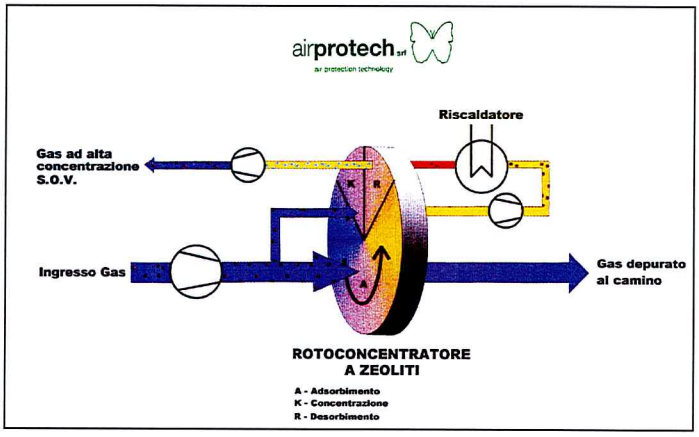
4. PLANT OPERATING PRINCIPLE

The plant consists of two fundamental units:
- pre-concentration unit
- oxidation unit

♦ Pre-concentration unit

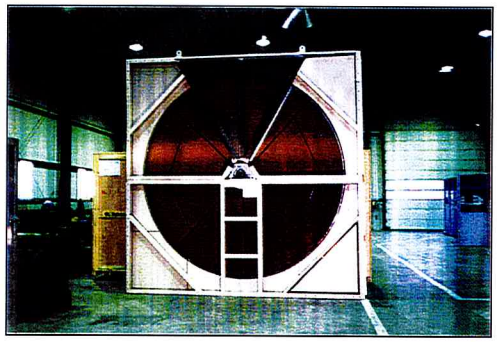
The total air flow rate coming from your departments is conveyed into the pre-concentration unit, composed by a concentrator RC-101, a filtration unit F-101 and a process fan BL-101.

Process air, with V.O.C. concentration is purified by the concentrator RC-101 made of N°1 zeolite rotor. Then the process air is exhausted to atmosphere by means a stack.



The advantage of this process is, consequently, to have a thermal oxidizer very much reduced in size with consequent minimised operating costs.

The rotor, that is the core of the plant, is made of adsorbent active material contained in a rotating structure.



The adsorbent material is made of a ceramic structured support, highly coated with hydrophobic material on which the solvents are adsorbed.

Zeolites offer the great advantage that they are not combustible. Moreover they are inert, very stable, water and acid resistant and can operate at temperatures up to 600°C.

Working principle

The desorption air, which has been taken off before the concentrator, crosses first the rotor and cools the zeolites sector just regenerated and then, after being heated up through a burner B-101, it is admitted to the desorption zone.

The outlet flow at high concentration coming from the concentrator is sent to the regenerative thermal oxidation unit where it is totally purified.

- **Oxidation unit**

The combustion unit consists of a main oxidation chamber with one burner, and two preheating/heat recovery chambers.

The main oxidation chamber consists of a carbon steel main structure, lined ceramic fibre in order to grant the working temperature of 800°C.

The preheating/heat recovery chambers contain ceramic honeycombs and, once running, they function alternately as preheater of gases to be burned and as thermal recuperator of purified fumes.

The polluted air, coming from the pre-concentration unit, is sucked by the centrifugal fan BL-01 and is convoyed to the thermal oxidiser. It alternately crosses the combustion unit R.C.U.C. (Regenerative Combustion Unit Ceramic).

Precisely:

Phase 1/A:
The gas enters in the lower part of the ceramic bed, crosses it from the lower part to the upper part and undergoes a pre-heating phase through contact with the ceramic mass.
Then the gas crosses the oxidation chamber where the thermal oxidation reaction will be completed only if the gases have reached the correct temperature. Otherwise, the oxidation reaction takes place in the oxidation chamber through a fuel fired auxiliary burner.
The temperature in the oxidation chamber is maintained constant through a regulation loop that acts on the modulating valve of the methane.

The regulation ratio of the burner is extremely wide and allows the optimal operation independently from the variations of V.O.C. load.

The released reaction heat is subsequently absorbed by the ceramic mass crossed by gas before it leaves the RTO unit.

Phase 2/A:
At the time of direction inversion of the gas flow, compensation is provided. The gas volume, not already completely oxidised, is diverted through the compensation chamber for a period of about 3 to 4 seconds.

Phase 1/B:
During this phase, the process is the same as already mentioned in phase 1/A. Between a compensation phase and the following, the pollutant gas volume contained in the oxidation chamber is drawn, together with the gas coming from the production, by the centrifugal fan BL-01, while an equivalent "clean" air volume enters in the same. The process continues cyclically until the plant is shut down.

At the exit of the combustion unit, the fumes are united with the air coming from the pre-concentration unit and they are conveyed to the stack.

Besides, the plant is equipped with the following safety devices:
- N°1 thermoelement with regulation loop TIC-04 for the regulation of the intake of the auxiliary fuel for the maintenance of the combustion temperature, with thresholds of high and very high temperature.
- N°2 thermoelements TE-02/03 to note the temperature of the smokes inside the ceramic masses, with thresholds of high and very high temperature.
- fuel feeding ramp realised according to the EN 746-2.

All the temperatures needed (combustion chamber, inlet process air and outlet air) are continuously controlled and partly registered so that the safe running of the plant is always assured.

In case of a malfunction in the plant for which it is required to shut the plant down, the valve KV-101 installed upstream of the system closes automatically and the valve KV-102 opens fully to allow the inlet of ambient air for the purging of the plant.

The total inlet gas flow rate can be regulated by the action of a control loop which will increase or decrease the rotation speed of the process fan BL-101 (**inverter and pressure transmitter**).

5. SUPPLYING DESCRIPTION

5.1. *Process fan BL-101*

for conveying the diluted flow rate to the concentrator

Design flow rate	36.700	Nm^3/h
Static head	240	mm wc
Installed power	55	kW
Motor protection	IP 55	
Regulation	Inverter	
Material:		
Body	carbon steel	
Impeller	carbon steel	
Sound Pressure Level (SPL)	85 dB(A) at 1,5 mt	

5.2. *Filter F-101* for reducing the present dust

The filter will be positioned in the housing with rotor. The box is made of painted carbon steel, with **3 stages** of filtration

- Pre-filter with interchangeable media (class G4)
- Rigid bag filters (class F9)
- Rigid bag filters (class F9)

5.3. *Rotorconcentrator RC–101* for V.O.C. adsorbing

Flow rate	40.000	Nm^3/h
Inlet concentration max	305	mg/Nm^3
Inlet temperature	20	°C
Outlet temperature	23	°C
Outlet C.O.T. concentration	20	mgC/Nm^3
Cooling air flow rate	4.000	Nm^3/h
Min cooling temperature	116	°C
Desorption air flow rate	4.000	Nm^3/h

Max desorption temperature (inlet)	200	°C
Max desorption temperature (outlet)	abt. 43	°C

This unit is made of painted steel solid which contains:
- plenum inlet process gas
- adsorption chamber with N°1 zeolite rotor complete with rotation system (0,37 kW)
- N°1 desorption sector
- N°1 cooling sector
- plenum outlet process gas
- insulation, flanges and piping required

Dimensions of the cassette	2.750 x 2.390 x 2.850 H	mm

5.4. ***Combustion unit*** made of carbon steel, composed by:

- Oxidation chamber dimensioned to grants a residence time in the combustion chamber of 0,6 seconds at 800°C.

- N. 2 recovery chambers with ceramic packing:

  Packing type structured

  The choice of the packing type and quantity grants a thermal recovery efficiency of 96 %.

- Thermal insulation with ceramic fibre

Isolation thickness	200	mm
Density	150	kg/m³

  This isolation type grants a wall temperature <60°C with outside air temperature of 20°C and wind speed of 0 m/s.

- N. 2 poppet valves pneumatic piston-operated made of carbon steel with:
  - acting actuators with command electro valves
  - two proximity switches
  - position's indicator

  The mechanism of these valves has been designed to resist to continuous loads (open/closed).

- service walkway for the access to the burner and the sample intakes (UNI normative), complete of ladder.

5.5. ***Compensation chamber*** made of carbon steel, in order to accumulate not completely oxidized gases during the direction inversion.

5.6. ***N°1 Burners B-101*** for desorption air heating

Type	line burner	
Fuel	natural gas	
Max capacity	185	kW

5.7. ***Burner B-01*** dimensioned to reach and keep the temperature of the oxidation chamber and composed by:

- combustion head with pilot burner
- sight glass port
- ignition road
- refractory block and SS 310 external sleeve
- flame detection with U.V. cell
- ignition transformer
- electrical board (waterproof), IP 54 with alarm circuit and emergency button
- air/gas valve with electrical regulation actuator and positioner 4-20 mA
- fuel feed ramp realised according to the EN 746-2

Max capacity	117	kW
Fuel	natural gas	

This burner type grants the operation at high temperature, where an elevated uniformity is necessary without located overheatings.

5.8. ***Process fan BL-01***

Design flow rate	4.300	Nm^3/h
Static head	590	mm wc
Installed power	18,5	kW
Motor protection	IP 55	
Material:		
Body	carbon steel	
Impeller	carbon steel	
Sound Pressure Level (SPL)	85 dB(A) at 1,5 mt	

5.9. *Combustion air fan BL-02*

Design flow rate	135	Nm^3/h
Static head	550	mbar
Installed power	2,2	kW
Motor protection	IP 55	
Material:		
Body	carbon steel	
Impeller	carbon steel	
Noise	85 dB(A) at 1,5 mt	

5.10. *Piping, valves and stack*

- N. 2 start-up wafer butterfly valves KV-101 and KV-102, N. 1 for combustion air KV-04;
- N°2 wafer butterfly valves KV-04 and KV-05 for convoying air to the stack or to the compensation chamber complete with actuator.
- Ducting for connection in carbon steel complete with expiation joints;

Piping and manual valves will be supplied where they are necessary.

5.11. *Stack*

The supplying will be complete with a stack with sample intakes.

Diameter	1.280	mm
Material	galvanized carbon steel	
Height	10.000	mm

5.12. *Insulation*

The insulation of the plant will be furnished where it is necessary, by means of mineral wool and sheet aluminium to finish.

5.13. *Painting*

Combustion unit and compensation chamber
* degreasing and brushing cycle
* polyurethan primer thickness 50 micron
* polyurethan coating layer total thickness 60 micron

Service walkway and ladder
* hot galvanizing

5.14. *Instrumentation*

We will supply the whole instrumentation to working order of plant, it includes:
- N. 6 thermoelements
- N. 1 pressure switch compressed air
- N. 1 pressure switch combustion air
- N. 1 pressure transmitter
- N. 1 temperature recorder

5.15. *Instrument/electric board and relative plant*

The plant will be controlled completely automatically by means of a programmable microprocessor. The board contains all the equipment needed for piloting both utilities and the indicated instruments. In particular, every utility is protected by fuses or equivalent systems. Start and stop controls can be manually operated for each utility, while utilities will be controlled automatically by the microprocessor and/or by the instrumentation concerned. Every utility has a red pilot lamp for the running. The board is equipped with a general ammeter, a general voltmeter, and a general switch with door locking.

The plant automation system will be complete with:
- PLC
- Operator panel

6. DOCUMENTATION

The supplying will be in accord with the section 5.

About the engineering of the plant, this will be carried out according to the criteria considered suitable and sufficient by air**protech** on the base of its own needs and experiences in analogous plants.

At the plant start, the customer will receive an instruction handbook including:

- technical notes of the instrumentation and equipment
- lay-out
- P&I diagram

Battery limits:

Polluted air

- at filter F-101

Natural gas

- at the valve located on the fuel train

Compressed air

- from the above mentioned valve (at customer charge) located to the geometrical limit of the plant.

The control cabinets have to be positioned in a safety and protected area. Their feeding will be at customer charge.

Our supplying will include electrical-instruments connections between instrumentation and control cabinet before a distance of 10 meters.