1. INTRODUCTION

WHO WE ARE:

Founded in 1993, BROFIND are leaders in the design and supply of plants dedicated to the treatment of gaseous emissions containing V.O.C. (Volatile Organic Compounds). We are proud to be one of the few companies in a position to boast their own know-how in **all available plant technologies** (solvent recovery with activated carbon, thermal oxidation, wet absorption, concentration, condensation).

The variety of developed processes and the hundreds of reference plants supplied to prestigious customers on all continents can easily demonstrate BROFIND ability to propose the suitable plant for any specific circumstances, enabling us to concentrate our greatest care on the customer assistance not only to find out the perfect solution for their VOC emission problems but also to guarantee an effective and satisfactory after-sale assistance service.

Our plants are designed to guarantee the highest operating efficiency, obtained through the meticulous respect of the following principles:

- study of the Best Available Technologies (B.A.T.);
- optimization of internal resources, using subcontractors only under special conditions;
- identification of qualified and trustworthy subcontractors;
- respect of the highest quality and safety standards;
- plant management though self-developed software;
- never-ending process optimization, to guarantee simple plant operation, saving and reduced maintenance.

Our structure is composed by a very qualified technical staff, organized in the following departments:

- Technical Sales Department, focusing on the plant and product division, keeping direct contact with our representatives, agents and partners all over the world.
- Engineering Department (process, mechanical and electro-instrumental detailed engineering), to adapt the process to the evolutions of the technology and the customer needs.
- Technical Project Department (mechanical and electro/instrumental).
- Software Development and Industrial Automation Department.
- Service Department, interfacing with the local partners all over the world and dedicating to start-up and after-sale services.

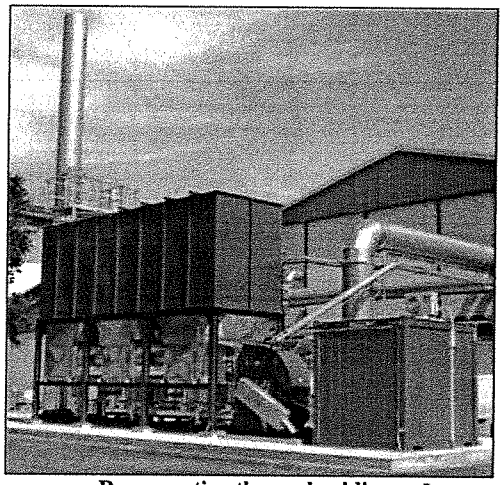
For each project, the interaction of the various departments is guaranteed by an appointed Project Manager, responsible for the coordination of the project completion and the necessary contacts with the customer.

EXPERIENCE IN THE THERMAL OXIDATION OF V.O.C. (Volatile Organic Compounds)

The know-how concerning regenerative thermal oxidation plants dates back to the '80s and led to the installation of hundreds of plants, most of which are still running successfully, some also in your sector.

The latest installations and the proposed services on regenerative thermal oxidizers enabled BROFIND to achieve a wide experience, not only on their own supplied plants, which led to the following results:

- Optimization of thermal recovery processes, searching for the correct ceramic packing for the considered application.
- Optimization of the abatement efficiency, thanks to the possibility of proposing a wide choice of different solution according to the required purification efficiency.
- Energy optimization, thanks to the possibility of combining different thermal recovery solutions (air, water and thermal oil heating; production of steam and chilling).
- Optimization of plant lay-outs, proposing compact solution, totally mechanically, electrically and pneumatically preassembled, to reduce the erection, assembly and star-up time on site.



Regenerative thermal oxidizer

PROFESSIONALISM, KNOW-HOW, COMPETENCE, FLEXIBILITY AND **AVAILABILTY** are the basic strengths enabling BROFIND to place themselves as main business partner to solve all problems related to our activity, as most of our customers can witness.

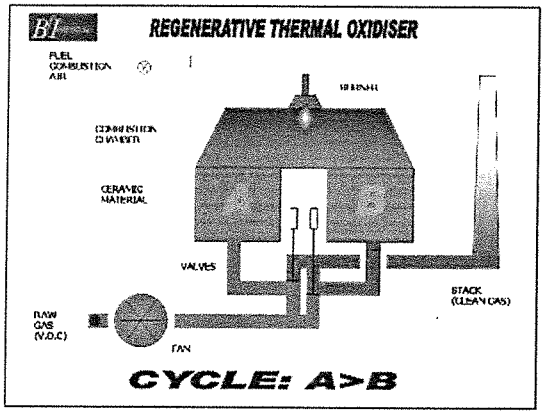
2. PROCESS DESCRIPTION

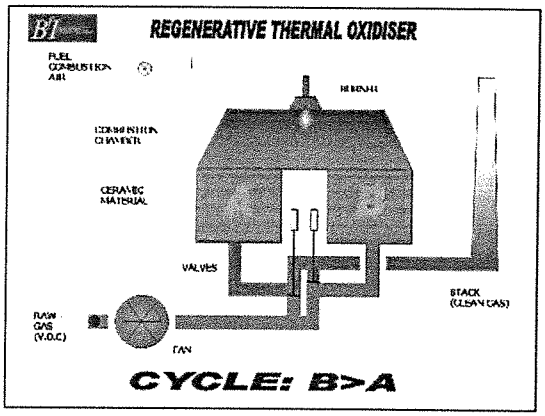
The regenerative thermal oxidation enables the V.O.C. abatement through the following reaction:

$$V.O.C. + O_2 + \text{activation energy} \rightarrow CO_2 + H_2O + \text{heat}$$

The reaction occurs in the combustion chamber, under suitable temperature, turbulence and residence time conditions.
The polluted air is preheated by layers of ceramic packing, which are heated or cooled according to the direction of the air stream passing though them, acting as heat accumulator.

The process is displayed in the following pictures:





2.1. Suction

The solvent laden air coming from the production process is extracted by the main fan and then sent to the regenerative thermal oxidizer. The suction is guaranteed by means of a regulation loop controlling the fan speed via a variable frequency drive. In this way, it is always possible to extract the correct airflow according to your production conditions and the effective necessary airflow.

2.2. Preheating

The air stream flows vertically through the ceramic bed, which was preheated by the hot gases of the previous phase. The heat is transferred from the ceramic packing to the air, which reaches a temperature approaching that necessary for oxidation of the VOCs, which is then completed in the combustion chamber.

2.3. Thermal Oxidation

In the combustion chamber, the optimum temperature is guaranteed by the presence of a burner, used to feed more energy in case the quantity of VOC is not sufficient to generate enough heat to achieve self-supporting conditions.

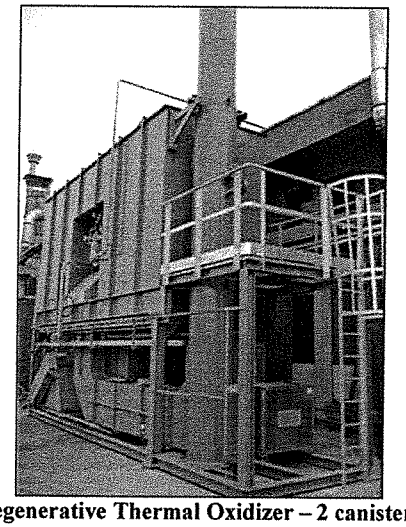
2.4. Cooling

The purified gases flow vertically through the second ceramic bed, transferring the heat to the ceramic mass, and they are then released to the atmosphere through the stack.
On a regular basis, (every 90-120 sec), the flow direction is changed, to ensure heat transfer between the outlet and inlet air as it passes through the ceramic mass.

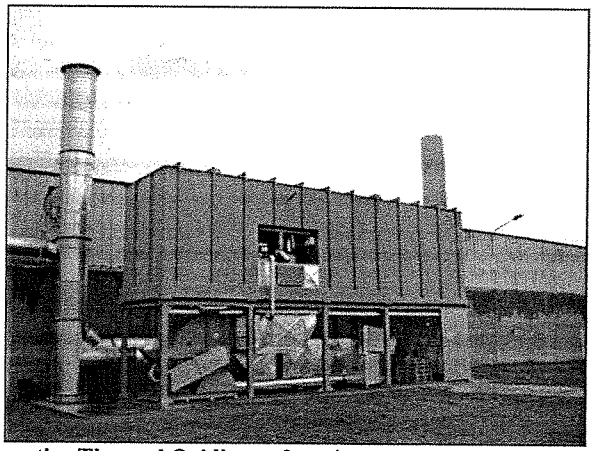
2.5. Purge

To prevent part of air from being released to the atmosphere at each time the direction of flow is reversed, without being completely purified and to increase the purification efficiency, the system is equipped with a buffer tank. This allows any unpurified air to be sent back to the inlet of the plant, by means of a purge circuit.

The plant operation is completely automatic, managed by means of a new generation PLC with a simple user interface.



Regenerative Thermal Oxidizer – 2 canisters



Regenerative Thermal Oxidizer – 2 canisters + compensation chamber

4. UTILITIES

4.1 Regenerative thermal oxidizer

Electric energy	*m.u.*	
Voltage	V	400
Frequency	Hz	60
Phases	#	3
Installed power	kW	35
Adsorbed power	kW	25

Fuel	*m.u.*	
Type	-	Natural gas
LHV	Kcal/Nm³	8,500
Pressure	Barg	100
Max. Flow	Nm³/h	27
Installed thermal power	kW	270

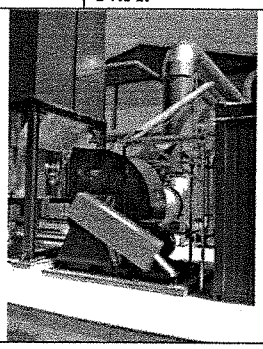
Instrument air (oil free)	*m.u.*	
Flow rate	Nm³/h	5
Pressure min	barg	6
Temperature max	°C	30 max
Dew point	°C	- 25

5. SUPPLY DESCRIPTION

5.1 Suction unit

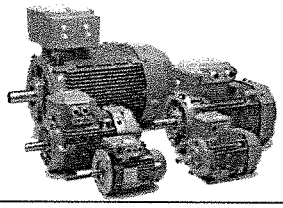
5.1.1 Laden air fan

Quantity	1
Airflow (Nm³/h)	14,500
Operating temperature (°C)	25
Total head (mbar)	-2
Type	Centrifugal
Execution	Direct or transmission coupling
Impeller material	Corten
Shaft material	C40
Case material	Fe36
Ant vibration joint	Included
Noise	80 dBA at 1 m
Painting	According to our standard
Manufacturer	N.A.



5.1.2 Fan motor

Quantity	1
Type	Three-phase, asynchronous
Poles	4
Protection	IP55
Absorbed power (kW)	23
Installed power (kW)	30
Painting	According to our standard
Manufacturer	N.A.



5.1.3 Inverter

Quantity	1
Protection	IP55
Installed power (kW)	30
Manufacturer	N.A.

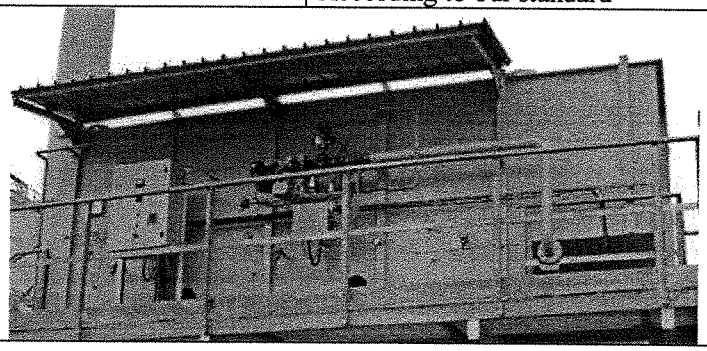
5.2. Reactors unit

5.2.1. Reactors housing the ceramic matrix

Quantity	2
Type	Vertical
Depth (mm)	NA
Length (mm)	NA
Material	Carbon steel
Grid material	Carbon steel
Painting	According to our standard

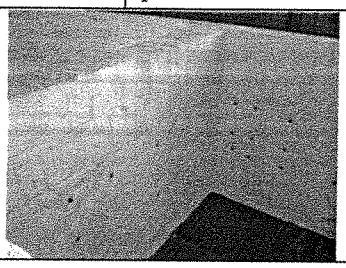
5.2.2. Combustion chamber

Quantity	1
Volume (m^3)	9
Residence time (s)	> 0.6
Operating temperature (°C)	750
Max. Operating temperature (°C)	1,050
Max. mechanical project temperature (°C)	1,250
Material	Carbon steel
Accessories	Manholes
Painting	According to our standard



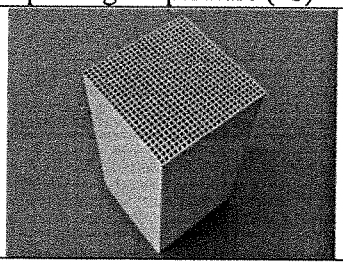
5.2.3. Thermal coating for reactors and combustion chamber

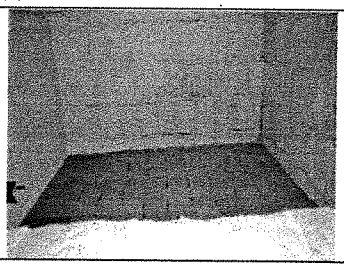
Material	Ceramic fibre
Type	Pre-compressed module
Thickness (mm)	≥ 200
Density (kg/m³)	≥ 160
Project external temperature (°C)	<+40 over ambient temperature
Ambient temperature (°C)	20
Wind speed (m/s)	1



5.2.4. Ceramic packing

Quantity (m³)	6
Type	Structured 43x43
Dimensions	150x150x300
Density (kg/m³)	800
Specific surface (m²/m³)	1,000
Max. operating temperature (°C)	1,100





5.2.5. Automatic process valves

Quantity	2
Type	3 ways Poppet
Diameter (mm)	NA
Body material	Carbon steel
Disc material	Carbon steel
Shaft material	Stainless steel
Sealing	Soft
Actuator	Pneumatic
Accessories	Magnetic limit switch
	Solenoid valve with flow regulators
Manufacturer	Brofind

5.2.6. Automatic start-up valve

Quantity	1
Type	Butterfly
Diameter (mm)	NA
Body material	Carbon steel
Disc material	Carbon steel
Shaft material	Carbon steel
Sealing	Metallic
Actuator	Pneumatic
Accessories	Mechanical/inductive limit switch
Manufacturer	NA

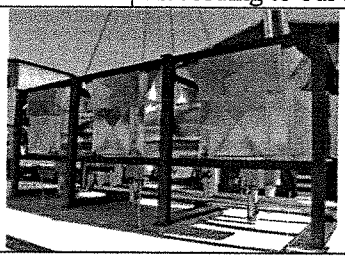
5.2.7. Ducts and steel structures

5.2.7.1 Ducts and piping for the connection of equipment within our scope of supply, with the following characteristics:

LINE	MATERIAL
Inlet SLA ducts	Carbon steel
Outlet purified air ducts	Carbon steel
Buffer tank circuits ducts	Carbon steel
Painting	According to our standard

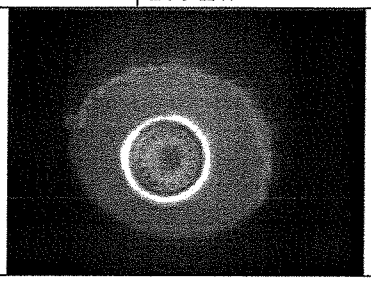
5.2.7.1 Supporting steel structure

Reactors and combustion chamber	Carbon steel
Ducts	Carbon steel
Painting	According to our standard

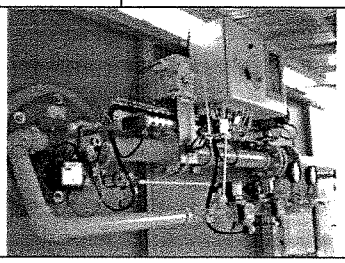


5.3 Burner package

5.3.1. Burner

Quantity	1
Fuel	Natural gas
Accessories	Refractory block
	Flame control sight glass
	Pilot burner
	Ignition electrode
	Flame detection electrode
Manufacturer	NA
Capacity	270 kW
	

5.3.2. Fuel train

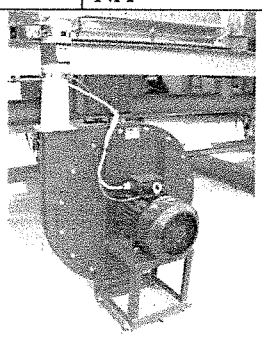
Quantity	1
Fuel	Natural gas
Modulating ratio	1:10
Accessories	Manual shut-off valve, ball type
	Ant vibration joint
	Filter
	Manometer
	Safety and shut-off solenoid valves
	Min. and max pressure switches
	Gas regulation valve
Gas duct	Carbon steel
	

5.3.3. Combustion air train

Quantity	1
Accessories	Automatic shut-off valve, with simple-effect pneumatic actuator
	Regulation valve
	Safety pressure switch
Air duct	Carbon steel

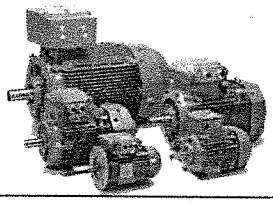
5.3.4. Combustion air fan

Quantity	1
Flowrate (Nm^3/h)	400
Total head (mbar)	65
Type	Centrifugal
Execution	Direct coupling
Impeller material	Carbon steel
Shaft material	Carbon steel
Case material	Carbon steel
Ant vibration joint	included
Noise	80 dBA at 1m
Painting	According to our standard
Manufacturer	NA



5.3.5. Combustion air fan motor

Quantity	1
Type	Asynchronous, three-phase
Poles	2
Protection	IP55
Absorbed power (kW)	NA
Installed power (kW)	NA
Painting	According to our standard
Manufacturer	NA



5.3.6. Burner control unit (BCU)

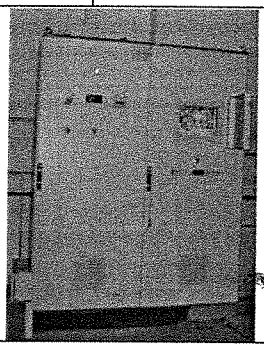
Quantity	1
Accessories	Ignition transformer
	Cabled terminal box
	Flame control

5.4 Instrumentation and power/control equipments

The instruments and control equipment ensure the automatic and safe operation of the plant.

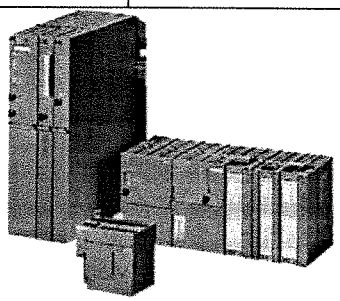
5.4.1. Power board (to be installed on plant skid under a roof)

The board includes the general switch, the variable speed drives, soft starters and all the motors starters.	
Protection	IP55

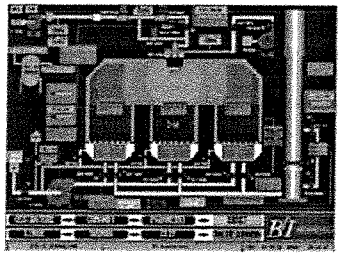
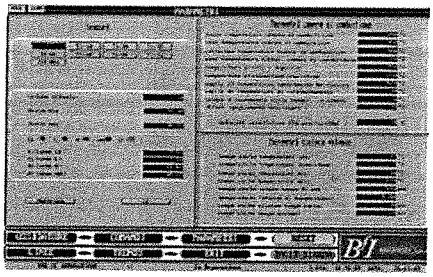


5.4.2. Control board (to be installed on plant skid under a roof)

This board includes the PLC and the suitable SW projected by our "automation dept." capable of operating the plant in a complete automatic way.	
PLC	Siemens S7 300
Software	YES
Software back-up copy	YES
Protection	IP55
Communication protocol	-

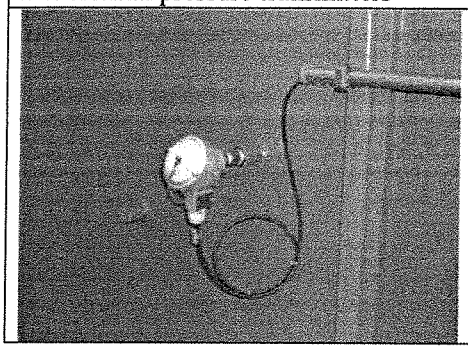
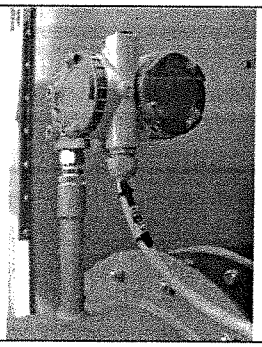


5.4.3. Supervision system and human-machine interface

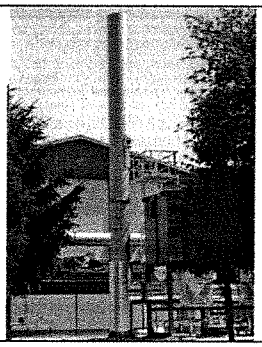
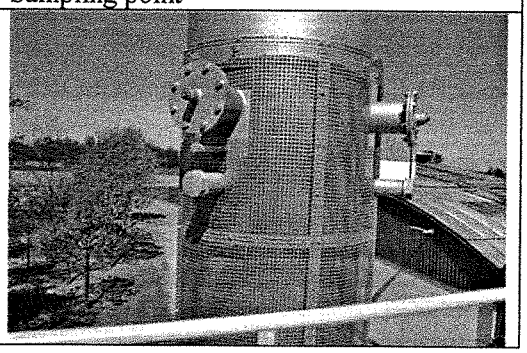
The plant will be controlled by means of a supervision system installed on a desktop PC. Through the supervision system it will be possible to monitor, register and control all plant operating parameters. Through an easy diagnostic of the above graphic pages you will be ready to monitor the correct operation of the plant and to easily identify any failures. All the alarms causing a direct shutdown of the plant will be available for direct submission to your maintenance/supervision staff.	
	
Hardware	New generation panel PC
Operating system	YES
Software	Superflash (Automa)
Monitor	YES
Standard graphic pages	Emissions synoptic
	Oxidizer synoptic
	Burner synoptic
	Commands
	Settings
	Trends
	Alarms
Basic foreseen alarms	blowers fault
	process valves wrong positioning
	High/low temperature in the combustion chamber
	High/low laden air pressure
	High/low combustion air pressure
	High/low laden air differential pressure
	High/low fuel pressure
	low instrument-air pressure
Remote connection	YES (Ethernet)
Switch selectors	Manual mode Automatic mode
Timer	Automatic

5.4.4. Instrumentation

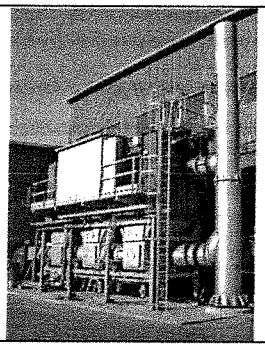
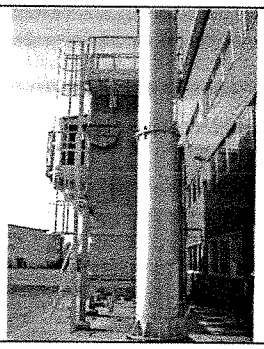
We will provide all instruments required for the control of the equipment within our scope of supply. The main foreseen instruments are:

Temperature transmitters	
Differential pressure transmitters	
	

5.5 Stack for final release to the atmosphere

Quantity	1
Type	Self-supporting
Diameter (mm)	n.a.
Height (m)	8
Material	Carbon steel
Accessories	Sampling point
	

5.6 **Ladders and platforms** for the access to the following maintenance and inspection areas:

Burner	Included
Sampling point at the stack	Included
Material	Galvanized steel
	

5.7 **Mechanical erection**

Mechanical erection includes the assembly of all equipment within our scope of supply. We have included for labour using specialized technicians and for the necessary instruments and equipment.

5.8 **Electric/pneumatic/instrumental assembly and wiring**

Including the supply of the following items:

5.8.1 Cables
- Control cables
- Power cables
- Pneumatic cables and compressed air pipes
- Fibre optics/Profibus cables

5.8.2 Accessories and labour
- Cable trays, railways, conduits
- Junction boxes
- Equipotential connections inside the supplied units
- Specialized labour for the installation of the items above
- Assembly of the supplied instrumentation.

The supply and the installation of the items above is intended for the equipment within our scope of supply.

8. GUARANTEES

8.1 MECHANICAL

All the materials of our supply will be guaranteed for **12** months from commissioning; in any case not beyond **18** months from the advice of dispatch.
Within these limits we will supply EXW, at our charge and as soon as possible all the plant components which prove to be defective due to poor quality or construction failures.
Our warranty will not apply to consumable materials or wear items or to parts damaged by improper operation or negligence.

8.2 PROCESS

Stack TOC concentration will comply with European Rules, calculated as hourly average and with the inlet VOC concentration max indicated at paragraph 3.3:

TOC	≤ 50 mg/Nm³
CO	≤ 100 mg/Nm³
NOx	≤ 100 mg/Nm³

This efficiency is guaranteed in the respect of the operating parameters and the project data.

8.3 APPLICATION CODES, STANDARDS AND REGULATIONS

The plant will be manufactured according to the European codes, standards and regulations in force at the moment of the contract, in particular:

-2006/42/CE	Machinery Directive
-2006/95/CE	Low Voltage Directive (LVD)
-2004/108/CE	Electromagnetic Compatibility (EMC)
-94/9/CE and 99/92/CE	ATEX Directive (if applicable)
-97/23/CE	Pressure Equipment PED Directive (if applicable)
-EN60439	Low-voltage switchgear and control gear assemblies
-EN60204-I	Electrical equipment of machinery
-EN746-I – II	Thermal processing equipments
-EN12753	Thermal cleaning systems for exhaust gas from surface treatment equipment Safety requirements