and during steady operation, this can be maintained. However, at sudden changes of load, minor overshooting may occur.

The guarantee period is 24,000 operation hours, however, maximum 3 calendar years starting from the day the flue gas is passed through the catalyst for the first time and maximum 42 calendar months from the delivery of the catalyst.

The catalyst performance guarantees are furthermore given on the condition of maximum imbalance of gas flow distribution at catalyst inlet surface and a maximum imbalance for NH3/NOx distribution in the flue gas with values as stated in Table above.

Miscellaneous changes from HAZOP results	
RTO inlet temperature	Low alarm TISL at TE-501

Rupture panels for RTO	
Function	To limit damage to the RTO and reduce personnel risks in case of a deflagration due to high LEL.
Location	On the inlet channel of the RTO and in the area below the ceramic media beds All panels will be located on the same side of the RTO.
Manufacturer	Rembe or equivalent
Not included	Protection/barrier at the surrounding area to limit access of personnel.

Rupture panels installed in an Epsilon RTO

In-Line Deflagration Flame Arresters	
Function	Flame transmission protection in case of ignition in the RTO inlet section
Description	The deflagration flame arrester is symmetrical and offers bidirectional flame transmission protection. Explosion group: IIB3 MESG >= 0,65 mm
Amount	2 pieces
Materials	Body: 1.4571 Filter: 1.4571 Sealing: PTFE
Location	1 in the duct at the inlet of the RTO 1 in the purge duct of the RTO
Manufacturer	Protego or equivalent

Main and purge flame arrestors installed in an Epsilon unit

15. INSTALLATION/START-UP/TRAINING OF EPSILON®

	Days	Client	MTS
Installation Oversight			

Oversight of offloading and positioning equipment for a maximum duration of (see days)…local codes may require 3rd party supervision which is excluded.	23 days 1 person (estimated)	•	
RTO Commissioning			
Commissioning duration – single continuous trip	25 days, 1 person (estimated)	•	
One commissioning engineer for start-up	-	•	
Technician will inspect delivered equipment	-	•	
Technician will verify operational and technical data.	-	•	
Technician will ensure correct functioning of RTO	-	•	
Process Balancing			
The balancing and commissioning of process exhaust air flows prior to the agreed battery limit	X days, X men		
Training			
Technician will instruct nominated personnel in the function, operation and maintenance of RTO during start-up…class room/large group training excluded.		•	

16. INCLUSIONS & EXCLUSIONS

The following exclusions can be included in the scope of supply upon request.

Scope Item	Client	MTS
Delivery to Site	•	
Site Preperation		
Clearance of site/removal of existing equipment	•	
Structural modifications/reinforcements/building penetrations	•	
Foundation design for RTO and ancillaries	•	
Foundation construction for RTO and ancillaries	•	
Installation area lighting	•	
Installation area and site security arrangements	•	
Installation Services		
Offloading, shimming and positioning of main RTO parts	•	
Mechanical Assembly of B&W MEGTEC supplied parts	•	
Scaffolding for installation	•	
Small crane/forklift /cherry picker hire	•	
Equipment pre-wiring to junction boxes (ET-200)		•
Main power supply to RTO electrical cabinet	•	
Wiring between RTO and Controls	•	
Wiring of scrubber instruments and pumps	•	
Wiring from DeNOx pumps skid to electrical cabinets	•	
Wiring of other field instruments and sensors to electrical cabinets	•	
Cable Trays & Cable Tray Bridges	•	
Fuel supply to inlet flange on RTO gas train	•	
Compressed air to single connecting point on RTO body	•	
Compressed air distribution from connection point to RTO ancillaries		•
Compressed air supplies to field dampers/equipment	•	
VPN connection to HMI	•	
Connection to scrubber and piping from pumps to scrubber etc.		•
Reagent storage	•	
RTO Interconnections		

Duct from process fan outlet to RTO inlet		•
Duct from RTO outlet to quench/scrubber		•
Duct from HSBP to quench/scrubber connection		•
Duct between scrubber – heat exchanger – inline burner – DeNOx		•
Duct from DeNOx outlet to stack	•	
Process Interface		
Process duct(s) to battery limit (process fan inlet)	•	
Process bypass damper (as described)		•
Process LEL measuring devices (as described)		•
Process signal wiring	•	
Field Damper Wiring	•	
Field Damper Pneumatic Air Supply Connections	•	
General		
Local authority/government permits	•	
Additional noise protection systems	•	
Lighting of the RTO and surrounding area	•	
Lightning protection, inner and outer protection	•	
Exhaust gas monitoring systems (as described)		•
Analyser gas bottles, gas storage facilities, pipework & valves	•	
Acting as chair in HAZOP	•	
ATEX rating of supplied parts	•	
Scope as identified in process HAZOP or SIL reviews	•	
VOC measurement for compliance test	•	
Assumptions		
Clear and unobstructed access during installation and start up	•	
Secure area for stored items and personnel tools	•	
Rest and wash facilities for personnel	•	
Work/office area for personnel local to site	•	
All materials, equipment/services not specifically stated in offer	•	
Disposal of waste from Site	•	
Provision of skips for removal of debris	•	
Permits/permissions for access to site	•	
Provision of clear access to site	•	
Temporary storage of pre-delivered items	•	
Temporary power supplies local to installation site	•	
Temporary area lighting	•	
Suitable process conditions for commissioning	•	
Verification of suitability of existing systems or components	•	

Notes

1. Prior to the arrival of the MTS technician the customer will be responsible for ensuring that all utilities and other specified responsibilities are fully installed and connected according to MTS's specifications.
2. If delays are encountered which are not attributable to MTS equipment as but not limited to safety trainings, induction, tests, weather breaks (typical in hot/cold regions) etc... The additional time and services required will be charged separately.
3. If delays are encountered which are attributable to climate, weather, local working code requirements, heat rest breaks, or non-availability of local support labour, the additional time and services required will be charged separately.

17. PERFORMANCE GUARANTEES

EMISSION GUARANTEE

B&W MEGTEC guarantees that the EPSILON® will comply with the following emission concentration limits expressed as 30 minute averages, based on the design data detailed herein and assumes no nitrogen-containing solvent in the waste gas stream.

Emission Criteria	Guaranteed Emission Limit	Units
VOC (as carbon)	≤5*	mg/Nm³
CO	≤100*	mg/Nm³
NOx	≤50*/**	mg/Nm³
HCl	≤ 3*	mg/Nm³
Cl2	≤1*	mg/Nm³

* based on half hour measurements
** With the assumption that the DeNOx system is installed.

Dioxins emissions:

At the given operating conditions it is not expected to have dioxins formation, nonetheless if required the scrubber system can be retrofitted with our Adiox® filling material for dioxin removal.

PERFORMANCE WARRANTY

B&W MEGTEC warrants that the Oxidiser during the warranty period defined hereafter will maintain a VOC destruction efficiency as specified above.

In respect of the arrangements in case the unit does not perform as predicted, B&W MEGTEC would seek your co-operation to allow access to the unit and time to review the operational settings and carry out changes to enable the unit to perform satisfactorily.

The oxidiser must be operating in accordance with the design characteristics (including flow, VOC type, temperature, VOC concentration) and also in accordance with the operating manual provided by B&W MEGTEC.

Non-conformance with this warranty shall be demonstrated to the satisfaction of B&W MEGTEC by and at the expense of BUYER.

MEASUREMENTS

For design, evaluation and guarantees the following guidelines for measurements (including accuracies) are assumed:

Temperatures:	± 2°C
Air flows:	± 5 %, Measured by traversing pitot tube.
Concentrations of Hydrocarbons:	Measured with FID instruments for which the accuracy is assumed to be ± 15 % of absolute values (± 3 % relative in/out).
Electricity:	Voltage (U) ± 10 %
	Current (I) ± 10 %
Calculation of Electrical Power:	P = 3 x U x I x cos
Pressure:	± 2 mm WC

This warranty is exclusive and is solely for the benefit of the buyer. It is in lieu of any and all other warranties, expressed or implied, including without limitation, the implied warranties of merchantability and fitness. The remedies for any breach of this warranty shall be limited to those herein provided. B&W MEGTEC shall not be liable in any case for special, incidental, consequential or penal damages.

THERMAL EFFICIENCY

B&W MEGTEC makes the following thermal efficiency guarantee.

The oxidiser regenerative heat exchanger thermal efficiency is guaranteed at the design efficiency noted ± 2.0%. This guarantee is based on operation within the allowable volumetric flow turndown range of 5:1 and for solvent concentrations less than or equal to that required for self-sustaining operation, and where the thermal efficiency (TER) is defined by the relationship:

%TER = MoCo (Tc – To) / MiCi (Tc – Ti)

Where:

1) %TER = Thermal Efficiency

MoCo = Thermal Mass flow exhaust rate from RTO

MiCi = Thermal Mass flow supply rate into RTO

Tc = RTO combustion chamber temperature

To = Exhaust temperature leaving RTO

Ti = Supply temperature entering RTO

2) To and Ti are time averaged at 10 second intervals over the same complete RTO regeneration cycle.

CRITERIA

- The length of term for this emission guarantee is twelve (12) months from date of start-up, not to exceed eighteen (18) months from shipment date (whichever is sooner).
- For the purposes of this warranty, a mutually agreed testing protocol is to be used.
- Use of the oxidiser must be in accordance with its operating instructions. Guaranteed performance is based on the use of the solvent description listed in the proposal.
- Non-conformance with this warranty shall be demonstrated to the seller's satisfaction by and at the expense of the buyer. The seller reserves the right to assist in the development of testing protocol in cooperation with the BUYER and their assigned consultants and/or testing contractor.

Note: Compounds such as, but not limited to, heavy metals, halogens other than chlorine can degrade the ceramic fibre insulation and oxidiser internal components. In addition silicone can lead to bed blockage and where present it should be accepted that bed replacement may therefore be periodically required. These compounds will void the warranty if found in process stream. These can originate from solvents containing halogens other than chlorine, silicone etcetera.

18. MECHANICAL WARRANTY

INCLUSIONS

MTS Environmental will provide Warranty Service for the equipment for a period of 12 months from start-up, and not exceeding 18 months from the shipment date (whichever is the sooner).

Warranty Service includes remedying any defects in workmanship and material in the equipment including furnishing necessary labour and replacement parts required.

Warranty Service covers costs of travel, site time, spare parts and shipping costs within the European Union, Switzerland and Norway. Additional charges will be incurred when the installation is undertaken outside these regions.

EXCLUSIONS

1. Replacement of parts damaged as a result of catastrophe, neglect, misuse, or negligence by the customer. Also for damage caused by failure of, or faulty electrical power or causes other than normal use of equipment.
2. Furnishing of labour to replace expendable parts, including but not limited to UV scanner, igniters, drive belts, light bulbs, thermocouples and gaskets.
3. Periodic tests or calibration according to ATEX or similar regulations, e.g., but not exclusively LEL measuring units, flame arrestors etc.
4. Repairs made necessary because of alterations, modifications, repairs or maintenance of equipment made by persons other than the seller or the seller's designated service personnel, without prior written authorization from the seller.
5. Consequential, special, incidental, or indirect damages, including but not limited to lost profits, even if the seller has been advised of the possibility of such damages.
6. Warranty terms do not apply where the exhaust flow contains compounds such as sulphur, heavy metals, silicone, phosphorous, dust or any other precipitating compounds. These compounds may lead to a blocking of the heat exchange resulting in a change of the heat exchange media.
7. All the agreements made for delivery dates and delivery times are only valid on condition that manufacture or supply are not made impossible or made difficult in any excessive way because of Force Majeure, war, strike, lock-outs, political unrest, circumstances impeding transport, problems in obtaining materials of any kind, governmental measures, breakdown of machinery, fire damage and other accidents in our own factory or in the factory of our suppliers. These events release the seller from their obligation to supply for the duration of this impediment or its consequences and entitle the seller in serious cases to rescind from the contract in whole or in part. Rescind from the contract in whole or in part.

POTENTIAL CHARGES

Should service requirements be outside warranty limits, all standard charges will be forwarded to the customer. Warranty will not cover repairs or alterations due to external influences (e.g. other auxiliary or accessory equipment on process line).

19. TERMS OF OFFER

Validity	Up to 60 days from the date of this offer
Prices	Net amounts plus applicable legal VAT
Currency	Euro
RTO Delivery	Delivery of the equipment at site week 30 of 2019, following receipt of written purchase order by November 23rd of 2018 and clarification of technical specification (subject to confirmation)
Shipment	Incoterms 2010, CIP 2674-506 Loures, Portugal
Conditions of Payment	30% with confirmation of order. Date of invoice. Against bank guarantee.
	40% on readiness for dispatch. 30 days net date of invoice
	30% on completion of commissioning and signed acceptance protocol, but not later than 60 days after readiness for dispatch. Against bank guarantee of 10% as performance warranty for the duration of the equipment warranty period.
Standard Conditions of Sale	MTS Environmental GmbH.
Supplying Entity	MTS Environmental GmbH Honeywellstraße 18 D - 63477 Maintal Tel +49-(0)6181-94040 Fax +49-(0)6181- 46646

20. PRICING

Item	Price Euro (€)
1. Design, Manufacture and Supply One (1) B&W MEGTEC EPSILON® RTO as described in this offer within Section "RTO Scope" Quench and Scrubber	€ 1.160.000
2. Engineering as defined in Section "Project Engineering Scope"	Included
3. Mechanical & Electrical Installation	Not included
4. Installation Oversight, Commissioning and Training as defined in Section "Installation/Start-up/Training"	€ 56.040
5. Transportation/Shipment [2]	€ 34.000
Additional equipment required	
6. 24/7 on-line support (hotline) during warranty period [3]	Included
7. RTO Hot side Bypass (HSBP)	Included
8. Mixing box for the HSBP and ductwork	Included
9. Quench and Scrubber for HCL removal	Included
10. FTA LEL Sensors and dilution control system	Included
11. Interconnecting ductwork inside battery limit	Included
12. DeNOx unit including Urea injection, inline burner and heat exchanger	€ 121.250
13. Stack	Not Included
14. CEMS, Continuous emission monitoring system for NOx, NH3, TOC, HCl, CO.	Not Included
15. Additional cost for process fan in stainless steel and for ATEX zone 2 inside.	5.180 €
Total Cost all Items Above	**1.371.290 €**
Options	
HAZOP: participation in a HAZOP meeting held at Havione in Loures. 1 person 2 days at site including travel cost and expenses [4]	- 3.960 €
Additional cost for larger RTO towers and combustion chamber to achieve 2 seconds of residence time at 1100°C	67.400 €
Additional cost for redundant process fan in stainless steel and for ATEX zone 2 inside. Including VFD and larger electrical cabinet. Including larger fan/motor/VFD for both fans for additional pressure drop from	34.230 €
Larger fan, motor and VFD (110 kW instead of 75kW) for both fans for additional pressure drop from the flame arresters	8.570 €
4 butterfly dampers to allow isolation of the fans. In 1.4301 with pneumatic actuators. DN630	11.470 €
Bypass damper in 1.4301 instead of carbon steel	2.910 €
Fresh air damper and fresh air heater in 1.4301 instead of carbon steel	3.680 €
Dilution air damper and dilution air heater in 1.4301 instead of carbon steel, including dP gage for the air filter	4.250 €
Additional cost for heat exchanger for energy recovery (DeNOx) in Stainless steel 1.4571 / 1.4301	12.720 €
Additional cost for upgrade of 8 manual valves for the recirculation and quench pumps to an automatic system as described	14.890 €
Burst panels for the RTO	32.440 €
Flame arrestors (2 pieces)	54.300 €
Maintenance inspection visit (2 days at site including travel time and all travel costs) [5]	3.890 €
Other changes from HAZOP recommendations	
Interlocks for TT-510, TT2034, dp through the scrubber. LS for LT-805, including additional engineering	6.340 €
Total Cost including all Items Above	**1.629.600 €**

Notes

1. Net amounts plus applicable legal VAT
2. In the event freight quotations have been provided, such amounts are solely for budgetary purposes. MTS Environmental GmbH (Seller) will arrange for shipments, the (Buyer) will be invoiced by MTS Environmental GmbH (Seller) for the actual shipping charges plus a handling fee will be billed back at time of shipment.
3. 24/7 on-line support after the warranty period is included if a maintenance contract is signed
4. If the HAZOP is ordered before the equipment, the cost for the HAZOP will be reimbursed at the time of the equipment order.
5. Cost for the maintenance visit does not include spare parts if required. Valid for 24 months after start-up, visits after this period will be charged at the standard MTS rates plus travel costs and expenses.

21. STANDARD DAILY RATES

RATES FOR ENGINEERING

For engineering outside of the scope of the above proposal

Standard Hourly Rates for Engagement Phases	Hourly €
Process/Applications Engineer	€ 100
Draughtsman	€ 90
Mechanical Engineer	€ 100
Electrical Engineer	€ 100
Expenses	Cost +6%

DAILY RATES FOR HAZOP & SIL

For engineering outside of the scope of the above proposal

Standard Daily Rates for Engagement Phases	Daily €
Process/Applications Engineer	€ 900
Mechanical Engineer	€ 900
Electrical Engineer	€ 900
Expenses	Cost +6%

DAILY RATES FOR INSTALLATION AND COMMISSIONING

For engineering outside of the scope of the above proposal

Standard Daily Rates	Daily €
Technician	€ 950
Process/Applications Engineer	-
Draughtsman (office based)	-
Supervisor	€ 950
Accommodation and Expenses	Cost +6%

22. TERMS & CONDITIONS OF SALE

Terms of sale and delivery
of
MTS Environmental GmbH
Honeywellstr. 18, D-63477 Maintal

1. Preamble

These terms of sale are exclusively valid for the sales and delivery of goods and services provided any stipulations deviating from or supplementary to these have been expressly agreed in writing.

Any other terms and conditions or any regulations of the buyer modifying the terms of the contract are not accepted; they are only valid for MTS ENVIRONMENTAL GMBH if their validity is confirmed in writing.

These stipulations are also valid for future legal transactions between the buyer and MTS ENVIRONMENTAL GMBH unless otherwise agreed in writing and without being exclusively integrated into the respective contract.

These General Terms of Sale are only valid between businessmen as well as governmental institutions in domestic trade and foreign trade.

2. Order and documents concerning the offer

Offers as well as leaflets, price lists etc. are always without engagement and without any responsibility on our part. Orders submitted are only deemed to be accepted if acceptance has been made in the form of a written order confirmation or concluent by executing the order. The order confirmation alone is decisive for the extent of the delivery. Measurements, weights, materials and nature of the goods are only approximate values provided they have not been fixed as binding.

The buyer is responsible for the exactness of the order and he is also liable for the fact to provide MTS ENVIRONMENTAL GMBH in time with all the information required for the correct execution of the order as to the request and the nature of the goods ordered.

If the goods have to be manufactured or otherwise treated or processed by MTS ENVIRONMENTAL GMBH and if the buyer has submitted a specification, the buyer has to exempt MTS ENVIRONMENTAL GMBH from any loss, damage, costs or other expenses to be paid if treatment or processing of the goods due to the specification of the buyer reveals to be an infringement of a patent, copyright, brand or other industrial property right of any third party.

We reserve the right to modify the description of the goods due to specification in a way as to respect legal requirements provided this modification does not lead to any deterioration of the order concerning quality and usability.

We reserve all the property rights and exploitation rights in cost estimates and drawings as well as in other documents prepared by MTS ENVIRONMENTAL GMBH without expressly indicating it. They are only to be used for the purpose of the contract and are not to be reproduced without the express authorisation of MTS ENVIRONMENTAL GMBH nor made accessible to third parties.

Prices are ex works, freight, packing, transport, insurance, assembly and commissioning not included, unless otherwise agreed upon. Prices are without VAT, which the beneficiary has to pay in addition as per the regulations concerning sales tax.

3. Delivery

Delivery times are only binding if laid down in the order confirmation as binding delivery times.

The delivery time is deemed to be respected:

a) with delivery without assembly when the consignment has left the factory within the delivery time agreed upon;

b) with delivery with assembly as soon as the installation of the plant has been effected within the delivery time agreed upon;

c) with delivery with commissioning as soon as the plant is working or is used by the buyer, even if some defects remain which do not restrict the use or only restrict it in an insignificant way.

If delivery is delayed because of reasons within the buyer's control, the delivery time is deemed to be respected if the buyer is informed of

a) the readiness for despatch

b) the readiness for assembly

c) the readiness for commissioning

All the agreements made for delivery dates and delivery times are only valid on condition that manufacture or supply are not made impossible or made difficult in any excessive way because of Force Majeure, war, strike, lock-outs, political unrest, circumstances impeding

transport, problems in obtaining materials of any kind, governmental measures, breakdown of machinery, fire damage and other accidents in our own factory or in the factory of our suppliers. These events release MTS ENVIRONMENTAL GMBH from their obligation to supply for the duration of this impediment or its consequences and entitle MTS ENVIRONMENTAL GMBH in serious cases to rescind from the contract in whole or in part.

MTS ENVIRONMENTAL GMBH is entitled to make part shipments and these deliveries are deemed to be separate operations as to the application of these terms and conditions.

In case delivery is not effected in time, the buyer has to fix a suitable additional period for delivery on expiry of which he is entitled to cancel the agreement. There is no obligation of fixing an additional period if a commercial firm deal has been agreed upon.

The buyer is only entitled to claim damages for non-performance of the contract if the delay in delivery is due to firm intention or gross negligence or if MTS ENVIRONMENTAL GMBH can be reproached for having committed a breach of a fundamental contractual obligation.

If the buyer has a delay in accepting the goods, he has to pay the purchase price nevertheless. Additional charges arising through the delay in acceptance (e.g. for storage of the goods), are at the buyer's expense.

4. Transfer of risks, Dispatch

The risk of damage or loss of the goods will be transferred to the buyer as follows:

- when the goods are supplied ex works ("Ex Works", Incoterms 2000) at the time MTS ENVIRONMENTAL GMBH informs the buyer that the goods are ready for collection;

- if dispatch of the goods has been agreed, with transfer of the goods to the carrier, and this is also the case if part shipments are effected or if MTS ENVIRONMENTAL GMBH has also taken over other services (delivery „Free carrier", Incoterms 2000).

If dispatch is delayed for reasons within the buyer's control, transfer of risks is made to the buyer on the day the goods are ready for dispatch. In this case, MTS ENVIRONMENTAL GMBH is entitled to charge storage fees as well as insurance fees for storage.

The buyer is entitled to ask for an insurance coverage of the transport risk at his expense.

If no specific shipping instructions have been made, selection of the way of transport, of the carrier and of the insurance company, if required, will be effected at MTS ENVIRONMENTAL GMBH's own discretion and without any guarantee that this is the most favourable form of dispatch or insurance.

Any damages incurred in transit have to be reported to the carrier without delay. Entitlement to compensation addressed from the buyer to MTS ENVIRONMENTAL GMBH, e.g. because of inadequate packing, is excluded if the buyer does not send a corresponding form of findings of the carrier to MTS ENVIRONMENTAL GMBH within one week.

If delivery is directly effected to the customer by component suppliers of MTS ENVIRONMENTAL GMBH, the customer is obliged to inform the supplier without delay on receipt of the consignment, to examine the consignment and to report all the deficiencies visible at a customary examination to MTS ENVIRONMENTAL GMBH without delay. The buyer is obliged to careful safekeeping of the goods delivered until the consignment is installed (assembled).

5. Assembly, commissioning

Assembly work and/or commissioning are to be paid separately, unless otherwise agreed. All the assembly work is exclusively carried out on the basis of the general terms and conditions for assembly of MTS ENVIRONMENTAL GMBH the contents of which is deemed to be known. The following points are only an excerpt of the terms and conditions of assembly. Should the complete terms and conditions of assembly not be known, a copy can be obtained from MTS ENVIRONMENTAL GMBH free of charge.

The costs of assembly in particular include travel expenses, daily travel allowance and man-hours of the staff employed, plus possible overtime pays, night work premiums and holiday pays and Sunday pays as per the valid pay grades of the supplier. Travel times and waiting times are invoiced as working times. If installation or commissioning is delayed for reasons not within MTS ENVIRONMENTAL GMBH's control, the buyer has to bear all the costs for the waiting time and / or for any additional journeys required.

All the lump sums agreed upon for assembly or commissioning do not include any overtime pay, night work premiums, Sunday pay and holiday pay which will become necessary. They can be invoiced separately.

If assembly is carried out by the buyer or by a third party authorised by him, the currently valid operating instructions and assembly instructions have to be obtained from MTS ENVIRONMENTAL GMBH and have to be strictly observed.

6. Reservation of ownership

Notwithstanding the delivery and the transfer of risks and other regulations of these terms of delivery, ownership of the goods is not to be transferred to the buyer unless the purchase price including possible charges and interests occurring from the delivery contract have been paid in full. MTS ENVIRONMENTAL GMBH is entitled to claim the goods back, to sell them elsewhere or to dispose of them in any other way,

if the buyer has a delay in payment and MTS ENVIRONMENTAL GMBH exercises the right of rescission they are entitled to. Up to the time of payment of the purchase price in full, the buyer has to keep the goods for MTS ENVIRONMENTAL GMBH as a trustee and handle them with care, a fact which assumes that they are properly stored, secured and also insured, if required.

The buyer is only to sell the goods delivered and the objects resulting from their processing in regular business transactions. He assigns all the claims he is entitled to because of the resale of the goods or of any other legal basis to MTS ENVIRONMENTAL GMBH as security. The buyer, however, is authorized to collection of the claims for MTS ENVIRONMENTAL GMBH until further notice. The buyer is obliged to give us any information on the claim we may ask at any time. MTS ENVIRONMENTAL GMBH commit themselves to release the securities they are entitled to on request of the buyer in so far as the value of the securities to be realised considerably increases the claims MTS ENVIRONMENTAL GMBH is entitled to. MTS ENVIRONMENTAL GMBH will carry out selection of the securities to be released as to their own reasonable discretion.

If the goods have been processed and if processing has been made with parts of which MTS ENVIRONMENTAL GMBH has no ownership, MTS ENVIRONMENTAL GMBH acquires the corresponding part ownership. The same is true of the fact of mixing the goods of MTS ENVIRONMENTAL GMBH with those of third parties. If the reservation of ownership of MTS ENVIRONMENTAL GMBH is not exercised because of legal regulations, MTS ENVIRONMENTAL GMBH has to be compensated for the loss of this right in any other suitable way.

The buyer is obliged to immediately inform MTS ENVIRONMENTAL GMBH of any access of third parties to the reserved goods or to any claims assigned as a security. Regardless of this and in such cases, the buyer has to inform the third party beforehand of the rights MTS ENVIRONMENTAL GMBH have to the goods or to the claim.

When the claims of MTS ENVIRONMENTAL GMBH are paid in full, the ownership of the reserved goods will be transferred to the buyer without further notice and he is entitled to the claims assigned.

7. Payment

Payment of the invoice amount is to be effected as per the terms of payment stipulated in the order confirmation.

MTS ENVIRONMENTAL GMBH reserves the right, upon notification of the buyer in time before carrying out the delivery, to increase the price agreed upon in a way as they deem necessary for compensating a price increase occurred in the meantime and for which MTS ENVIRONMENTAL GMBH have not been responsible for (i.e. because of exchange rate fluctuations, currency regulations, customs modifications, considerable increase in material costs and production costs).

All the payments have to be effected in the currency agreed upon and free of charge for MTS ENVIRONMENTAL GMBH by transfer to one of the bank accounts or postal cheque accounts of MTS ENVIRONMENTAL GMBH. Third parties such as employees or carriers are not entitled to accept payments. Payments of the buyer made to non-authorized third parties do not release him from his obligation to effect payment to MTS ENVIRONMENTAL GMBH.

Payment by bill of exchange or cheque can only be made subject to the express consent of MTS ENVIRONMENTAL GMBH. Cheques and bills of exchange are only accepted on account of performance, i.e. only if they are honoured or cashed in by the drawee within the period agreed upon, and presentation by MTS ENVIRONMENTAL GMBH in time will not be guaranteed. All the costs incurred will be at the presenter's expense.

If the payment times agreed upon are exceeded, MTS ENVIRONMENTAL GMBH is entitled to claim the customary past due interests subject to all further legal requirements, at least in the amount of 5 % beyond the base lending rate of the European Central Bank.

8. Warranty and liability

The buyer has to immediately examine the goods after delivery and make complaints, if necessary. Notification of complaints has to be made to MTS ENVIRONMENTAL GMBH within one week on receipt of the goods and if the defects are not visible, when the defect is found, otherwise our liability for defects no longer applies.

All the parts which reveal to be unusable or the usability of which is significantly impaired within 6 months following the transfer of risks due to circumstances occurred before the transfer of risks, have to be repaired free of charge or replaced by new ones at MTS ENVIRONMENTAL GMBH's choice. Replaced parts become the property of MTS ENVIRONMENTAL GMBH. If MTS ENVIRONMENTAL GMBH is not willing or not able to remedy the defects or to replace the goods, the buyer is entitled at his own discretion to ask for cancellation of the contract or reduction of the purchase price.

For the replacement part or for repair, the warranty period is 3 months; however, it will be at least up to expiry of the initial warranty period for the object delivered.

MTS ENVIRONMENTAL GMBH does not assume any responsibility for the fact that the goods are suitable for a specific purpose, unless they expressly agreed to this responsibility.

Any warranty claims and liability claims cease to apply,

a) when damages have occurred because of unsuitable or inappropriate use, incorrect assembly, commissioning or maintenance by the buyer or third parties, by incorrect or careless handling by the buyer, inappropriate production equipment and facilities or inappropriate replacement materials;

b) when the parts, material or other equipment have been manufactured or supplied by the buyer himself or by third parties on behalf of the buyer;

c) when the damage occurred because of the non-observance of the indications, the assembly instructions, operating instructions or maintenance instructions of MTS ENVIRONMENTAL GMBH on the part of the buyer.

The buyer has to grant MTS ENVIRONMENTAL GMBH the required time and has to give them the chance to carry out all the repairs and replacements necessary. If deemed reasonable as to MTS ENVIRONMENTAL GMBH's own discretion, the buyer has to send the defective parts to the MTS ENVIRONMENTAL GMBH factory in Germany, carriage and duty paid, if MTS ENVIRONMENTAL GMBH requests to do so. If a case of warranty occurs, MTS ENVIRONMENTAL GMBH will refund the proven costs for mounting and dismounting as well as for sending / returning the goods or the parts concerned within the boundaries of the Federal Republic of Germany. Any other costs for sending the goods abroad (freight charges, duties etc.) will be borne by the buyer. If no case of warranty occurs, MTS ENVIRONMENTAL GMBH is entitled to invoice the customary rates for working time and material as well as all other costs.

Apart from the warranty claims not depending on a fault, MTS ENVIRONMENTAL GMBH is liable for firm intent and gross negligence, for initial inability, delay and impossibility, for the existence of guaranteed qualities as well as for slight negligence as to obligations essential to the contract even with regard to vicarious agents, however, limited to predictable damages in every case.

Liability is excluded in all other cases. This is also true of data losses and other consequential damages such as breakdown of machinery or loss of profit. Liability as per the product liability law remains unaffected.

9. Rescission

If MTS ENVIRONMENTAL GMBH is unable to perform the contract in full or in part, the buyer can rescind from the contract. If performance of the contract is only partly not possible, he can request a suitable reduction in price.

The buyer can only rescind from the contract in case of partly impossibility to perform the contract on the part of MTS ENVIRONMENTAL GMBH if his interests in the supply are considerably impaired because of this fact.

If unforeseen circumstances as per § 3 of these terms of delivery occur, MTS ENVIRONMENTAL GMBH is entitled to rescind from the contract wholly or in part.

Claims for damages because of such a rescission cannot be made. If MTS ENVIRONMENTAL GMBH wants to exercise its right of rescission, MTS ENVIRONMENTAL GMBH has to inform the buyer without delay.

10. Place of performance and jurisdiction, applicable law

Place of performance for all the claims resulting from the contracts concluded with MTS ENVIRONMENTAL GMBH is the registered office of MTS ENVIRONMENTAL GMBH in Maintal near Frankfurt. All mutual claims arising from the business relationship, also concerning legal actions with bills of exchange and cheques, will be settled at the court of Frankfurt am Main, but as to MTS ENVIRONMENTAL GMBH's discretion, also at the competent court for the registered office of the other party to the contract.

This contract will be governed by the law of the Federal Republic of Germany, regardless of the UN sales law.

11. Final provisions

These stipulations substitute all the other agreements made orally or in writing between the parties to the contract before. Amendments and supplements have to be made in writing.

The contract and the remaining stipulations will be valid even if individual stipulations may become ineffective. In case of ineffectiveness of one of the stipulations, the parties to the contract commit themselves to have a valid stipulation replaced the ineffective one the economic contents of which comes closest to the purpose of the ineffective stipulation.