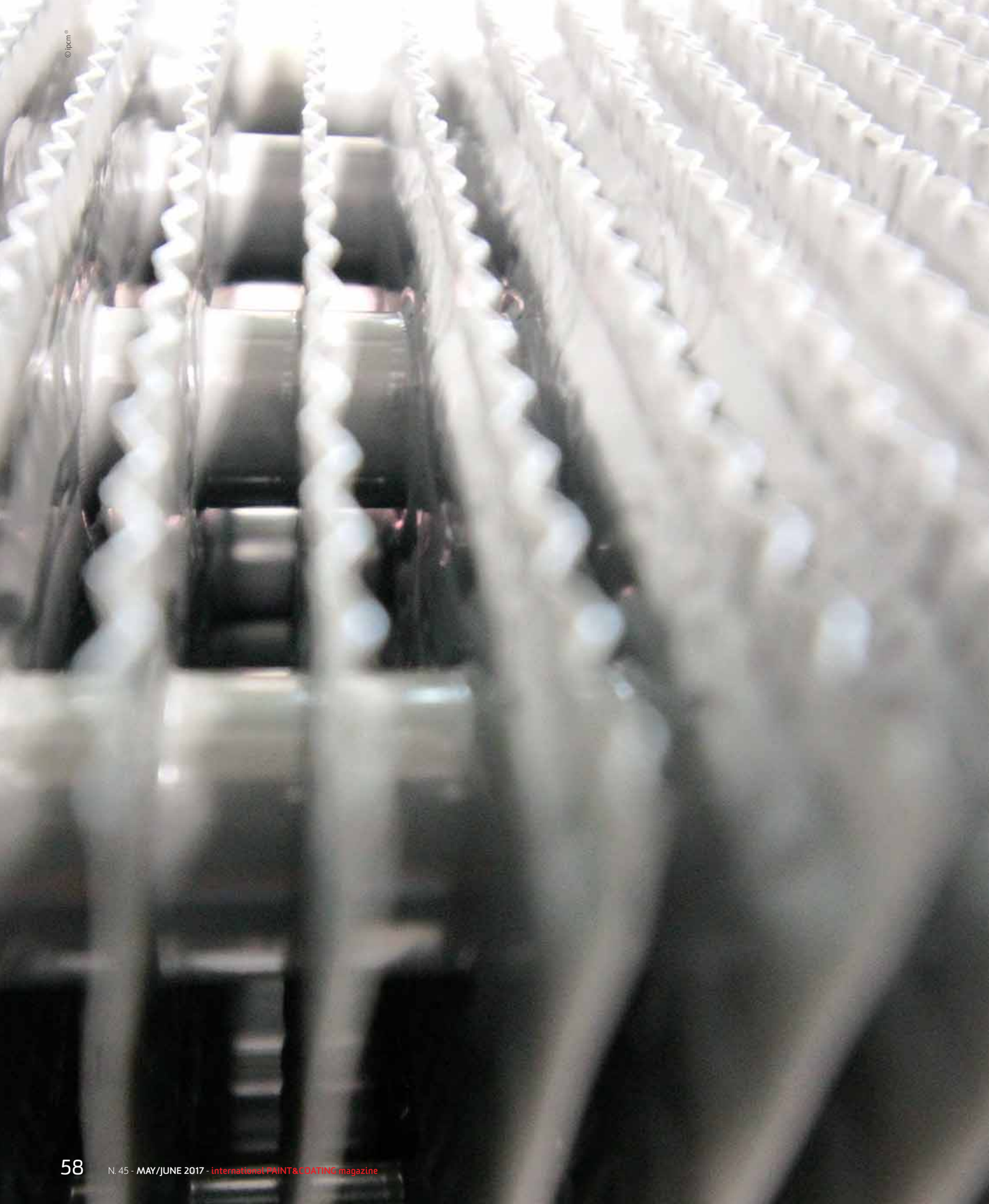

A Cataphoresis Wastewater Treatment System Optimised for the Refrigeration Industry: Sest Spa's CATOCOAT Process

Monica Fumagalli ipcm®

The industrial conditioning and refrigeration sector is crucial to the preservation of food and the sustenance of society. The delivery of products with a long shelf life and the excellent operation as well as nice look of the systems are the leitmotifs of this industry.

Sest Spa is one of the most important European manufacturers of evaporators and condensers for refrigerated counters and it is one of the largest producers of heat exchange finned coils (**ref. Opening photo**). This company, headquartered in Limana (Belluno, Italy), has recently celebrated forty years of activity. Since 1991 it belongs to the LU-VE Group, a multinational Italian company listed on the Milan Stock Exchange.

"Our reference market," says Nicola Decet, Sest's Engineering Manager (**Fig. 1**), "requires products that can withstand severe operating conditions and aggressive climatic agents. That is why the anticorrosion surface treatment of our components is so important. We have been offering to our clients CATOCOAT, a tried and tested cataphoretic coating process, since 1996; last October, we have further optimised it with the replacement of our old treatment plant with a new generation one, also ensuring a significant reduction in the environmental impact of our production processes. When we have had to change our coating plant, we sought a solution that could ensure lower energy consumption and the total recovery of the water used. The prime contractor of this engineering project, Imel (Codroipo, Udine, Italy), involved one of its strategic partners to design a suitable wastewater treatment system for our coating process: that is how we came into contact with the Italian branch of KMU Loft Cleanwater, a German company specialising in the development of process water recovery technologies."

Figure 1: From right to left: Alessia Venturi from ipcm, Klemens Schwienbacher, KMU Loft Italia's managing director, and Doris D'Incà from Sest (Coating Technical Supervisor).

The peculiarities of Sest's heat exchange products

Sest's finned coils for heat exchangers are made up of components of different materials and typologies. They are produced with aluminium continuous coils and copper tubes with different diameters; the tubes are fixed into the conical holes of the tubular plates by

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Opening photo: A detail of a finned coil produced by Sest Spa.

widening the end of the tubes themselves with a mechanical spindle. This system ensures perfect adherence between the tube and the coil even in case of high temperature differences and contributes to creating the best conditions for heat exchange between the primary fluid and water.

The metal sheet used for the fins can be treated with different machining operations to obtain three surface types: louvered, in order to increase the heat transfer capacity through the creation of air turbulence; corrugated, with a lower load loss on the air side compared with the previous one; or flat, with minimal airflow resistance and reduced ice formation. After machining, the workpieces, which are up to 1,000 mm wide, 4,200 mm long and 1,200 mm high, are loaded on the 18-bar Power & Free conveyor designed by Futura Convogliatori Aerei (Robecco Pavese, Pavia, Italy).

This takes them to the pre-treatment stations and to the subsequent cataphoresis one at a 5-minute rate (**Fig. 2**).

The coating process

In order to overcome the difficulties that may arise when cleaning such complex shaped parts, Sest uses an evaporating oil during machining. "In this way," Decet adds, "the coils reach the pre-treatment station with a good cleanliness grade, since most of the processing oil has already evaporated. The pre-treatment stage is used to clean the parts from hydrocarbon residues and

"At Sest's premises, we have implemented a very compact, closed-loop wastewater treatment system, located alongside the pre-treatment plant. All the active bath fluids, the rinsing water, the anolyte and the demineralisation plant's eluate reach the evaporator, which has a capacity of 500 l/hour (about 22 m³/day) and is equipped with two wastewater storage tanks made in fiberglass."

Figure 2: The coil loading area.

Figure 3: **The pre-treatment tanks.**

metal dust as well as improving paint adhesion and corrosion resistance. It includes an alkaline degreasing phase for 3 minutes at 58°C (**Fig. 3**) followed by two rinses (using water treated with the KMU Loft evaporator and then recirculated into these two process stages), and a spray rinse with demineralised water (**Fig. 4**)."
After pre-treatment, the coils are blow dried so that no degreasing product residue remains on their surfaces during the immersion into the cataphoresis tank (**Fig. 5**). After the cataphoresis treatment at 32°C, the parts are brought to two ultrafiltrate cleaning tanks and to the final spray cleaning and blow drying stations. They are transferred to a traverser through an automatic system (**Fig. 6**) and then to an overhead monorail conveyor taking them to the cataphoresis curing oven where they remain for 30 minutes at 180°C. Finally, they are unloaded.

The wastewater treatment plant

"At Sest's premises, we have implemented a very compact, closed-loop wastewater treatment system, located alongside the pre-treatment plant," says Klemens Schwienbacher, the managing director of KMU Loft Italia. "All the active bath fluids, the rinsing water, the anolyte and the demineralisation plant's eluate reach the evaporator, which has a capacity of 500 l/hour (about 22 m^3/day) and is equipped with two wastewater storage tanks made in fiberglass (**Figs. 7 and 8**). One tank contains only fluids from the rinsing stages, the other treats the alkaline degreasing wastewater, the eluate of the demineralisation plant and the anolyte of the cataphoresis tank. All wastewater is mixed in a third tank for pH correction; this is managed through a PLC with which the operator can set different percentages and control the process (**Fig. 9**). The distillate produced by the evaporator is sent to a coalescence separator where the volatile

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Figure 4: The spray cleaning process with demineralised water.

hydrocarbons left in it are eliminated. Subsequently, it is recirculated to the pre-treatment plant with a cascade in the degreasing and the first rinsing tanks. The effluents of the demineralised water rinse, on the other hand, reach the water treatment plant with a conductivity of about 20-30 microsiemens, a value that enables to avoid the evaporator stage and send them directly to the distillate tank. The residual concentrate from the wastewater treatment process, about 3% of the total volume of waste processed, is then disposed of."

CATOCOAT: the approved cataphoresis process

"We treat most of our products with our cataphoresis process," Decet explains, "in order to increase their corrosion resistance, especially for the devices operating in deteriorating food

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Figure 6: The traverser for transferring the parts to the monorail conveyor of the cataphoresis curing oven.

"Another benefit for our customers is the very thin coating film applied, an indispensable feature to avoid altering the thermal exchange performance. We also perform some tests, including the salt spray test, essential for meeting the needs of the market."

environments or with aggressive climatic agents. The coating of our coils is a critical phase of our production process due to the issues related to the particular shape of the workpieces: the coating of their edges and the penetration in their cavities have always been the most significant

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Figure 5: The cataphoresis tank.

problem. The cataphoresis process that we have been using on our products for over twenty years – so much so that we have certified it with CATOCOAT – and that we have recently improved with the new Imel system enables us to solve this problem because it applies a uniform paint film on the entire surface of the workpiece, with deep penetration even in the difficult-to-reach areas. Another benefit for our customers is the very thin coating film applied, an indispensable feature to avoid altering the thermal exchange performance. We also perform some tests, including the salt spray test, essential for meeting the needs of the market. We have also purchased the necessary equipment to carry out these tests in-house (**Fig. 10**). The 1,000 hours salt spray test was certified by the Trento University. Other important advantages include the compatibility of the cataphoretic coating with food products

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This zero-liquid discharge system is a big advantage in terms of economic saving, but, above all, it has no impact on the environment.”

Figure 7: **KMU Loft’s evaporator.**

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Figure 8: **The inside of the evaporator.**

and the low environmental impact ensured by the use of advanced plant solutions, such as the wastewater treatment unit integrated into the coating system."

The advantages of a zero-liquid discharge system

"The quality of the distillate recirculated into the cataphoresis plant is excellent," Decet states, "and the good results of the new process are proof of it. This zero-liquid discharge system is a big advantage in terms of economic saving, but, above all, it has no impact on the environment. With our old cataphoresis plant, it was not possible to treat and recover any process water (**Fig. 11**).

We had an average of 15,000 litres of wastewater per month, which were disposed of as special waste: our evaporator now treats 270 m^3 of water per month, we have no sewer discharge, and we dispose of the concentrate as normal waste.

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"We have noticed a remarkable economic saving also in the production of demineralised water: the water cleanliness degree is so high that the resins make a lesser effort and therefore have longer regeneration intervals. Another aspect of KMU Loft's intervention that we have greatly appreciated, in addition to the ease of management of the plant, has been their ability to integrate the system into our cataphoresis plant without the need to use any additional spaces for the water treatment process."

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Figure 9: **The eluate collection tank.**

Figure 10: **The salt spray test machine.**

“Thanks to our new cataphoresis plant, we have considerably increased our production capacity from 4,000 m² of metal sheet per day in three shifts to 8,000 m² in two shifts: the higher yield goal, therefore, has been achieved”.

that we have greatly appreciated, in addition to the ease of management of the plant, has been their ability to integrate the system into our cataphoresis plant without the need to use any additional spaces for the water treatment process (**Fig. 12**). The plant is so compact that it has not required any type of expansion”.

Figure 11: **Skids with the anolyte (bottom) and ultrafiltrate (top) tank.**

The whole new line has been designed for maximum energy efficiency as well as time and cost saving. "We recover the air exiting the oven with an air-to-air exchanger, sending one part back to the oven itself and the other to an air-to-water exchanger used to heat the degreasing bath. We have also installed a post-combustor that prevents any VOC emission."

Conclusions

"Thanks to our new cataphoresis plant, we have considerably increased our production capacity from 4,000 m^2 of metal sheet per day in three shifts to 8,000 m^2 in two shifts: the higher yield goal, therefore, has been achieved. However, another important aspect for us, in line with the philosophy of the LU-VE Group (which has always been sensitive to environmental issues), was the possibility to increase our products' quality with the use of environmentally friendly substances and plants. Now, we can offer a version of our CATOCOAT process that has been improved in some of its most distinctive aspects, such as our very low environmental impact alkaline degreasing process and the complete and uniform coating coverage of our coils. Our collaboration with Imel and KMU Loft has been profitable under all points of view," Decet states.

Figure 12: In the foreground, the wastewater treatment tank and, beside it, the evaporator. On top, the Futura Convogliatori Aerei Power & Free conveyor and, in the background, the traverser taking the workpieces to the oven's monorail conveyor.

SEST: the Largest European Manufacturer of Finned Coils

SEST belongs to the LU-VE Group. Listed on the Milan Stock Exchange, on the AIM Market since 2015 and on the MTS Stock Exchange since June 2017, this Group operates in different sectors: commercial and industrial refrigeration; civil, industrial and precision air conditioning; industrial applications; power generation; and glass doors and closure systems for refrigerated counters and display cases. Altogether, the LU-VE Group has more than 2,400 employees (about 700 in Italy), manufacturing facilities in seven different countries (three in Italy, but also China, India, Poland, the Czech Republic, Russia and Sweden) and a firm specialising in IT, IoT and computing software for refrigeration. Its 2016 aggregate turnover was over € 250 million, with 76% of production exported to 100 countries. The LU-VE Group owns a total area of 340,000 m^2 (145,000 of which are covered) and 99 production lines. Its research and development laboratories (2,350 m^2) are the largest in the industry in Europe and the only ones who can perform tests with CO_2. The R&D activities of the Group have always been carried out together with the Politecnico di Milano since 1986, and later collaborations have been developed with 21 other universities and research institutes, in 13 countries of 3 continents.
In 1974, its establishment year, SEST specialised in the manufacturing of tailor-made evaporators intended for refrigerated counters; it then extended its production to other applications. Thanks to the intelligence and passion of a determined team, its growth has led it to evolve from a manufacturer of semi-finished products to a service provider, also accessing other market niches. Acquired by the LU-VE Group in 1991, SEST has become the largest European and one of the global major manufacturers of heat exchange finned coils for the commercial refrigeration and air conditioning sectors. SEST is part of the "Components Business Unit" including as follows: Sest LU-VE Polska, Sest LU-VE (Russia) and HTS (Czech Republic) for the production of static evaporators for refrigerated counters and display cases; TGD (Italy) for glass doors and closure systems for refrigerated counters and display cases; and, since September 2016, Spirotech (India) for heat exchangers intended for domestic appliances, refrigeration and air conditioning. In 2016 it also started producing coils in China, at the LU-VE Changshu plant near Shanghai. The "Components Business Unit" currently manages 35 production lines of finned coils, which manufacture over 1.2 million units a year.