

SINGLE SCREW PLUS COROTATING TWIN SCREW SYSTEM

# UPCYCLING IN THE MOST COMPLETE SENSE

THE MUCH SOUGHT-AFTER CIRCULAR ECONOMY BECOMES A REALITY ONLY WHEN IT OFFERS ADEQUATE ENVIRONMENTAL AND ECONOMIC SUSTAINABILITY. WITH THIS IN MIND, MARIS HAS COME UP WITH A NEW UPCYCLING PROPOSAL FOR THE WORLD OF RECYCLING. THANKS TO AN ORIGINAL TANDEM COMBINATION OF A SINGLE SCREW EXTRUDER AND A COROTATING TWIN SCREW EXTRUDER, THIS NEW SOLUTION CONFERS REAL ADDED VALUE ON RECYCLED PRODUCTS

BY ERMANN0 PEDROTTI AND LUCA MEI

According to the Ellen MacArthur Foundation's definition, circular economy is a generic term that describes an economy designed to be able to regenerate itself. In a circular economy there are two types of material flow: the biological kind which can be put back into the biosphere, and technical waste which has to be revalued without ever entering the biosphere.

What this academic definition tells us is that the circular economy is an economic system planned in such a way as to promote the reuse of materials in subsequent production cycles, thereby minimizing waste. As Lucia-

no Battistutta, sales area manager at Maris, remarks from the perspective of an industry operator, "From the Green Deal to the first European climate law, and also with Next Generation EU, we have all been well aware that the European Union has given itself a growth strategy designed to move Europe in the direction of a zero climate and environmental impact society. In order to adapt to the resulting green policies, industry, and primarily the plastics sector, is striving to recycle as much as possible. As industry operators well know, the business of plastics recycling began with the "noblest" materials, or the most easily recyclable ones, for

which there is an already well-established supply chain. Just think to a polymer such as polyethylene terephthalate (PET), used in plastic bottles, which has a well-defined composition, is readily selectable, and has recently been approved for reuse in the production of new bottles for the food industry. But then we also have a whole series of other plastics - these account for the majority, or at least a substantial proportion - that, for a variety of reasons (for example because they are contaminated by other polymers or pollutants), need to undergo more significant, complex and demanding revaluation processes".

These words take us straight to the crux of this article: continuous recycling process allowed by the tandem combination of a single screw extruder and a corotating twin screw extruder - a system developed by Maris. Although this is not a new combination in plastics processing, this solution, thanks to its remarkable mix of technological and process devices and developments, confers new life and greater value on waste products.

Before examining this combination in detail, it is useful and interesting to set it in context and take a background look at Maris, an all-Italian family-run industrial reality, currently in its second generation. Now, with approximately 100 employees, it reckons with competitors that are true global industrial giants.

**THE BUZZWORDS: TECHNOLOGY AND TAILOR-MADE PRODUCTS ... ALWAYS!**

Established near Turin in 1962, with a mission to manufacture extruders and dies for the production of pipes and profiles, Maris quickly became a leading player in the early development of polymers, aspiring to contribute to the evolution of the related nascent technologies. To set the story in context, it is worth remembering that isotactic polypropylene was invented in the 1950s by the Italian chemist Giulio Natta, who won the Nobel Prize for chemistry in 1963, a year after Maris was founded.

Maris soon chose compounding as its main mission, and the 1970s saw it build-

ing new corotating twin screw extruders with self-cleaning screws and modular sections. The 1980s brought two- and three-lobes plasticising screws, while in 1990s the company embarked on the production of high-torque, high-performance lines, and also began offering Maris lines to new application sectors.

"This is a far-sighted family that, ever since the 1960s, has focused on the production of corotating twin screw extruders for application wherever there is a need to process materials continuously", says Luciano Battistutta. "I am talking about a range of sectors: first, the production of masterbatches, which soon became a traditional application for Maris; then the production of highly filled, reinforced compounds, TPE, TPV, adhesives and bioplastics, and now rubber compounds and - remaining in the world of elastomers -the recently patented continuous de-vulcanisation process.

In this latter case, the vulcanised rubbers are recycled using a continuous system, allowing them to be reused (in proportions ranging from 15% to 50%) in new formulations for the same original application.

What is more, the percentage of de-vulcanised material in the compound can be further increased to obtain different formulations. In this regard, we can affirm that our de-vulcanisation process can also be applied to post-consumer materials, since it involves careful material selection, identification and treatment steps. I am referring, in particular, to the large volumes of end-of-life



Luciano Battistutta, sales area manager at Maris

tyres (ELTs) that we can certainly consider a very useful "secondary raw material". Still in application terms, recycling, or better, upcycling, is a constantly evolving and growing sector. Maris is already strongly present and operational in this field and proud to have already implemented numerous innovative processes in the treatment of post-consumer materials and production waste; for example, in the fields of polyolefins, PVC, PET and also expanded materials".

And this leads us on to a further characteristic of Maris, namely the fact that it has opted to be a "one-stop shop".

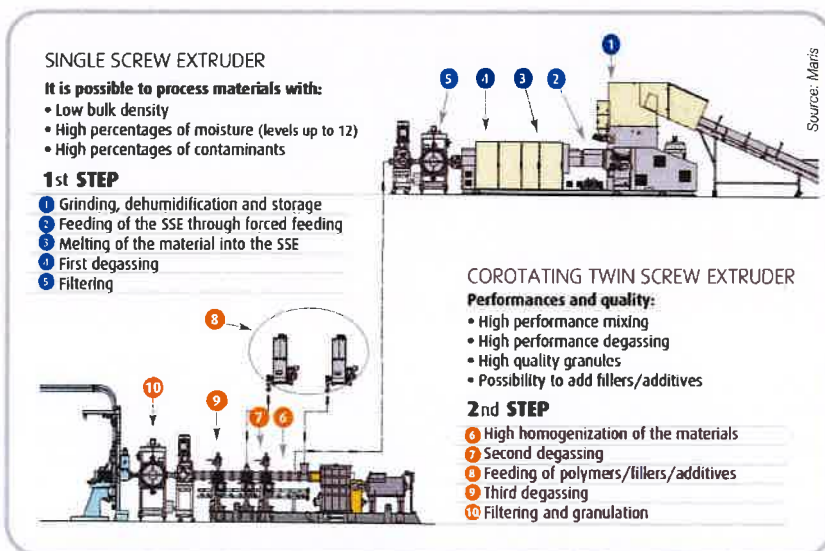


Figure 1 - "Just to summarise the particular features of this tandem solution", Muscato explains, "we have now reached a point at which it is possible to fully exploit the potential of both the single screw extruder and the corotating twin screw extruder, in a single machine and in a single step"

**MARIS' CHOICE BETWEEN "MAKE OR BUY" IS DEFINITELY "MAKE"**

"Make or buy" is the choice between building a product in-house or buying it from an external supplier. The choice is based on the comparison of the total costs to be incurred in the two cases, taking into account both availability on the market - and therefore any critical issues associated with it - and the resources available within the company. It is a fundamental strategic choice for the management of a company; a choice which defines the integration level of upstream and downstream operations and determines the cost structure, the organization and also the positioning on the market.

The "make" option offers above all the advantage of ensuring direct control over the production operations, the supplies and the quality of the final product. It also makes it possible to maintain and devel-

op a proprietary technological know-how. "We have always been proud to be 100% owner of our technology", Battistutta underlines, "and this is possible because the fundamental parts of our corotating twin screw extruders are made entirely in-house with top level production processes and quality. Evidence of this is the production of screw elements, process sections (barrels), as well as the manufacture of complete gearboxes, which represent a focal point of an extruder. This is a choice that allows us to build machines that stand out for their high quality standards and versatility". Logistically, in addition to the office building, Maris is composed of three other large and distinct departments. The largest is the production department, where last generation CNC machining centres operate along with more consolidated metalworking systems, because, as Battistutta explains: "The alternation of cutting-edge machines and other more traditional ones makes it possible to manage the individual phases of orders with flexibility and to achieve, therefore, a very high customization level". Equally important is the department dedicated to the assembly and testing of extrusion lines. Maintenance of extruders is also carried out here. "We are able to carry out regular and extraordinary maintenance on extruders built several decades



Bruno Muscato, the process expert within the research and development team of Maris Technological Center

ago (and still operational). This prerogative allows us to provide a reliable, effective, high quality after-sales service and, therefore, to establish lasting relations with our customers", Battistutta adds. Last but not least, the third department is the Maris Technological Center, which deserves a separate chapter.

## 1,000 SQUARE METRES WHERE IDEAS BECOME REALITY

The Maris Technological Center is the department responsible for the study and optimization of the customers' production processes, as well as for the research and development activities aimed to constantly improve the technology of twin screw extruders. At Maris, in fact, there is no standard order and the watchword is flexibility at the service of the customer.

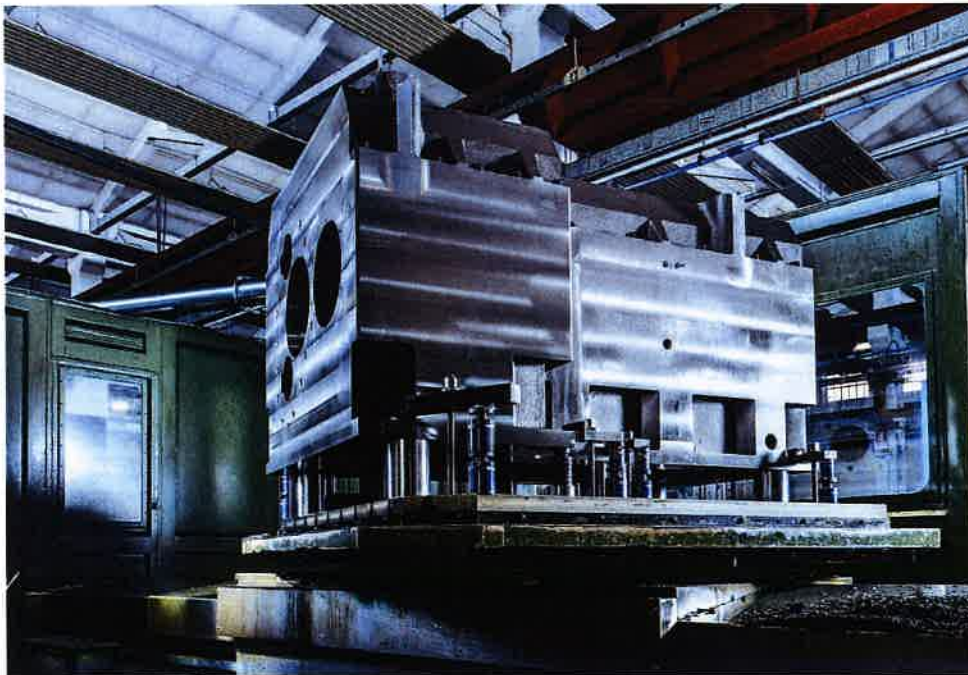
Therefore, the customers communicate the information useful for the configuration of the pilot line to the research and development team of this department. Then the line is tested using the materials supplied by the customer and, if necessary, laboratory analyses are carried out to test the quality of the finished product under different processing conditions.

In this regard, Bruno Muscato, the process expert within the research and development team, says: "To evaluate in real time the results of the tests carried out at the Maris Technological Center we have set up a laboratory where we perform the characterization procedure with an optical microscope in reflection and one in transmission, as well as the rheological and melt index analyses. Finally, we can assess the mechanical properties of the materials, after moulding, with a dynamometer".

It is with a certain pride that Bruno Muscato - who is an industrial chemist - showed us the "filter test". A fast analysis devised by Maris, thanks to which, by measuring the clogging speed of the filter, it is possible to measure the dispersion of fillers/pigments within the polymer matrix.

All this makes us understand how a family-run company can compete in an international context in the world of extrusion. As a confirmation of this, in fact, Maris cooperates with universities, public and private authorities (Italian and international), but also with manufacturers of ancillary production systems, with engineering companies and with car manufacturers in the development of research projects such as the one that allowed the company to obtain the patent for its rubber de-vulcanisation technology.

"Our Technological Center is equipped with four lines of different sizes that enable us to carry out both basic research activities and production simulations on an industrial scale", Muscato explains, "starting from the 20-mm screw diameter line (for laboratories or very limited productions), then passing to the 30 mm and the 40 mm versions, and fi-



Maris has always been the owner of its technology; the fundamental parts of its corotating twin screw extruders are made entirely in-house with top level production and high quality processes

Compound obtained with the upcycling process on the Evorec Plastic Plus line



nally arriving to the largest line, with a screw diameter of 58 mm. These extrusion lines allow us to replicate the final application conditions with an excellent degree of precision and to perform the appropriate scale-ups by identifying the most suitable machine size to reach the production target of the customer. The range of our extruders is very wide: their diameter can reach up to 223 mm and the hourly output rate varies depending on the formulation and size of the machine.

The twin screw corotating extruders are modular and this gives us the possibility of varying the extruder length according to the processing needs, as well as to feed solid or liquid materials in different points of the extruder thanks to specific barrels. Our extrusion lines can be integrated with upstream and downstream equipment (providing, in practice, a turnkey solution) thanks to the cooperation with the sector's most renowned brands. At the Technological Center all this equipment is at our disposal in order to identify the most appropriate solution to meet the customers' needs".

Upstream equipment can include a wide choice of gravimetric feeders for solids and liquids, while downstream it is possible to find gear pump, screen changer, underwater, water-ring, remote and air pelletising systems and, finally, vacuum or high vacuum pumps.

#### FOCUS ON EVOREC PLASTIC PLUS: SINGLE SCREW PLUS COROTATING TWIN SCREW EXTRUSION SYSTEM

Maris's response to the need to recycle highly contaminated materials with a high moisture content is the Evorec Plastic Plus. This com-

bination of two technologies - a single screw extruder and a corotating twin screw extruder - makes it possible to recycle very critical materials with a single extrusion system. "Just to summarise the particular features of this tandem solution", Muscato explains, "we have now reached a point at which it is possible to fully exploit the potential of both the single screw extruder and the corotating twin screw extruder, in a single machine and in a single step. In other words, by combining two specific, complementary expressions of our know-how, we have made it possible to feed non-free-flowing materials, carry out double filtration, obtain highly homogeneous materials, and introduce additives/fillers into the recycled polymer. It is also possible to process materials with a high moisture content and a very high level of contamination; this would not be possible with a twin screw extruder alone, but thanks to this combination, it is now feasible".

Regarding the upcycling example described in this article, **figure 1** comes to our aid, showing the five phases of the single screw extruder: 1) grinding, dehumidification, storage; 2) feeding; 3) melting; 4) first degassing; 5) first filtration. After these operations, the post-industrial or post-consumer waste is ready to be fed continuously towards the corotating twin screw extruder. Figure 1 also lists the phases of this second step: 1) homogenization; 2) second degassing; 3) side feeding of polymers, fillers or additives; 4) third degassing; 5) second filtration and granulation/pelletising. ■

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