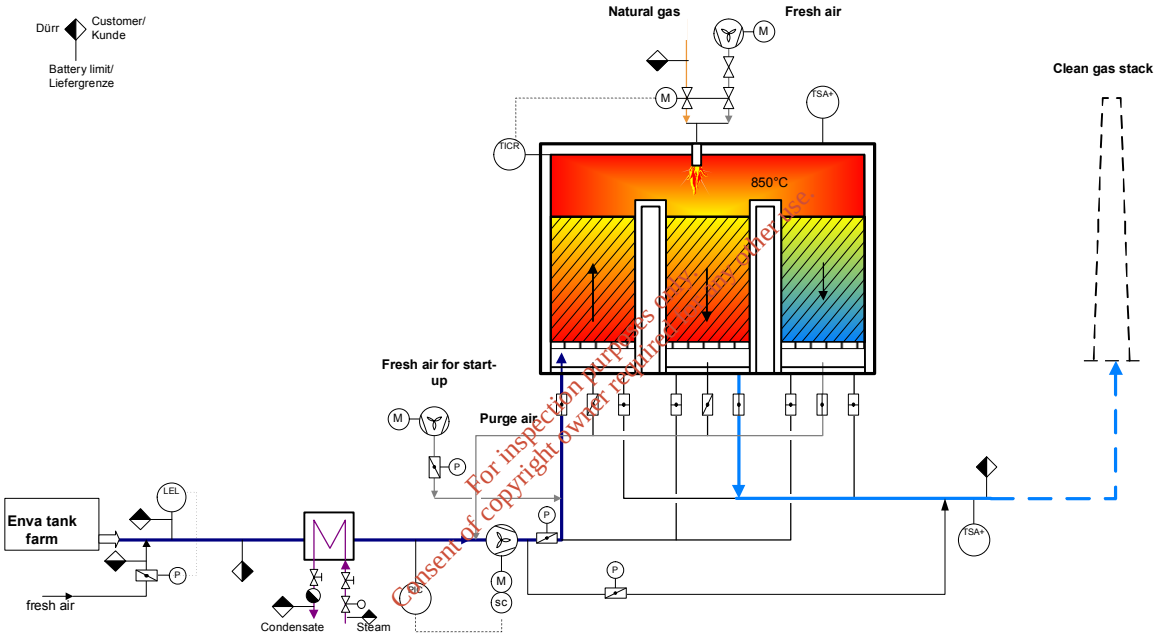
1 Functional description

Regenerative thermal oxidizer
The Regenerative Thermal Oxidizer (RTO) unit comprises essentially of regeneration towers, combustion chamber with burner system and related air ducting system equipped with valves and fan.

The regeneration towers are filled with ceramic packing and clad with an insulation layer to suit the high reaction temperatures involved. The combustion chambers are also clad with fibrous material and link the individual regeneration towers with one another. The burner system is installed at the side for easy accessibility and has a separate connection for combustion air. All necessary monitoring instruments are installed and tested by us at the factory and are connected to the burner via flexible connections.



Ecopure RTO, Poppet valve

The RTO's air ducting system includes ducts for untreated and purified gas with integrated, tightly sealing valves for inlet of exhaust air stream and outlet of treated gas as well as dampers for outlet of purge air. All valves and dampers are installed in easily accessible positions in the lower section of the regeneration tower group.

The warm water-laden airstream from the oil tanks is captured by new ductwork to be installed and delivering the exhaust airstream to an initial preheat step to increase the temperature to over 110°C. This is to ensure there are no aerosols or oil or water droplets in the airstream and prevent condensation and corrosion in the RTO. The preheat step will be facilitated by a heat exchanger with the heat feed being provided by steam from the existing steam raising boiler.

The exhaust air stream is then pushed through the RTO by the fan and led, in sequence, via time-controlled valves to one or other of the regeneration towers. The exhaust air stream flows through the hot heat exchanger material from bottom to top, and is pre-heated in the process where a large part of the hydrocarbons are oxidized. The exhaust air stream is then heated further, as necessary, to its ultimate reaction temperature in the combustion chamber. The burner will provided additional energy (if necessary) to maintain a temperature in the combustion area above 850°C all the time. The hot purified exhaust air stream then flows through the other towers in the group from top to bottom transferring its heat to the ceramic packing.
As is proposed where an RTO is made up of an uneven number of towers, one tower is purged with air before the exhaust air stream is led into it as part of the next cycle. The use of this method, whereby one tower is always in the purge phase, prevents peaks in pollutants in the purified gas stream when the poppet valves are switched from open to closed or vice versa.

The RTO system is started and heated up at a reduced air flow rate by the fresh air fan and by the natural gas burner system. Only fresh air will be used for heat up and shut down of the RTO unit.

The system is especially designed for a high thermal efficiency of the ceramic heat exchanger packing in the 3 towers to reduce the energy consumption during operation to a minimum. Any VOCs in the exhaust air stream provide additional exothermal energy for the oxidation. At a certain level of heat input from the oxidation reaction of the VOCs the natural gas burner system can switch off and the RTO unit operates autothermally without any natural gas consumption.

Certain substances if present in the exhaust air (e.g. silicon) can lead to the formation of dust/deposits in the RTO unit which if not removed can build up and block the ceramic heat exchanger packing over time. The proposed system provides good access for cleaning the ceramic heat exchanger packing when build ups occur in order to reduce the required down time for this cleaning to a minimum.

Safety Measures & Abnormal Operation

As the organic content of VOCs in the exhaust air stream could potentially be above the permitted lower explosion limit LEL value of 25 % LEL, an LEL monitor will be installed in the ductwork to the RTO and if necessary atmospheric air will be added to the exhaust air stream prior to the RTO to ensure that the organic content in the vent gas at the RTO inlet is always below 25% of LEL.

Additionally the system includes a bypass line to feed the exhaust air stream directly to the stack in case of shut down of the RTO or of inadmissible high VOC concentration above 25 % LEL.

Components delivered as pre-assembled sections for fast installation

1.1 Technical data relating to the system

Off gas flow rate – with 6m^3 water vapor at 90°C	approx. 20,000	m³/h
Off gas flow rate – maximum possible at 90°C	24,600	m³/h
Off gas flow rate – minimum at 90°C	4,000	m³/h
Purified gas flow rate to stack – maximum possible at 140°C	30,000	m³/h
Maximum amount of VOCs that can be handled by the RTO	160	kg/h
Exhaust air temperature before pre-heat	90	°C
Exhaust air temperature after pre-heat	> 110	°C
Combustion chamber temperature	850	°C
Purified air temperature at outlet	123 - 140	°C
Required natural gas connection	45	Nm³/h
Natural gas in standby mode – no water being evaporated	6	Nm³/h
Natural gas when > 4 kg/h VOCs/oil and 1m^3/h evaporated water	0	Nm³/h
Natural gas at 20.000 Nm³/h, 6 m^3./h water evaporated and no VOCs	21	Nm³/h
Required electrical power connection	52	kW
Electrical power consumption for fan motors at 20,000 m³/h air flow	48	kW
Compressed air consumption at 6 bar	8	Nm³/h

1.2 Space requirements and weight incl. fan

Plant dimensions		RTO
Length approx.	m	8,0
Width approx.	m	4,0
Height approx.	m	4,8
Weight	kg	33,000

1.3 Emission levels during stable operation

Removal efficiency of organic odours	> 95	%
TOC	≤ 20	mg/Nm³
CO	≤ 100	mg/Nm³
NOx	≤ 200	mg/Nm³

Remarks
Pure gas data based on actual composition of the pure gas and at 1013 mbar.

1.4 Scope of proposed RTO

- RTO unit consisting of 3 canisters in carbon steel 1 combustion chamber with ceramic heat exchanger packing, internal ceramic fibre insulation
- 1 natural gas burner with gas train, combustion air fan, inlet and outlet valves, valve blades in stainless steel 304 with actuators, support grids in temperature resistant steel
- Dampers for fresh air with drive and damper for isolation of exhaust air with drive
- 1 exhaust fan with motor and frequency converter
- 1 combustion air fan with motor
- exhaust air duct in carbon steel and purified air duct in carbon steel external lagged and cladded underneath the RTO canisters and from fan to RTO inlet and from RTO outlet to stack or collection duct
- Control panel with PLC and HMI, type Siemens, installed in a cabinet with air conditioning at the RTO unit
- Steel construction underneath the RTO canisters and platform with access ladder along the burner

The proposed Thermal Oxidizer is manufactured according European regulations and Durr standard.