Termomeccanica Industrial Process

Termomeccanica Group

RTO Regenerative Thermal Oxidizers

Rev 2020

Process Description

The Regenerative Thermal Oxidizer (RTO) is a thermal treatment of exhaust process gas for pollutant removal before the ambient emission.

The system is a type of thermal oxidizers that uses a bed of ceramic material to absorb heat from the exhaust gas. It then uses this captured heat to preheat the incoming process gas stream and destroy air pollutants emitted from process exhaust streams at temperatures ranging from 800 °C to 950 °C.

The Regenerative Thermal Oxidizer (RTO) utilizes the thermal power of the pollutants contained in the exhaust waste air for the combustion process. The thermal energy, which is produced during combustion, is recovered and used to heat the incoming exhaust air.

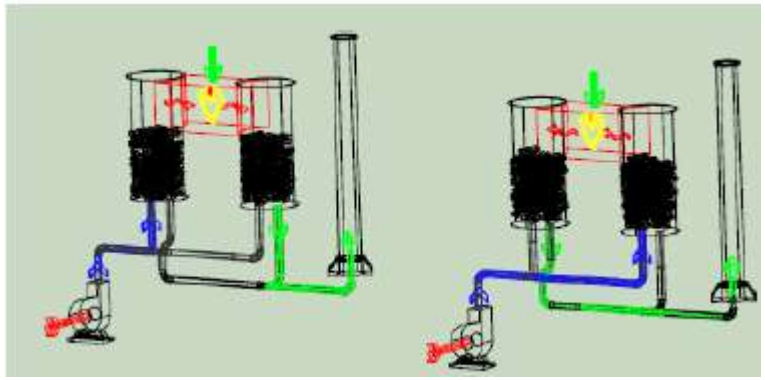
The oxidizer utilizes a fuel gas burner for system start-up and for heat integration if the VOCs concentration is low.

Diverting valves allow the process airflow to be diverted into and out of the oxidizer in either a clockwise or counter-clockwise mode.

Heat Recovery Ceramic Media

TMIP Diverting Valves

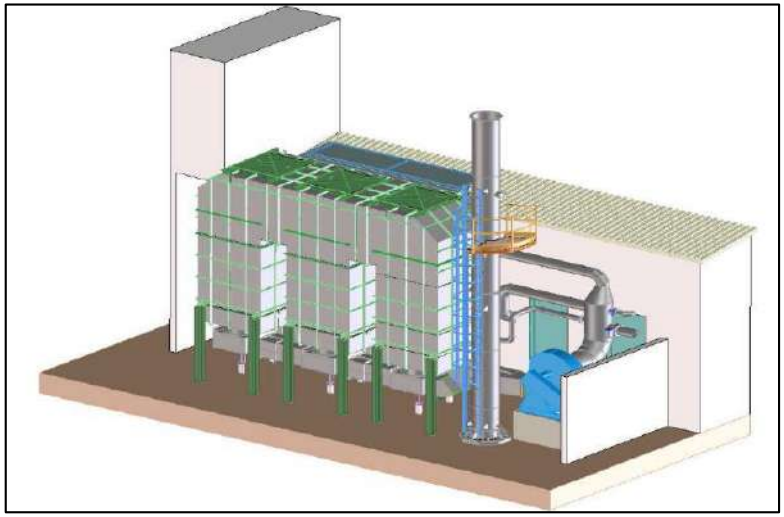
Operative Scheme 2 Canister Configuration



Configuration

RTO can be designed using different number of ceramic media canisters ,depending on flowrate.

At least 2 of these modules are used – one is always absorbing heat from the flue gas and one is always shedding heat into the waste gas. The modules are insulated boxes (canisters) by ceramic fiber filled by heat exchange media. When a chamber has absorbed all the heat it can, it is taken offline and waste gas is sent through it backwards until it is cool again. Once cooled, it is taken offline and hot flue gas is again sent through it. Two chambers are needed so the flue gas always has a path to the exhaust stack. The installation of the third chamber (purging chamber) maximizes the VOC removal and minimizes the flow of untreated air direct to atmosphere during flow reversal. The average cycle time (90-120 s) is depending on the nature and concentration of the contaminants.Typical configurations are shown below but also 7 canisters RTO systems can be provided for large flowrates:



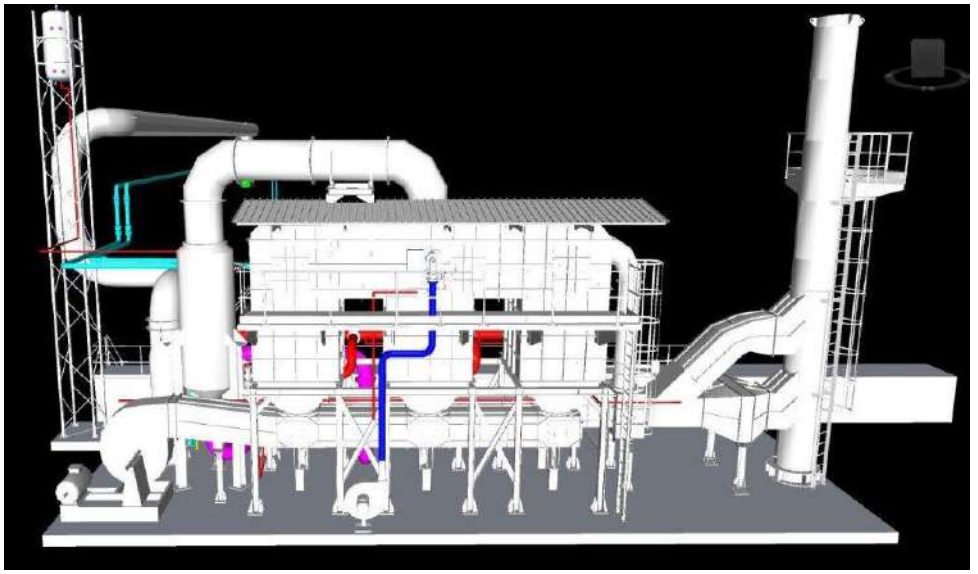
3 Chamber RTO

5 Chamber RTO

RTO cycle (3 canisters type)

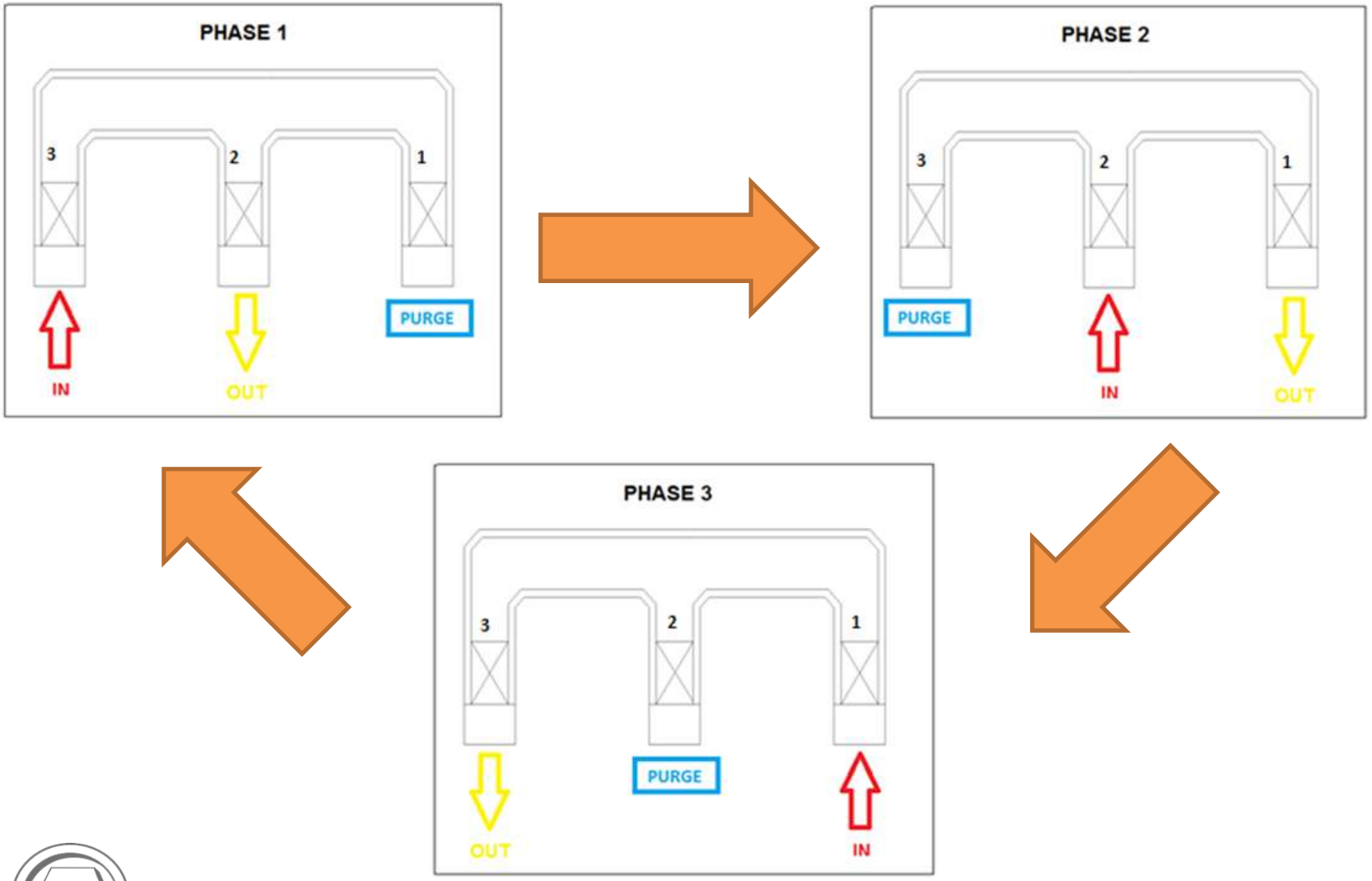
Looking schemes below it is possible understand how RTO is working.

1, 2 and 3 canister are the energy recovery chambers in which are located the ceramic bed media the recovery heat from inlet and outlet process gas stream.



	canister 1	canister 2	canister 3
Phase 1	Inlet	Outlet	Purge
Phase 2	Purge	Inlet	Outlet
Phase 3	Outlet	Purge	Inlet

RTO cycle


PHASE 1
3
2
1
IN
OUT
PURGE
PHASE 2
3
2
1
PURGE
IN
OUT
PHASE 3
3
2
1
OUT
PURGE
IN

Theory of Combustion

RTO Operating Parameters

VOC destruction efficiency is maximized when the thermal oxidation systems are properly designed and operated. The major perating parameters are illustrated as the ‘’ three Ts of VOC destruction”:

Time, Temperature and Turbulence. Additionally, the amount of oxygen affects the rate of oxidation.

Temperature

The operating temperature of the thermal oxidizer affects the level of VOC destruction. Operating temperatures for thermal oxidizers typically range between 760°C to 900°C. The general method of estimating the temperature required for destruction of an organic compound is the corresponding self-ignition temperature (SIT). It is the temperature of a compound above which a flammable mixture will be capable of extracting sufficient energy from the environment to self-ignite. The destruction of compounds with higher SITs is more difficult.

Residence Time

Another factor affecting the destruction of VOCs is residence time, although it does not have the same impact as temperature on VOC destruction efficiency. The typical range for residence times in thermal oxidizers are 0.5 to 2 seconds. A lower residence times correspond to lower destruction efficiencies and vice versa.

The residence time of the RTO unit will be greater than 0.5 seconds.

Theory of Combustion

Temperature will be monitored and recorded by the process monitoring probes installed in the unit. Residence time can then be calculated from the flow rate, combustion chamber volume and temperature measurements.

Turbulence

The turbulence inside the thermal oxidizer ensures good mixing of oxygen and VOCs at the specified temperature. The RTO has been designed to ensure complete mixing and clean combustion.

Oxygen Concentration

The supply of oxygen is through the incoming VOC laden air stream. The oxygen concentration in the exhaust gas from the RTO will be of the order of 20% to 20.5%, close to ambient air concentration. Significant excess oxygen is therefore available to ensure clean and complete combustion of the VOC and no correction for oxygen will be required for defined emission limit values within the Industrial Emission Licence.

Theory of Combustion

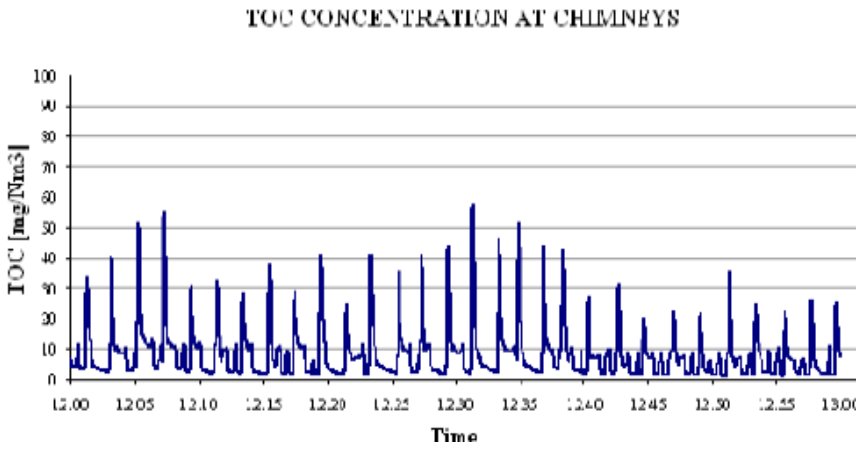
VOC destruction efficiency vs Time and Temperature

Destruction Efficiency DRE %	Degree above SIT (°C)	Residence Time
95	149	0.5
98	204	0.5
99	246	0.75
99.9	288	1
99.99	343	2

Target Emission Value for RTO Exhaust

Pollutant	Typical Perfomance Expectation	Emission Limit	Unit
NOx (as NO_2)	<200	<200	mg/Nm3
SOx (as SO_2)	<50	<100	mg/Nm3
CO	<100	<100	mg/Nm3
TOC*	<20	<50	mg/Nm3

*In according to TA Luft 2002 and therefore stricter than European regulations (< 50 mg/Nm3 according to VOC-directive 1999/13/EC).



Hot-Bypass Damper for RTO

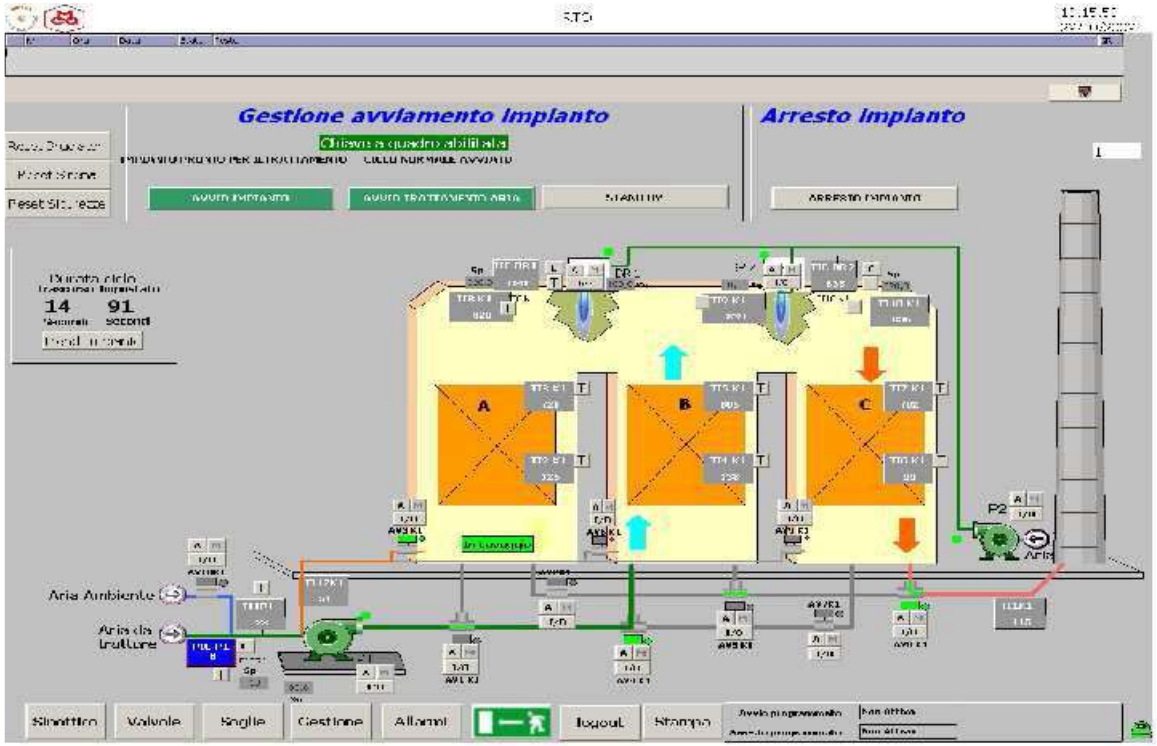
At installations with high thermal efficiency of the heat exchanger, an inadmissible high increase of temperature in the combustion chamber can occur at high solvent concentrations. The installation can therefore be equipped with a "hot bypass". This means that a part of the clean gas is directly routed to the stack without passing the heat exchanger. The necessary clean gas volume is regulated via a special TMIP hot gas damper and a temperature controller.

For safety reasons, the stack temperature has to be monitored.

For continuous high VOC-concentrations of > 2.5 g/Nm³, a hot bypass is necessary in order to handle the high energy input.

Control system

TM.I.P. oxidizers are completed by a control system which permits to manage all the variables in the plant, such as switch times, pressure and temperatures.



The control system is designed to permit real time plant checking.

RTO with heat recovery

In case inlet solvent or organic are over the RTO self sustaining concentration we can provide an heat recovery system to produce hot water or hot oil or steam

RTO with flue gas treatment

In case the RTO treat air or gas contaminated by alogenated or sulphur elements a flue gas tretment section can be installed .
We are able to provide as dry and wet systems .

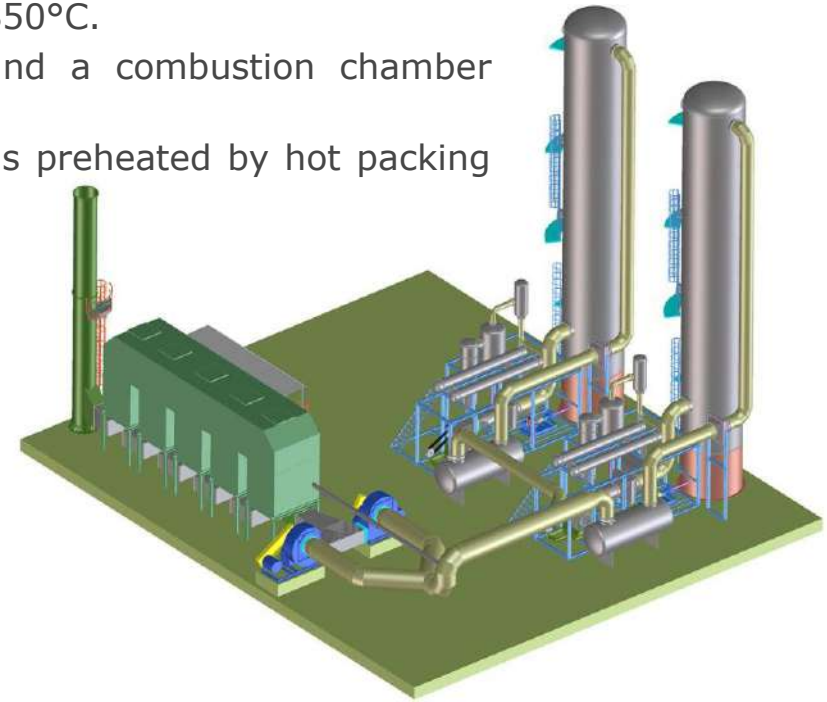
RTO downstream stripping process

Exhausted process air, containing stripped solvent vapours is fed directly to the oxidation system “RTO” (Regenerative Thermal Oxidation) of gaseous stream and vents.

Due to very high heat recovery in RTO system, difference between inlet and outlet temperature of gas doesn’t exceeds 70°C, with a working temperature in combustion chamber of about 850°C.

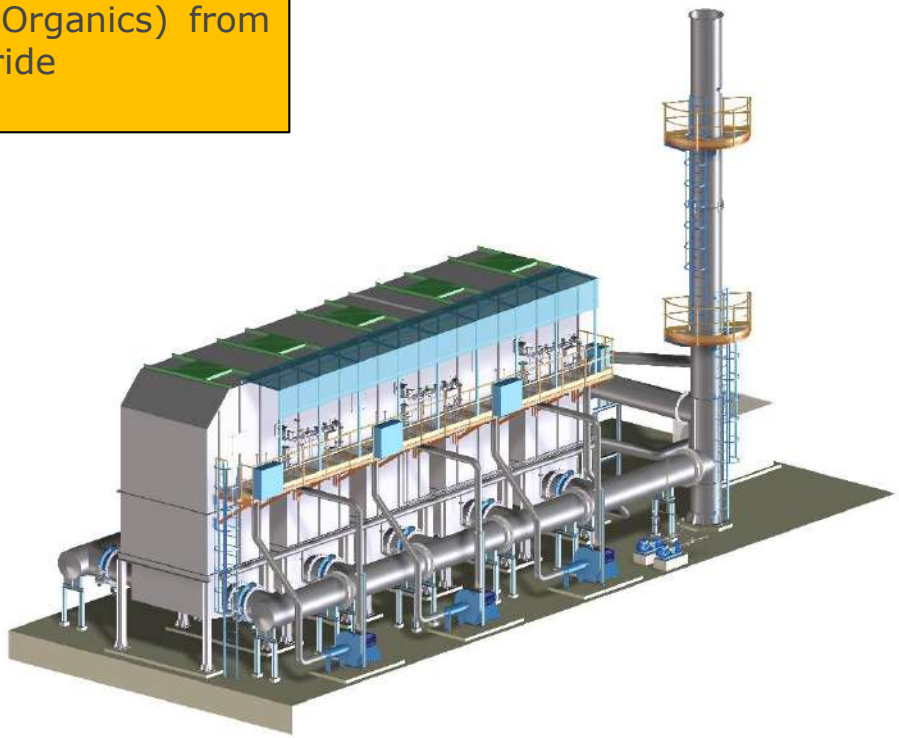
RTO plant consists of three packing beds and a combustion chamber where burned is installed.

Waste gas passes through two beds where it is preheated by hot packing heated during previous cycles.



RTO downstream scrubbing process

- **Process Data**
- **Type**: RTO 5 Canister
- **Source of wastes**: Solvent scrubbing
- **Flow rate**: 75'000 Nm^3/h Air from maleic anhydride production and 1600 kg/h waste liquid (15% Organics) from scrubber of maleic anhydride



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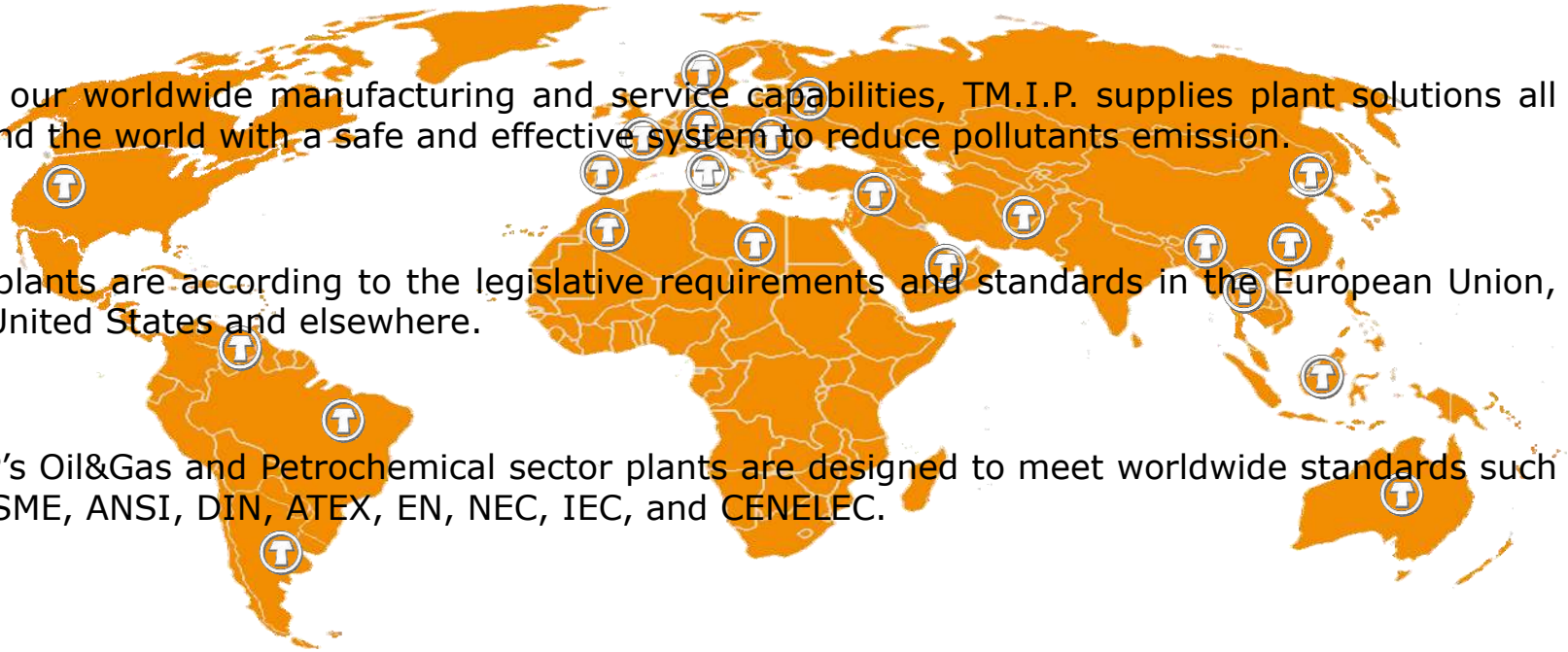

With our worldwide manufacturing and service capabilities, TM.I.P. supplies plant solutions all around the world with a safe and effective system to reduce pollutants emission.

Our plants are according to the legislative requirements and standards in the European Union, the United States and elsewhere.

TMIP's Oil&Gas and Petrochemical sector plants are designed to meet worldwide standards such as ASME, ANSI, DIN, ATEX, EN, NEC, IEC, and CENELEC.

thank you

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