# 2. INTRODUCTION

## 2.1. General

This offer is relative to the equipment engineering supplying, the assembly for the realisation of the "**turn key plant**" as under mentioned.

In particular, our supply will include:
- process, basic and detail engineering
- equipment: all the necessary equipment for the plant realisation
- assembly
- erection on site (mechanical and electrical) – *only supervision*
- commissioning and start-up activities
- training activity

The supplying and the battery limits are described in the following sections.
The characteristics of the supply will be in accord to the normative in force and to the "Machine Directive".

The supplying and the battery limit are following described.

## 2.2. Clarifications and deviations

1. **Certification.**
   - air**protech** is ISO 9001:2015 certified.
   - Declaration of conformity CE.
   - UKCA where it is possible, however the European Directives are applicable until 31st December 2024.
2. **Standard and Codes.**
   - The plant object of the supplying has been projected for the application in zone defined in the following way according to the **ATEX norm 2014/34/UE**:

| | |
|---|---|
| **Inside of the pipeline** | **Not hazardous area** |
| **Installation area** | **Not hazardous area** |

*The classification must be confirmed by Customer.*

   - Appendix 5_UKBIC Controls Design and Build Standards.
     With reference to UKBIC Specification, the preliminary list of deviations from air**protech** supply is reported inside document **13601LET02**.

3. **Plant design.**
   The proposed plant is a Regenerative Thermal Oxidizer plant at three chambers (**RTO 3CC**) plant, suitable to treat a DESIGN flow rate of 5.300 Nm³/h with V.O.C.

   The plant has been designed in order to treat the process gas flow coming from the two (2) coating line in standard maximum conditions simultaneously working.

   As a matter of good engineering and design practice of the RTO plant, the maximum V.O.C. concentration at the inlet of the plant should be < 7 g/Nm³.
   According to the V.O.C. load coming from coaters and in order to ensure this condition, the abatement system will be designed as follows:

| | Load of V.O.C. *Maximum Standard Conditions* | Concentration of V.O.C. | Flow rate |
|---|---|---|---|
| MACHINE N°1 | 15 kg/h | | |
| MACHINE N°2 | 22 kg/h | | |
| | **37 kg/h** | **7 g/Nm³** | **5.300 Nm³/h** |

   For safety reasons, to be able to manage the system in case of fault conditions (V.O.C. concentrations > 7 g/Nm³), the **by-pass system** has to be installed.
   The by-pass system consists of N.1 control valve KV-103 and the interconnecting piping to convoying air directly to atmosphere.

   Due to the very low emission limits of N-methyl-2-pyrrolidone (NMP), the plant is finished with a **catalytic system** involved in the oxidation of the residual NMP from first combustion.

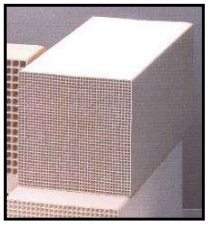
4. **NOx abatement.**
Considering the presence of N-methyl-2-pyrrolidone (NMP) in the process air, during the combustion some NOx are produced. So, after RTO, it is necessary to install a Selective Catalytic Reactor (**SCR)** unit in order to keep the NOx value under the emission limit required of 100 mg/Nm³. ***– option***

5. **Utilities adjustment.**
As per Your request it is separately quoted the price for a gas booster.

*Connections of the gas booster are excluded from air**protech** supply.*

6. **Ceramic materials.**
Inert material mass that is able to accumulate heat and release it in a successive phase.
Thanks to the ceramic materials, it is possible to recover up to 96% of the heat produced from the V.O.C. oxidation reaction and the support fuel and it is possible to reduce drastically the plant operating costs.

Ceramic packing:
- Type **Structured (HONEYCOMB)** stackable bricks that ensure easy movement of the same



- High surface
- Low pressure drop
- Compactness of the beds
- Resistant at the thermal shock
- Thermal recove ry efficiency **≥ 96%**.

- Type **Random Material (SADDLES)**
- More turbulence
- Low costs

7. **Gi-tech system.**
The offered plant is the up-to-date solution of RTO referred to the energy cost saving. It has a very high efficiency of thermal recovery (≥96%) given by the use of the best ceramic materials on the market and it is equipped with the **gi-tech system**. The gi-tech system allows you to shut off the burner when you are running at process conditions (since the burner is used only during the pre-heating phase) and consequently you switch off the air combustion fan needed by the burner once reached the working temperature in the combustion chamber.

8. **Hot by-pass system.**
Considering the V.O.C. high concentration, the plant could be completed with a hot by-pass automatic system of ceramic bed, to avoid very high temperature in combustion chamber. A modulating valve TCV-06 allows to divert a part of purified air from combustion chamber directly to the stack, bypassing the ceramic bed.

9. **Heat recovery.**
   The RTO plant is completed with an air/air heat exchanger HE-02 (***option***) in order to produce hot air to be sent to dryers, using purified fumes coming from combustion chamber.

10. **Remote control.**
    RTO plant can be equipped with remote monitoring system to supervise the operating parameters from remote to support Customers in their daily operations, to enhance troubleshooting detecting eventual malfunctions as soon as the first appearance, to prevent possible failures or damages, minimize unexpected shutdowns or process interruptions, ensure the maximal availability of machinery and plants.

11. **Airprotech is the direct manufacturer of the plant.**
    In-house design and fabrication of equipment and plants to guarantee the best performances and highest quality standards.
    Production processes and flows are optimized to ensure efficient project management and reduced lead time.

12. **Plant Geometry.**
    The **preliminary and indicative** data for plant installation could be approx.:

    Footprint dimensions: **20.000 x 10.000**[1] **mm**

    In any case, relating to the plant geometry, we underline that air**protech** is the direct manufacturer of the plant; this is why, following the Customer needs, we are available to study an alternative solution.

[1] Also considering the SCR unit (***option***) inside the footprint dimensions evaluation.

## 2.3. Supply list

| Description | Included | Option | Exclusion |
|---|---|---|---|
| Process, basic and detail engineering | ● | | |
| F.I.D. analyser | | | ● |
| By-pass system[2]:<br>- Valve KV-103<br>- Emergency stack | | ● | |
| Combustion unit | ● | | |
| Gas booster | | ● | |
| Connections of gas booster | | | ● |
| Burner and gi-tech system | ● | | |
| Process air fan complete with inverter | ● | | |
| Combustion air fan | ● | | |
| Hot by-pass | ● | | |
| Connection pipes and valves | ● | | |
| CT system | ● | | |
| Heat exchanger | ● | | |
| Burner for CT system | ● | | |
| Mixer and SCR system | | ● | |
| Dosing unit | | ● | |
| Tank for reagent | | | ● |
| Air/air heat exchanger HE-02 | | ● | |
| Fresh air circuit | | | ● |
| Stack | ● | | |
| Insulation | ● | | |
| Painting | ● | | |
| Instruments | ● | | |
| NOx analyser | | ● | |
| Electrical board with PLC | ● | | |
| Second HMI *(only material)* | ● | | |
| Remote control | ● | | |
| Skids | ● | | |
| Assembly in our workshop | ● | | |
| Packaging | | | ● |
| Transport | ● | | |
| Erection on site | | | ● |
| Supervision to erection on site – *Mechanical & electrical* | ● | | |
| Commissioning and start-up activities | ● | | |
| Training activity | ● | | |

[2] We assume a positive pressure of the process gas at the safety by-pass valve.

| | | | |
|---|---|---|---|
| Documentation | ● | | |
| Participation to HAZOP study | | | ● |
| Additional soundproofing | | | ● |
| Lifting equipment as crane truck, platform, forklift etc, stairs and scaffolding | | | ● |
| Intake line from production department | | | ● |
| Utility connections beyond the battery limits | | | ● |
| Grounding ring and relative connections | | | ● |
| Civil engineering and relevant foundations | | | ● |
| All civil works | | | ● |
| Foundation | | | ● |
| Fire-fighting system | | | ● |
| Plant lighting | | | ● |
| Analysis and performance test done by an external and certified laboratory | | | ● |
| Spare parts and consumables | | | ● |
| Import and duty taxes, insurance and custom duty | | | ● |

# 3. PROJECT DATA

- **Inlet conditions**

| | | |
|---|---|---|
| **DESIGN flow rate** | **5.300** | **Nm³/h** |
| Temperature | 130 | °C |
| Water content | abt. 12 | g/kg$_{d.a.}$ |
| Pollutants | ***Benzyl alcohol – 100%***<br>L.H.V. = 8.190 kcal/kg<br>or<br>***N-methyl-2-pyrrolidone (NMP) – 100%***<br>L.H.V. = 7.120 kcal/kg | |
| Inlet V.O.C. load MAXIMUM | 37 | kg/h |
| Inlet V.O.C. concentration MAX. | 7 | g/Nm³ |
| Dust inlet concentration | Absent | |

- **Outlet conditions**

| | | |
|---|---|---|
| Max flow rate | abt. 5.350 | Nm³/h |
| Temperature | 195÷295 | °C |

| | | |
|---|---|---|
| **T.O.C.** concentration max | **20** | **mgC/Nm³** |
| **NOx (as $NO_2$)** concentration max | **100**[3] | **mg/Nm³** |
| **CO** concentration max | **100** | **mg/Nm³** |
| **NMP** concentration max | **1** | **mg/Nm³** |

[3] Only with the installation of the SCR unit (***option***).

- **Utilities**

**Electric energy**

| | | |
|---|---|---|
| Voltage \ phases \ frequency | 400V \ 3f + N \ 50 Hz | |
| Installed power | 31,5 | kW |
| Absorbed power[4] | abt. 19 | kW |

**Combustible** *(Natural gas)*

| | | |
|---|---|---|
| Pressure | 250 | mbar |
| L.H.V. | 8.300 | kcal/Nm$^3$ |

| Pollutants | *Benzyl alcohol* | *NMP* | |
|---|---|---|---|
| **BURNER B-01 – RTO unit:** | | | |
| Max. flow | abt. 20 | | Nm$^3$/h |
| Without solvent | abt. 10 | abt. 10 | Nm$^3$/h |
| With solvent 7 g/Nm$^3$ | 0 | 0 | Nm$^3$/h |

| **BURNER B-02 – CT unit:** | | | |
|---|---|---|---|
| Max. flow | abt.13 | | Nm$^3$/h |
| Without solvent | 0 | 0 | Nm$^3$/h |
| With solvent 7 g/Nm$^3$ | 0 | abt. 4 | Nm$^3$/h |

**Compressed air**

| | | |
|---|---|---|
| Pressure | 6 | bar(g) |
| **Dew point** | **-20** | **°C** |
| Max flow RTO (for max. 3sec) | abt. 25 m³/h @ 6 bar(g) | |
| Consumption | abt. 15 m³/h @ 6 bar(g) | |

[4] At the battery limits, without considering 100 mm w.c. at your disposal for piping, 200 mm w.c. for the SCR system (***option***) and 50 mm w.c. for the air/air heat exchanger HE-02 (***option***).

# 4. PLANT OPERATING PRINCIPLE

The plant consists of two fundamental units:

- RTO plant
- CT unit

♦ **RTO plant**

The plant is a **three chambers system** with regenerative thermal recovery on ceramic beds.
The ceramic packing accumulates the thermal energy of the purified air leaving the combustion chamber and uses it back during the following phase for heating the polluted air entering the plant.
The main oxidation chamber consists of a carbon steel main structure, lined ceramic fiber in order to grant the minimum working temperature.
The oxidation chamber has been designed to grant a minimum residence time of 0,6 seconds at the minimum operating temperature of 800°C.

This temperature is kept steady and even in the whole combustion chamber by means of the modulating valve placed on the fuel feed and controlled by temperature regulator.
At this temperature, the C.O.V. are oxidized to $CO_2$ and $H_2O$.

**The presence of three chambers allows a continuous operation without the transient phase which is peculiar to the two chamber systems.**

The chambers will operate as follows:

1st chamber : as **pre-heater** of the inlet air

2nd chamber : as **heat recuperator** from the air leaving the combustion chamber

3rd chamber : for **washing phase** with clean air

The switching between the different phases takes place about every 120 secs by means of special valves placed under the combustion unit forming the body of the combustor.

*Operation cycle description*

Polluted air coming from your departments is sucked in by the process fan BL-01 and it is convoyed to the lower part of the combustion unit from where goes to chamber A.
In chamber A, air is warmed up and V.O.C. are oxidized.
After leaving the chamber, air passes through the combustion chamber whose temperature is kept steady by means of the burner B-01 and regardless from the solvent concentration.
Air leaves then the combustion chamber and passes through chamber B in which it gives up some of its heat to the ceramic bed and cools.
Cleaned air leaves chamber B.

In the meantime, the third chamber (C) is undergoing the washing phase so that, during the following cycle, the cleaned air leaving the combustion chamber can pass through it without dragging not oxidized V.O.C. to the atmosphere.
During this phase, the fresh air can enter chamber C.
This air leaves the combustion unit from chamber B along with the process air.
The total air volume leaving the combustion unit is sent to the SCR unit.

The three chambers will alternate cyclically in the different phases allowing in this way the continuous operation of the plant.
Besides, the plant is equipped with the following safety devices:

- N.1 thermoelement TE-01 for measuring the process gas inlet temperature
- N.6 thermoelements TE-02A/B/C, TE-03A/B/C for measuring the temperatures inside the ceramic beds
- N.2 thermoelements TE-03A, TE-03B/C for measuring the temperatures inside the oxidizer, with thresholds of high and very high temperature
- N.1 regulation loop TIC-average 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.1 thermoelement TE-04 for measuring the process gas outlet temperature
- fuel feed ramp realized according to the EN 746-2.
- secondary fuel feeding ramp **(gi-tech).**

**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.**

After the preheating phase, the working temperature in combustion chamber is keep constant with a device that permits to feed the natural gas directly in combustion chamber **(gi-tech),** avoiding the use of combustion air.

In case of a malfunction in the plant which requires the plant shut 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 inlet gas flow rate can be regulated by the action of the control loop which will increase or decrease the rotation speed of the process fan BL-01 (**inverter and pressure transmitter**).

The plant will be completed with a **hot by-pass** automatic system of ceramic bed, in order to avoid very high temperature inside the combustion chamber. A modulating valve TCV-06 allows to divert a part of purified air from combustion chamber directly at the output of the RTO, by-passing the ceramic bed.

♦ **CT unit**

The fumes coming from the RTO containing the remaining NMP to be abated, are heated up to abt. 300°C thanks to a heat exchanger HE-01 and a burner B-02. The flow passes through the catalytic reactor where the oxidation happens through the catalyst bed (exothermic reaction). During the oxidation, the NMP molecule are transformed in $CO_2$ + $H_2O$ + NOx supplying a quantity of energy in the form of heat that is underlined by a temperature increase proportional to the NMP concentration.

Then the treated air coming from the catalytic unit is sent to the heat exchanger, where it preheats the polluted air and then it is sent in atmosphere through the stack.

♦ **SCR unit** - ***OPTION***

The reducing of the NOx happens through a process of Selective Catalytic Reduction (SCR) with ammonia. In this process, the ammonia is the reducing agent that reacts with nitrogen oxides and transforms them in $N_2$.

The fumes coming from the CT unit and RTO plant containing the NOx to be abated, are heated up to abt. 300°C. Then, the flow passes through the catalytic reactor where the reduction of nitrogen oxides happens through the ammonia dosage.

The catalysis unit consists of an envelope containing a catalytic bed. The chosen catalyst is of the honeycomb type with vanadium as active catalytic component.
The units are covered by insulating material with a thickness sufficient to contain the losses of heat towards the outside.
On the catalytic bed, the air comes to contact with the catalyst, on which the reduction transforms the NOx in $N_2$ and $H_2O$.

The purified air is sucked by the SCR process is sends to the atmosphere thanks to the stack.

♦ **Heat exchanger** - ***OPTION***

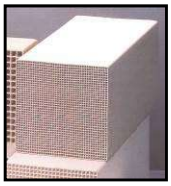
The purified fumes coming from SCR unit are sent to an **air/air heat exchanger HE-02** with the aim of producing hot air to be sent to dryer.

# 5. SCOPE OF SUPPLY

**5.1.** ***Combustion unit*** made of carbon steel, composed of:

- Oxidation chamber designed to allow a residence time in the combustion chamber of 0,6 second at 800°C**.**
- N°3 recovery chambers with ceramic packing:

  Packing type Structured (Honeycomb)



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

- Thermal insulation with ceramic fibre

| | | |
|---|---|---|
| Insulation thickness | 200 | mm |
| Density | 170 | kg/m³ |

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

- N°3 poppet valves pneumatic piston-operated made of carbon steel with:
  - acting actuators with solenoid valves
  - two proximity switches
  - position's indicator

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

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

**5.2.** ***Burner B-01***, designed 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 feeding ramp made according to the **EN 746-2**
- secondary fuel feeding ramp made according to the EN 746-2 **(gi-tech)**

| | | |
|---|---|---|
| Max capacity | abt. 160.000 | kcal/h |
| Fuel | *Natural Gas* | |

**This burner type allows the operation at high temperature, where an elevated uniformity is necessary without located overheating.**

**5.3.** ***Process fan BL-01***

| | | |
|---|---|---|
| Max flow rate | abt. 5.580 | $Nm^3/h$ |
| Static head[5] | 770 | mm w.c. |
| **Installed power** | **30** | **kW** |
| | | |
| Motor protection | IP 55 | |
| Regulation | by INVERTER | |
| | | |
| Material: | | |
| Body | Carbon Steel | |
| Impeller | Carbon Steel | |
| | | |
| Sound pressure level (SPL) | 85 dB(A) at 1,5 m | |

**5.4.** ***Combustion air fan BL-02***

| | | |
|---|---|---|
| Max flow rate | abt. 210 | $Nm^3/h$ |
| Static head | 600 | mm w.c. |
| Absorbed power | abt. 0,7 | kW |
| **Installed power** | **1,5** | **kW** |
| | | |
| Motor protection | IP 55 | |

[5] At the battery limit, including 100 mm w.c. at Your disposal for piping and 50 mm w.c. for the air/air heat exchanger HE-02 (***option***).

| | |
|---|---|
| Material: | |
| Body | Carbon Steel |
| Impeller | Carbon Steel |
| | |
| Sound pressure level (SPL) | 85 dB(A) at 1,5 m |

## 5.5. ***Piping and valves***

- N°2 start-up wafer butterfly valves KV-101, KV-102 and N°1 for combustion air KV-04, in carbon steel complete with actuator.
- N. 3 wafer butterfly valves KV-03 A/B/C for washing of chambers, in carbon steel complete with actuator.
- Ducting for connection complete with expiation joints

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

## 5.6. ***Heat exchanger HE-01***

| | | |
|---|---|---|
| Type | Air/air | |
| Max capacity | abt. 55.000[6] | kcal/h |
| | | |
| Hot fumes: | | |
| Flow rate max | abt. 5.300 | Nm³/h |
| Temperature inlet | 300 | °C |
| Temperature outlet | 230÷285 | °C |
| | | |
| Cold fumes: | | |
| Flow rate max | abt. 5.300 | kg/h |
| Temperature inlet | 270÷290 | °C |
| Temperature outlet | 290÷295 | °C |
| | | |
| Material | Carbon Steel complete with insulation. | |

**5.7.** ***Burner B-02*** designed to reach and keep the temperature of the catalytic reduction process and composed by:

- combustion head with pilot burner
- sight glass port
- ignition road
- refractory block and SS 310 external sleeve
- ignition transformer
- flame detection with U.V. cell
- fuel feeding ramp made according to the EN 746-2.
- air/gas valve with electrical regulation actuator and positioner 4-20 mA

| | | |
|---|---|---|
| Max capacity | 131.000 | kcal/h |
| Fuel | *Natural Gas* | |

[6] **HOLD.** *To be discussed.*

## 5.8. ***Catalytic reactor CT-01***

That consists of the following components:

- inlet section
- reactor housing
- outlet section
- catalyst layers

| | | |
|---|---|---|
| Material | AISI 304 | |
| Dimension | 1.300 X 700 X (H) 700 | mm |
| Type of catalyst | Honeycomb | |

## 5.9. ***Insulation***

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

## 5.10. ***Painting***

Combustor unit
* degreasing and brushing cycle
* polyurethane primer thickness 50 micron
* polyurethane coating layer total thickness 60 micron

Service walkway and ladder
* hot galvanized

Skid
* hot galvanized

## 5.11. ***Instrumentation***

We will supply the whole instrumentation to work the order of plant, it includes:
- N°13 thermo-elements
- N°1 pressure switch compressed air
- N°1 pressure switch combustion air
- N°1 pressure transmitter

## 5.12. *Instrument/electric board and relative plant*

The control and electric board **will be installed on the same skid of the RTO plant**; this layout assures the be pre-cabling and pretesting of all the electrical parts already done in airprotech.

The supply includes:
a. Electric cabinet, automation with PLC and operator panel HMI
b. Second HMI panel (*only material*)
c. Electric and instrument connections in our Workshop
d. Remote control

The software for the PLC and operator panel management will be done by air**protech**.

### a. Electric cabinet:

The electric cabinet consists of N°1 modular cabinet, with forced ventilation through roof fan, protection min. IP 54. It is divided in two sections:
- POWER SECTION
- CONTROL SECTION

POWER SECTION:
- General panel switch with fuses
- Fuses for utilities protection
- 400/24 Vdc phase-changing transformer for auxiliary circuits
- Power supply circuit for each utility
- Interconnection terminal board with field-utilities
- Inverter for the regulation of the fan BL-01 rpm
- Emergency stop push button (front panel)

CONTROL SECTION
- PLC **SIEMENS – Fail Safe**
- Operator panel **SIEMENS** (12" TOUCH)
- Alarm and signal lamps
- Manual start/stop selectors (front panel)
- Voltage alarm, general alarm and plant status (front panel)

The plant will be automatically controlled by means of:

- **PLC** installed on the electric board. It is programmable with the same Siemens operating system.

  The PLC is composed of:
  * CPU
  * Digital I/O cards
  * Analogical I/O cards

- **N°1 Operator panel SIEMENS (HMI)**

  The HMI application is the user interface with the entire system; it allows the real-time monitoring of the operating status, of all values, both analogical and digital and of subsequent analysis of trends and alarms. It allows to provide commands to cycles or to single users and to set all the parameters (such as thresholds, delay times, etc.) essential to the proper functioning of the plant.

  In the panel, the graphic pages are organized for the setting of several parameters and for the plant operating conditions' control.

**Data storage (CSV format)**

The panel automatically creates each year/month, a directory in which, every day, a file is created including data sampled every minute. The file is in CSV format and contain the data of the historical information with date, time and value of recorded samples; each measure has its own column of samples.
These files are stored in a USB flash drive included in the supply.

**b. Second HMI:**

The supply will be completed with N.1 additional HMI operator panel (**SIEMENS)**, installed near to Mathis unit.

*The connections and installation of second HMI panel are excluded from air**protech** supply.*

**c. Installation of the electrical system:**

Instrument/electric connections between the electric board and field-utilities and between electric board and field-instruments will be supplied:

- The cables will be FG16 type. All the cabling will be multi conductor that can be shielded, where required, and suitable for the expected ambient temperatures.
- Perforated cable trays will be supplied, complete with cover.
- The pneumatic plant will be realized with aluminium pipes, starting from the valve located at the geometrical limit of the plant, until the utilities.

**d. Remote control by PROFINET**

This system consists in the possibility, from air**protech**, to have a remote access to the operator panel of the plant in order to be able to visualize the plant status, the operating parameters and, eventually, to modify these parameters.

An Ethernet/Internet connection, in the electric board, is required to the Customer.

## 5.13. ***Skid***

All the equipment will be installed on N.2 Skids (Skid-RTO and Skid-CT unit) made of hot galvanized carbon steel.

## 5.14. ***Supervision to erection on site***

air**protech** technicians will be present during the erection activities on Site for the supervision activities.

We provide a preliminary evaluation of the days planned for the erection on site activity; we underline that estimated working times are **strongly influenced by the Site conditions, accessibility of the area available for the installation and ability of Your staff.**

For the erection activity of the total supply, we've considered in a preliminary way (estimate – *including travel and transfer expenses*):

- Mechanical erection: 10 days/man x N°3 technician

*Our staff's services, as indicated above, are intended to be continuous, meant as maximum daily presence of one of our technicians of 10 working hours/day.*

# OPTIONS:

## 5.15. *SCR unit*

The plant will be completed with an SCR system for the NOx abatement.
The SCR unit is composed by:

- **Dosing unit**

| | | |
|---|---|---|
| Dimension | 900 x 600 | mm |
| Protection | IP 54 | |

The dosing unit is composed of:
- Dosing pump
- Magnetic valve, shutdown valves.

**Abatement solution**

| | | |
|---|---|---|
| Ammonia solution | 24,5 | % |

| Pollutants | *Benzyl alcohol* | *NMP* | |
|---|---|---|---|
| **AMMONIA:** | | | |
| Without solvent | 0 | 0 | kg/h |
| With solvent 7 g/Nm$^3$ | 0 | abt. 26 | kg/h |

- **Mixing unit MIX-01**

| | |
|---|---|
| Mixer type | Cross-impulse-mixer |
| Material | Stainless steel AISI 304 |
| Installation direction | According assembling instruction |

- **Catalytic reactor SCR-01**

That consists of the following components:

- inlet section
- reactor housing
- outlet section
- catalyst layers

| | | |
|---|---|---|
| Material | AISI 304 | |
| Dimensions | 1.500 X 1.000 X (H) 1.000 | mm |
| Type of catalyst | Honeycomb | |

- **Instrumentation**

  - N°1 NOx analysers – at the outlet of the SCR system

- **Process fan BL-01.** Extra-cost for a BL-01 process fan with higher installed power.

| | | |
|---|---|---|
| Max flow rate | abt. 5.580 | $Nm^3/h$ |
| Static head[7] | 1.010 | mm w.c. |
| Absorbed power[8] | abt. 26 | kW |
| **Installed power** | **45** | **kW** |
| | | |
| Motor protection | IP 55 | |
| Regulation | by INVERTER | |
| | | |
| Material: | | |
| Body | Carbon Steel | |
| Impeller | Carbon Steel | |
| | | |
| Sound pressure level (SPL) | 85 dB(A) at 1,5 mt | |

## 5.16. ***Heat exchanger HE-02***

| | | |
|---|---|---|
| Type | Air/air | |
| Max capacity | abt. 292.000[9] | kcal/h |
| | | |
| Hot fumes: | | |
| Flow rate max | abt. 5.300 | $Nm^3/h$ |
| Temperature inlet | 270÷290 | °C |
| Temperature outlet | 110÷115 | °C |
| | | |
| Cold fumes: | | |
| Flow rate max | abt. 5.300 | kg/h |
| Temperature inlet | 20 | °C |
| Temperature outlet | abt. 200[7] | °C |
| | | |
| Material | Carbon Steel complete with insulation. | |

## 5.17. ***By-pass system***

The supply will be completed with a by-pass system, composed by:

- N°1 on-off valve **KV -103** (Carbon Steel) complete with actuator.
- Piping in stainless steel Carbon Steel for convoying the air directly to atmosphere.

[7] At the battery limit, including 100 mm w.c. at Your disposal for piping and 50 mm w.c. for the heat exchanger HE-02 (***option***).
[8] ***HOLD.*** To be confirmed after technical discussion.
[9] ***HOLD.*** To be confirmed after technical discussion.

# 6. DOCUMENTATION

The supplying will be in accordance with the section 5.

About the engineering of the plant, this will be carried out according to the criteria considered suitable and sufficient by airprotech on the basis of its own needs and experiences in similar plants.

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

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

**Plant general instructions manual, HMI systems, electrical diagrams and equipment data sheets will be in English.**

**Battery limits:**

Polluted air

- at the valve KV-101

Natural gas

- at the valve located on the fuel train

Compressed air

- from the valve located to the geometrical limit of the plant

Ammonia ***(option)***

- at the pump PD-01

Electric energy

Our supplying will include electrical-instruments connections between instrumentation and control and electrical cabinet located on the same skid.

*The feeding of the control cabinet will be at Customer charge.*

# 7. EXCLUSIONS

Our supply will not include the following items:

- Intake lines from production departments
- Grounding ring and relative connections
- Civil engineering and relevant foundations and estimates
- Utility connections beyond the battery limits
- Lifting equipment as crane truck, platform, forklift etc, stairs and scaffoldings
- All civil works
- Plant lighting
- Fire-fighting system
- Foundation
- Spare parts and consumables
- F.I.D. analyser
- By-pass system ***- option***
- Gas booster ***- option***
- Gas booster connections
- Packaging
- Analysis and performance test done by an external and certified laboratory
- SCR unit ***- option***
- Tank for reagent
- Air/air heat exchanger HE-02 ***– option***
- Fresh air circuit
- Connections of second HMI
- Erection on site
- Participation to HAZOP study
- Additional soundproofing
- Insurances and custom duty
- Import and duty taxes
- Custom clearance
- **Anything else which isn't expressly described in this offer.**

# 8. COMMISSIONING AND START-UP

Preliminary test and test run will be carried out by our skilled workers, unless differently specified in section 7.

## 8.1. *Preliminary test*

By "preliminary test" we mean the checking of the correct operation of the equipment, of all the instruments and all the valves that compose the plant and, in addition, the calibration of the instruments themselves.

## 8.2. *Test run*

By "test run", we mean the checking, during operation of the plant, of the data included in section 3 or, if different, previously accepted by air**protech**.
This test will have to be carried out soon after the positive issue of the preliminary test.

For commissioning & start-up activities, we have considered: **N°12 days**.
(*Included journey times*)

Our staff's services, as indicated above, are intended to be continuous, meant as maximum daily presence of one of our technicians of 10 working hours/day.

If a protracted presence of our staff were needed, owing to causes not depending on us, this extension would have to be paid to us according to ANIMA TARIFFS for foreign countries, with reimbursement of expenses on the base of our list.

*If a report of the conformity established by a qualified organization is required, this is at Customer charge.*

## 8.3. *Training activity*

The training of personnel will be performed during the test run phase by the members of our staff.

For training activities, we have considered: **a maximum of N°4 working hours.**

# 9. GUARANTEE

## 9.1. *Working guarantees*

| | | |
|---|---|---|
| **T.O.C.** concentration max | **20** | **mgC/Nm$^3$** |
| **NOx (as $NO_2$)** concentration max | **100**[10] | **mg/Nm$^3$** |
| **CO** concentration max | **100** | **mg/Nm$^3$** |
| **NMP** concentration max | **1** | **mg/Nm$^3$** |

## 9.2. *Manufacturing guarantees*

air**protech** guarantees every part of the plant against design and manufacturing defects for **24 months from the date of material delivery**.
The warranty does not cover normal wear and tear as well as parts subject to regular wear and tear, and does not cover defects arising from improper use, lacking maintenance, or caused by surrounding systems. The presupposition for this warranty is that the plant is operated within the design operating conditions and has not been modified or tampered with from its original design.
In case of delivery of spare parts or other remedies of defects during the warranty period, the warranty period for replaced or repaired parts starts anew but ends with the contractually stipulated length of the warranty of the total scope of supply.
The warranty terms referred to in this document include, except where expressly stated: EXW's delivery of defective and/or warranted parts.
The parts to be replaced or repaired in guarantee shall be available free of charge at your disposal at our works.
To facilitate plant availability, air**protech** strongly suggests purchasing the recommended spare parts and making them available at the yard.

[10] Only with the installation of the SCR unit (***option***).