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Opening photo: **One of the plants built by Airprotech Srl (Magenta, Italy).**

INNOVATIONS: PRESENT&FUTURE

Management and Abatement of Emissions Generated by Industrial Coating Processes

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Industrial coating processes using solvent-based products require the adoption of systems that reduce the emission of the volatile organic compounds VOC present in the plants' air intake. Airprotech is a leading company in the design, production, and turnkey supply of technologies and plants for air purification and VOC emission control.

Fields of application of industrial coating processes

The industrial coating sector includes a wide variety of different applications, performed either automatically or manually on metal, polymers, wood, glass, fabrics, synthetic leather, and much more. Coating processes involve the use of more or less automated and complex systems and machines,

depending on the application. Surface finishing processes have both an aesthetic and functional purpose and they provide the treated surfaces with chemical and physical characteristics that guarantee their protection over time.
In the case of metal, the coating process preserves their raw surfaces against atmospheric and chemical agents, in addition to enhance its aesthetical aspect. In the case of plastic, different primers are used depending on the raw material that makes up the substrate, in order to guarantee maximum adhesion of the applied coating film. Another important application field is that of wood and its derivatives, which generally includes the sectors of furniture and design.

Types of coating plants

The plants used are mostly spray coating machines, booths, or continuous flow lines painting with pump and gun devices that can finish components with various sizes and shapes. Pressurised booths are closed systems that allow to obtain top-level aesthetic and functional results thanks to a controlled atmosphere environment. This type of plant must be designed with extreme accuracy in order to prevent dust and other impurities from entering the system and thus compromise the final quality of the product. Continuous flow lines are composed of rail conveyors or carousels. They are employed for the industrial coating of large-sized parts or large quantities of workpieces and they can operate in a manual, semi-automatic, or fully automatic mode depending on the customer's needs and production processes.

Project capacity	60,000	Nm^3/h
Temperature	30	°C
Relative humidity	60	%
Pollutants	various V.O.C. non-chlorinated	mg/Nm^3
Project V.O.C. concentration	200÷900	mg/Nm^3
Inlet V.O.C. load	27÷54	kg/h
Medium LHV considered (*lower heating value*)	8,000	kcal/kg

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Table 1: **Project data of the case study.**

Industrial coatings and application technologies

There are two main coating processes, requiring different technologies and featuring different characteristics: namely, liquid and powder coating. The choice between the two systems is based on the specific application needs, the materials to be coated and the required results.
The main difference lies in the drying temperatures, which are higher in the case of powder coating (about 140-180 °C), thus limiting its fields of application. Liquid coating, on the other hand, generally guarantees more flexibility and a wider range of possibilities, in addition to simpler drying systems reaching lower temperatures (about 60-80 °C).

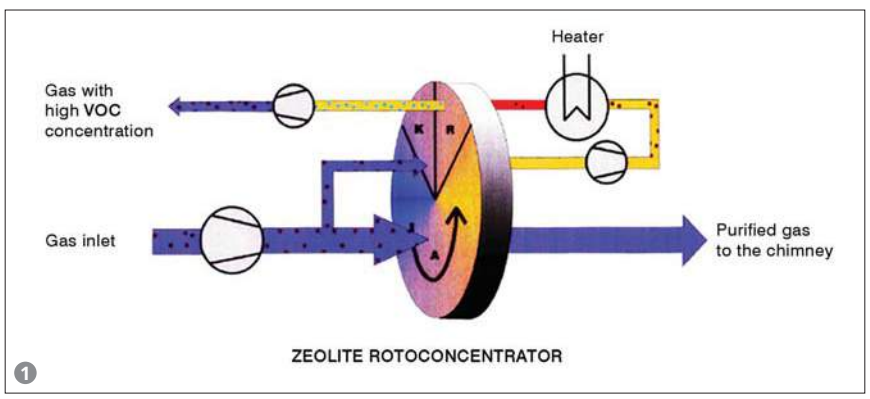

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Figure 1: **The pre-concentration process.**

The use of liquid paints allows to obtain very well finished surfaces with countless aesthetic effects. This process is suitable for all industries requiring a high finishing and gloss degree of products or excellent resistance to external (environmental or chemical) aggressions.
Liquid coatings are divided into two main categories: namely, solvent-based and water-based products.
The former generally guarantee a higher quality level making the surfaces smooth and shiny, precisely thanks to the use of solvents that ensure a homogeneous drying process, optimal results and at the same time high chemical resistance. Water-based coatings, on the other hand, were developed with the aim of reducing the presence of potentially toxic components in paints. However, they provide lower quality finishes due to the not perfectly homogeneous drying phase.

Management and abatement of emissions generated by industrial coating processes

In coating processes using solvent-based paints, a key role is played by the part of the plant dedicated to the management and abatement of emissions. The presence of volatile organic compounds VOC as solvents in the coating products requires the adoption of abatement systems to comply with the emission limit values of waste gases. Indeed, during application and drying, the solvents contained in the paints evaporate and they must be suitably sucked and conveyed to a system that prevents them from being released into the atmosphere.

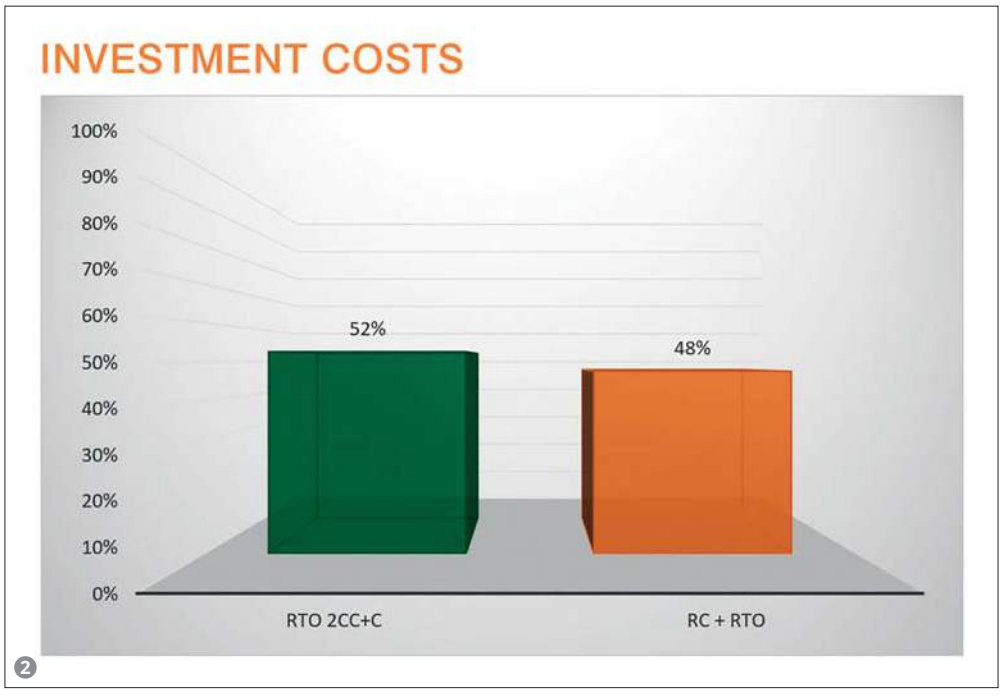


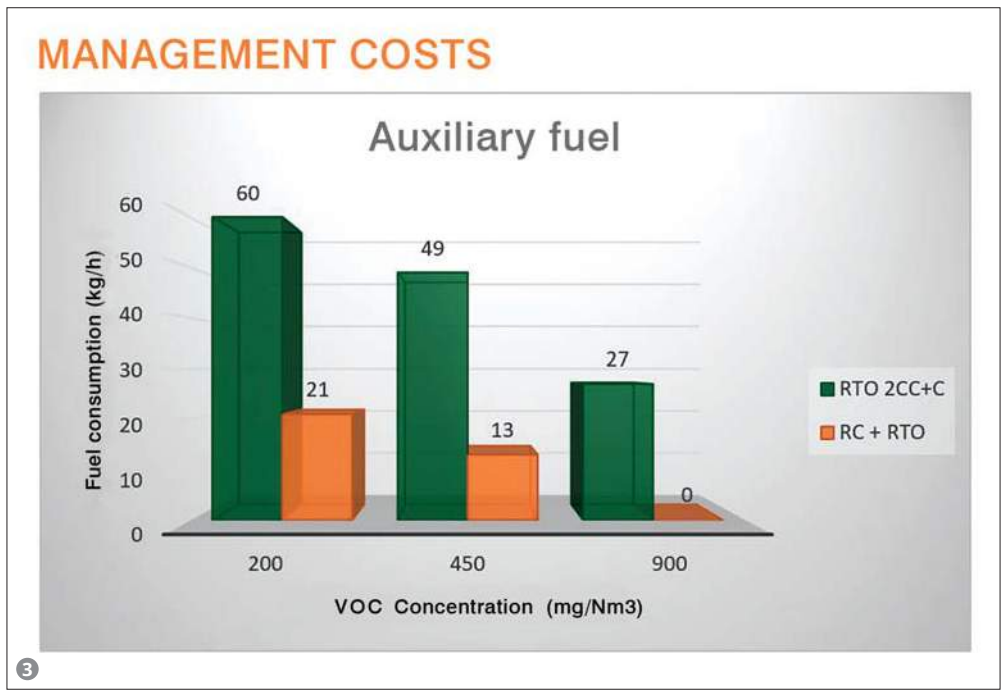
Figure 2: A comparison between the investments required by a regenerative thermal combustor and by a system including pre-concentration and regenerative thermal combustion processes. Such investment costs include the amortisation costs of the emission treatment plant, its maintenance costs, and financing costs.

An emission abatement system for a furniture panel coating plant

Here below, we present the example of a typical solvent emission abatement system developed for a coating plant treating panels and profiles for the furniture industry.
This includes various automatic coating lines and carousels connected to a main air purification plant. **Table 1** shows the project data related to this case study.
Given the need to reduce VOC emissions and considering the low concentration level, has been foreseen a system composed by a pre-concentration unit plus a regenerative thermal oxidizer RTO (**ref. Opening photo**).
This purification plant consists of two basic units: a pre-concentration unit using a zeolite wheel and a RTO regenerative thermal oxidizer that guarantees high-energy efficiency.

Figure 3: A comparison between the operating costs of a regenerative thermal combustor and of a system including pre-concentration and regenerative thermal combustion processes. Such costs include the cost of auxiliary fuel and electricity.

The operating principle of the pre-concentration wheel is based on the properties of the zeolite rotor. This is the core of the system and it is made up of active adsorbent material contained in a rotating structure.



"The purification plant consists of two basic units: a pre-concentration unit using a zeolite wheel and a efficiency RTO regenerative thermal oxidizer that guarantees high-energy efficiency. The operating principle of the pre-concentration wheel is based on the properties of the zeolite rotor."

Zeolites offer great advantages because they are not combustible, they are inert, very stable, and resistant to water and acids, and they can withstand high temperatures.
The process takes place in three distinct, but connected and interconnected phases (**Fig. 1**): **Adsorption (A):** the process air from the production departments is conveyed to the pre-concentration unit, where it is purified when passing through the roto-concentrator. Then, it can be sent directly into the atmosphere by means of a chimney. In this phase, the zeolites are loaded with the pollutants removed from the process gas.

A small part of process air, up to 10-15 times less than the total capacity, is removed before entering the zeolite wheel and sent to the K sector. It is then used for the desorption of the pollutants transferred to the zeolite wheel.

Cooling (K): the desorption air taken from the process gas upstream of the plant passes through the rotor, thus cooling the newly regenerated wheel K sector.

Desorption-concentration (R): the desorption air is heated to a pre-set temperature and sent to the R desorption sector, where it is loaded with solvents while regenerating the rotor. The flow exiting the desorption zone, loaded with VOC, is sent to the thermal oxidizer, where the concentrated flow is completely purified by the solvent. Regenerative thermal oxidizers RTO are specifically designed to destroy the pollutants through thermal oxidation at high temperature, the chemical energy contained in the pollutants is transformed in thermic energy to sustain the combustion itself.

Design is focused to optimize the gas mix and distribution inside the combustion chamber, to achieve the required residence time for a complete oxidation process.

The polluted gases are burned together with the support fuel such natural gas, LPG, gas oil etc.

Regenerative thermal oxidizers exploit the capacity of a mass of inert material to accumulate cyclically and give back the heat generated by the combustion process.

The efficacy of the thermal recovery can reach up to 96%, thus drastically reducing the consumption of the support fuel and consequently the plant operating costs.

Energy efficiency is guaranteed by optimal system sizing, the optimisation of each phase of the pollutant abatement process, the use of the proper ceramic materials and the overall quality of the plant itself.

This pre-concentration and regenerative thermal combustion system is the ideal plant solution for the treatment of significant airflows containing low concentrations of pollutants, which would otherwise require large-sized plants with high management costs.

As shown by the graphs, this plant has substantially reduced the management costs faced by the customer each year. As shown by **Figures 2** and **3**, in this specific case a regenerative thermal combustor alone, although effective in terms of compliance with emission limits, would not have proved to be the most suitable and sustainable technical solution in terms of operating and management costs.