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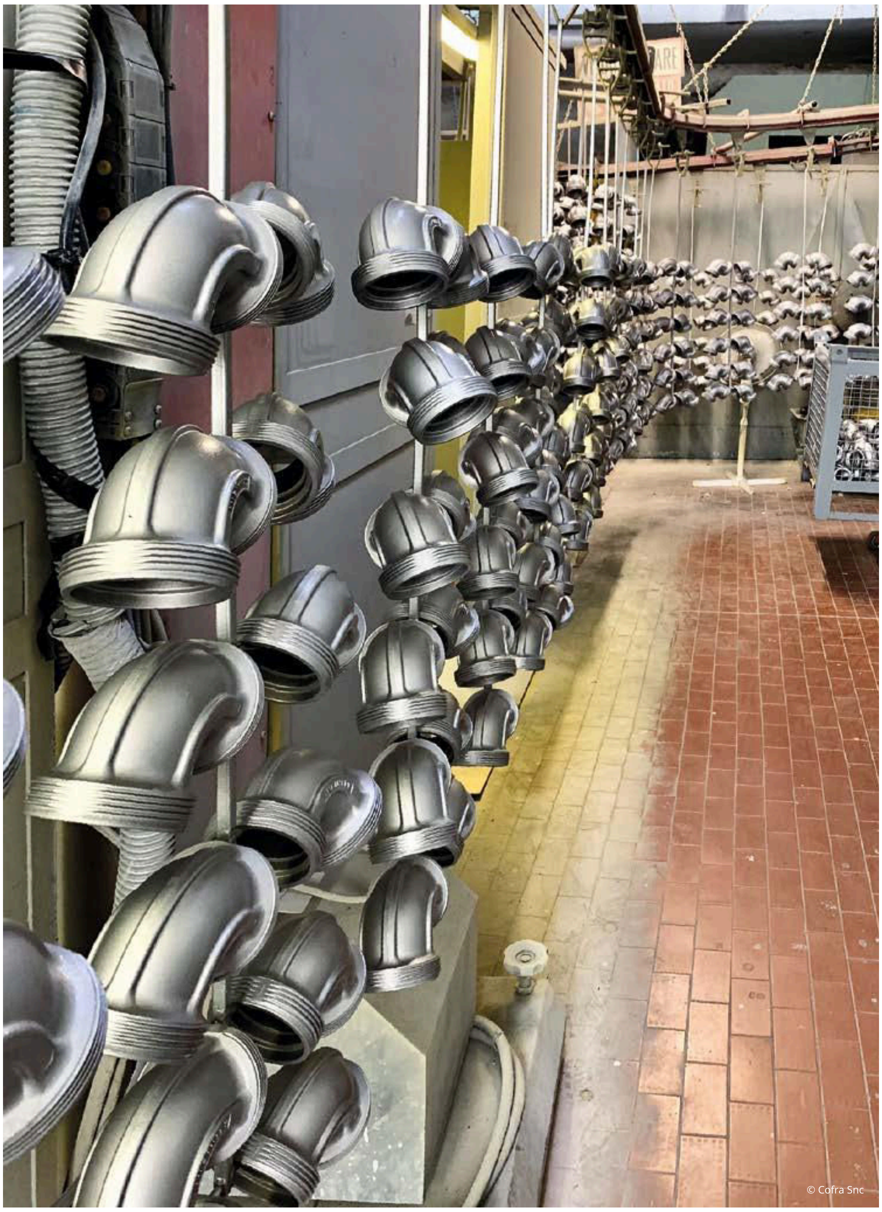
An innovative multi-drum vacuum impregnation plant becomes a technological lever for business growth

Cofra Snc is a company specialising in the surface treatment of castings, from vibratory finishing to cleaning, up to liquid coating. It has recently installed a new vacuum impregnation plant designed by STS srl (Ravenna) in order to offer an all-round service to its customers, operating mainly in the automotive sector, and start a long-planned development project.



Cofra Snc specialises in cleaning, vacuum impregnation, and painting of automotive components.

Microporosity is among the most common surface defects resulting from casting, die-casting, and sintering processes. It is caused by the shrinkage of metal as it passes from the liquid to the solid state, due to the release of previously absorbed gases. The presence of microporosity in the mechanical manufactured castings can compromise their seal, leading to the rejection of large quantities of parts. Vacuum impregnation is one of the most popular methods to solve this problem: the components are immersed in catalysed thermosetting resin to seal their pores and enable them to pass leakage tests and be suitable for eventual coating.

Although little known, vacuum impregnation is actually a popular process among contractors performing surface treatments on castings. It is, in fact, one of the services often offered by metal cleaning firms in one of the areas with the highest density of foundries and metallurgical companies in Italy, that is, the Brescia area. This is also home to a company, Cofra Snc, which is experimenting with an innovative system capable of performing vacuum impregnation and cleaning with one automatic system, designed and installed by STS srl (Ravenna, Italy). This firm was founded around forty years ago, and it is now managed by Paola, Federica and Luca Cometti, with the aim of offering contract cleaning services to local manufacturers of fittings and automotive components. Then, it gradually integrated vibratory finishing and liquid painting plants into its factory and, in order to offer an even more complete service, it insourced first the assembly and then the vacuum impregnation process phases, previously entrusted to an external company also belonging to the Cometti family.

The RS30-4 vacuum impregnation system from STS' AQUASEALER® series.

The integration of the vacuum impregnation process

"As soon as the foundries send us their castings and other mechanical components," explains Luca Cometti, the technical manager of Cofra, "we treat them in our vibratory finishing plant to remove burrs, clean them, dry them, and send them to a few metallurgical companies for some machining operations such as threading. Then, we receive them back to perform vacuum impregnation and its related drying phase; afterwards, we send them to our coating department, where they are pre-treated in our belt phospho-degreasing and passivation system, and finally we liquid coat, dry, assemble, and package them."
The choice to insource the vacuum impregnation process, in particular, was motivated by Cofra's need to supply its customers with finished products quickly and without excessive handling. STS' plant engineering solution met this requirement perfectly, thanks to the possibility of managing several stages in a single machine via the control PLC equipped with a touch screen display. "The installed system has been in operation since January this year," indicates the technician from STS. "It is an RS30-4 machine from STS' AQUASEALER® series, designed for vacuum impregnation operations. It is the result of more than twenty years' experience gained by the company in the vacuum impregnation field and by STS' technical staff in the cleaning field. Compared with the first vacuum impregnation plant installed by STS back in 2003, numerous technological evolutions have led to the integration of an additional cleaning chamber and of some technical measures related to the recovery of resin and water coming out of the treatment tanks and even of air, which is also recirculated into the system."

The multi-drum system

The plant consists of four treatment stations: vacuum impregnation, cleaning, rinsing, and polymerisation. The components are placed inside the baskets in bulk or in a fixed-position mode, depending on their characteristics and geometry. Even those whose surfaces are less complex and do not risk denting, however, are only allowed limited movement of 1 or 2 mm within the basket. The most delicate parts, on the other hand, are carefully placed and separated on several

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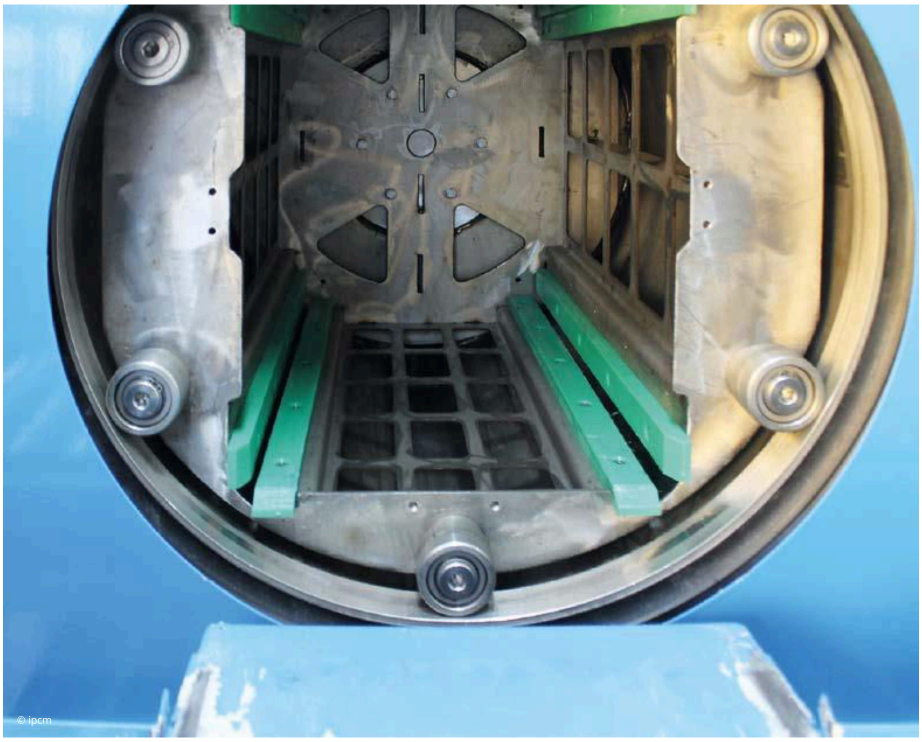


The inside of one of the plant's four chambers.

levels with custom-made nets, depending on their size. The multi-drum structure allows the simultaneous processing of baskets in all four stations. The plant is configured for manual loading, but it is also prearranged for the integration of an automatic handling and loading system. Already now, however, thanks to the front-loading option instead of the more common top-loading one, material handling by the operator is easier.

The first and second phases: vacuum impregnation and cleaning

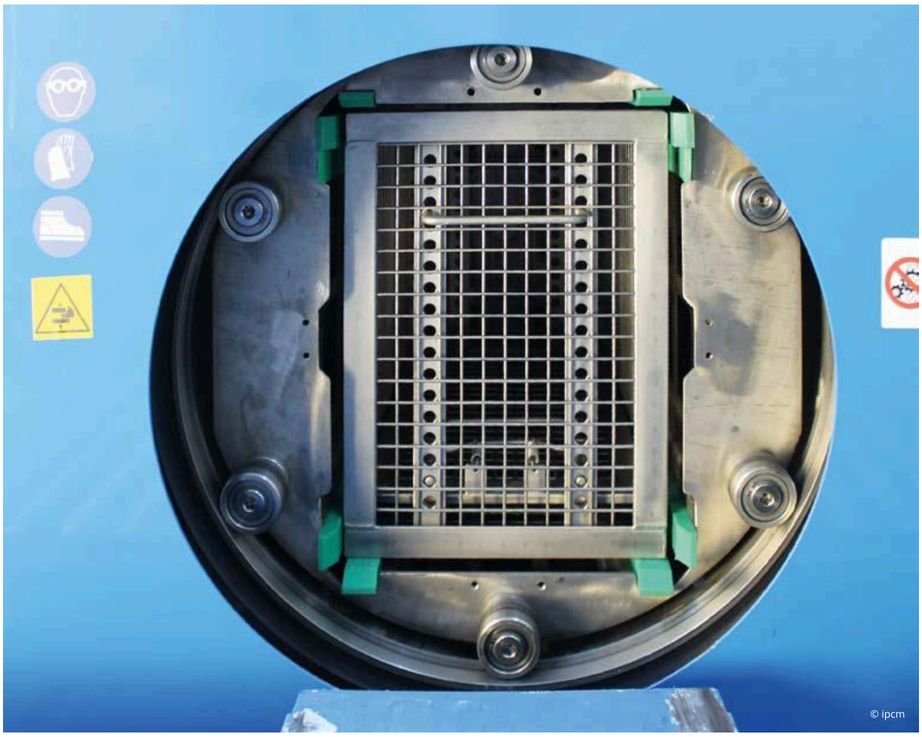
"Once a basket containing material is placed inside the drum," explains the technician from STS, "the first dry vacuum phase begins. A vacuum pump extracts air until a residual pressure of less than 25 mbar is reached. Then, liquid resin is introduced into the drum until the components are fully immersed. Vacuum below 25 mbar is maintained for a few more minutes, in what is known as the "wet vacuum" stage. When a pressure value of 1 atm is restored in the drum, the liquid resin penetrates the material's pores, driven by the atmospheric pressure itself. Finally, a basket rotating phase helps to remove all resin residues, which drip toward the collection tank. This ends the first stage." The basket is then moved manually into the second chamber for the cleaning phase. "The material inside the basket is washed in the second drum with demineralised water at room temperature. In this way, liquid resin is completely removed from the parts' surfaces, whereas it remains in the micropores due to the principle of capillarity. In other words, the resin that seals the castings' porosity remains locked in the micropores and is not removed during cleaning. The water used, appropriately filtered by the recovery system, is separated from the resin, which is insoluble in water, so that it can be reused in the first stage of vacuum impregnation. Thanks to the filtration system, it is indeed possible to recover 80% of resin and 100% of water, which are fed back into the system."

The third and fourth phases: rinsing and polymerisation

The third step involves rinsing the components at room temperature with demineralised water and additives compatible with the resin used, in order to prevent their surfaces from oxidising. At this stage, rinsing is essential to remove any microdroplets containing water and resin stuck inside the threaded holes and grooves, which could jeopardise the success of the subsequent polymerisation. "In addition, this prevents any deposit of polymerised resin from forming at the bottom of the polymerisation chamber, which would require frequent removal with a high-pressure cleaner," emphasises the technician from STS. Precisely the polymerisation process takes place in the fourth drum. "The basket, kept rotating at all times to promote uniformity of treatment, is immersed in hot water at 90 °C, which, by heating the parts, causes rapid and complete polymerisation of the resin contained in the micropores. While the hot water is collected in the storage tank, a device insufflates air for drying, which can reach 150 °C thanks to a heater. The last stage consists of creating vacuum to remove moisture from the inside of pores, with two purposes: guaranteeing optimal paint adhesion for the parts to be coated and eliminating any risk of oxidation for the parts to be stored, thanks to the antioxidant product mixed with the hot water used."

Fundamental time savings and additional benefits

The cycle time of each phase is about 15 minutes in compliance with the standard MIL 276A, which sets out the parameters to be met for vacuum impregnation processes. "The entire vacuum impregnation and cleaning cycle, therefore, lasts about one hour," says Cometti, "After that, the workpieces leave the plant at room temperature and they are ready for further processing or leakage tests. This is a strategic advantage for us. With other



The components are placed inside the baskets in bulk or in a fixed-position mode, depending on their characteristics and geometry.

At Cofra, basket loading is done manually by an operator.

Liquid coating of parts.

The coated components.

technologies, the waiting time before handling the parts is of 48 to 72 hours: therefore, this enables us to save two to three days."

"Another innovative element of AQUASEALER®," notes the technician from STS, "is its air purification system that condenses the vapours produced by the plant: both the air extracted from the chambers by the vacuum pumps and the vapour generated in the polymerisation tank are sucked by a condensation filter that returns them to the treatment chambers. This eliminates the need for a chimney and creates a completely closed-loop and, consequently, environmentally friendly system."

The machine's Industry 4.0-oriented configuration is also an added advantage, as Cometti explains: "The possibility to manage orders directly from the control PLC has simplified our business. With this system, we can manage cycle times and temperatures, retrieve and record detailed data for each process step and, in the event of any problems, remotely connect with the STS technical assistance team. Indeed, their support service, both remotely and in person, has always been very precise and reliable, an important aspect for Cofra: the STS team advised us on the ideal solution when we had some issues with the quality of resins and corrosion inhibitors and helped us preparing our first offers to customers. Their assistance service really went beyond the mere sales and after-sales relationship. We can therefore only be satisfied, especially since our customers are equally pleased with our part quality degree and delivery speed. I am sure that focusing precisely on quality and speed of delivery will be the right weapon to start the expansion of our business that we have been planning for a long time."

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Impianto di impregnazione

Impregnation plant

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