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Opening photo Carbon fibre spray booms manufactured by King Agro and fitted on boomers.



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KingAgro: Innovation in Agriculture Thanks to Carbon Fibres. An Innovative Coating Plant for Carbon Fibre Spray Booms

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Innovation and development in the agricultural sector are currently made possible by the use of carbon fibres as an alternative building material to steel. Carbon fibres were first used in the military and aerospace industry, but, as their cost diminished, new possible applications were found in several sectors. In the field of machines and agricultural tools such as tractor-mounted extensible spray booms,

carbon fibres' properties enable to increase productivity and process quality. Indeed, they ensure a longer working radius, weight reduction, greater control of the equipment, and less impact on soil compaction (**ref. Opening photo**). Building carbon fibre components requires a profound knowledge of this material, high technical skills, and advanced production technologies. Carbon fibres

also pose great challenges in terms of coating. Cabycal is a highly innovative engineering firm based in Alaquàs (Valencia, Spain) that designs, develops and builds surface treatment and coating plants and lines for the industrial and automotive sectors all over the world. It has recently installed a liquid coating line for large components made of carbon fibre material near Valencia (**Fig. 1**).

KingAgro: sea experience at the service of agriculture

KingAgro, opened a new manufacturing facility in Picassent early in 2017 for the production and finishing of revolutionary carbon fibre spray booms. The new factory required an investment of 8 million Euros. It will cooperate with the KingAgro plant of Campana, Argentina. The facility covers an area of 5,500 m² and employs about 100 people. It is equipped with all the latest manufacturing technologies and it will produce up to 1,800 carbon fibre spray booms every year (Fig. 2).

KingAgro has over twenty-five years of experience in the use of carbon fibres because it was established as KingMarine, a firm specialising in the application of this material to the high performance nautical industry. The

quality and reliability of its products are the result of a corporate philosophy based on innovation, technical rigour, quality control and detail care. The production of the booms starts with precision moulds created with a 5-axis CNC plotter. The

Kevlar and carbon fibres are cut to precise measures and shapes with a CNC cutter before the rolling phase in a controlled and dust-free environment. The carbon composite components are polymerised with high temperatures and pressures up to 5 atmospheres. Machining, coating and final assembly complete

the production cycle of the spray booms, which are then ready to be installed on sprinklers. KingAgro’s president Guillermo Mariani has stated: “Our goal is to change the paradigm of steel in agricultural machinery. We believe that

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Figure 1: An exterior view of the new pressurised and dust-free coating plant.

- E-coat systems
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Figure 2: A carbon fibre spray boom.

“The King Agro’s goal is to change the paradigm of steel in agricultural machinery. Its staff believes that carbon fibre spray booms are just the beginning of a trend that will offer innumerable advantages linked to increased productivity, lower costs and reduced soil compaction.”

carbon fibre spray booms are just the beginning of a trend that will offer innumerable advantages linked to increased productivity, lower costs and reduced soil compaction.” KingAgro’s carbon fibre spray booms are six times stronger and over five times lighter than their steel equivalents. Highly durable and resistant to fatigue and corrosion levels that affect spray booms in steel and especially aluminium, they offer a longer service life and lower operating costs. The material’s light weight allows overall sprayer weight to be reduced, resulting not only in less soil compaction but also in lower fuel consumption. Moreover, the low inertia of carbon fibre booms has benefits on the machines’ performance, because it provides workflow optimisation and better control of the booms themselves, thus increasing crop coverage and reducing spray drift (Fig. 3).

“The new King Agro’s Spanish facility is equipped with all the latest manufacturing technologies and it will produce up to 1,800 carbon fibre spray booms every year.”



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Figure 3: A carbon fibre boom on the two-rail conveyor (Futura Convogliatori Aerei).

“Each year, KingAgro invests 75% of operating profits in the research and development of new processes and products. Our commitment to continuously improve our vacuum, resin infusion, rolling, autoclave, robotic machining, water jet cutting, and coating processes increases the quality of our products. The market is responding very well to carbon composites thanks to the direct improvements they ensure,” says Guillermo Ponzinibbio, KingAgro’s European COO (Fig. 4). KingAgro’s coating process consists in the manual application of a two-component solvent-based system including a

Figure 4: KingAgro’s president Guillermo Mariani on the left, with Sergio Mateo from Cabycal.



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Figure 5: The mixer for two-component coatings (Graco).

transparent primer and a UV protection transparent topcoat. This was exclusively developed by PPG to enhance the carbon fibres' technical characteristics and protect them from aging. KingAgro manages to obtain high quality finishes in a controlled environment thanks to the line that Cabycal developed and installed after careful analysis of the needs and peculiarities of the carbon composite material (Fig. 5).

“ KingAgro’s coating process consists in the manual application of a two-component solvent-based system including a transparent primer and a UV protection transparent topcoat. This was exclusively developed by PPG to enhance the carbon fibres’ technical characteristics and protect them from aging.”



Figure 6: The booth with the sanding stations.



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Figure 7: The IR polymerisation oven.

The strengths of this coating system

With a total length of 65.5 metres, a maximum height of 7.5 metres, and an internal width of the cleaning and coating booths of 3.3 metres, this system features a 120 metre long mixed conveyor with 10 metre long loading bars. The conveyors features a manual loop for loading and unloading the pieces and an automatic power&free loop for the treatment process, with automatic devices for the feeding of the parts at pre-determined time intervals. With a power of 170 kW, a 125,000 m³/h moving air flow, the system can treat up to 10 metre long extensible booms weighing up to 100 kg. “Our spray booms are made up of a mixture of carbon fibre, Kevlar and epoxy resins. Once the components have been pressed, cut and machined, we sand them. At this point, the finishing process begins,” says Guillermo Ponzinibbio. “We have worked for two years with Emilio Ferrando, Managing Director of Cabycal, to fine-tune this five-station system.”

“ KingAgro manages to obtain high quality finishes in a controlled environment thanks to the line that Cabycal developed and installed after careful analysis of the needs and peculiarities of the carbon composite material.”





Figure 8: The detection of the products' temperature inside the oven.

“Cabycal built a plant where many operations are necessarily manual, due to the shape and size of components, but that is equipped with the most sophisticated automatic control systems of the parameters, the process conditions and the functioning of the entire line through a Siemens PLC.”

“The surface treatment process of the booms is divided into 5 stages. The cycle starts with the manual sanding for the sanding of the machined carbon fibre components (Fig. 6). The second stage is a manual high-pressure cleaning station to remove dirt and residues from the surface. In the third stage, the pieces go through a drying oven at 45°C with an automatic high-energy blowing to dry off water drops. The high-energy drying oven also pre-heats the workpieces before the manual electrostatic application of the paint. The fourth stage is the application of the protective paint to the carbon fibre in a manual booth with controlled temperature at 21°C and 60% humidity via an air treatment unit. The last automatic stage is the curing of the pieces in an oven (Fig. 7) with IR lamps and recirculated air at 120°C, a small cooling section, the quality control station (thickness and curing conditions, (Fig. 8), and the unloading station,” states Sergio Mateo Teruel, the Project Manager of Cabycal. “We designed the air recirculation system of the coating booth very carefully. The air is always maintained at a

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“The line was inaugurated in March and started operating in April. It was designed for a capacity of 5 coated booms per day. King Agro is currently working at 50% of its capacity. This means it will be able to smoothly handle the expected increase in the demand for this high-tech agricultural equipment.”

controlled temperature, in line with the parameters required by the process and in particular to maintain the viscosity of the coating product. The air suction and filtration systems were adjusted to eliminate any type of residue and to keep solvent emissions below the limits imposed by the Spanish law. The infrared polymerisation oven is equipped with high energy-efficiency lamps (72 kW dedicated power). The timed IR lamps and the related workpiece temperature control with IR sensors improve the efficiency of the polymerisation stage.”

“Cabycal built a plant where many operations are necessarily manual, due to the shape and size of components, but that is equipped with the most sophisticated automatic control systems of the parameters, the process conditions and the functioning of the entire line through a Siemens PLC (Fig. 9),” says Patricia del Rio Arauzo, the Communication Manager of the Spanish plant engineering company. “The coating process is programmed on a tablet by choosing among different treatment programs

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Figure 9: The plant is equipped with the most sophisticated control systems of the parameters, the process conditions and the functioning of the entire line through a Siemens PLC.

depending on the number of paint layers to be applied and the drying and polymerisation conditions (time, IR ray intensity, and so on). An alarm system with a timer warns the operator when the polymerisation cycle is over, enabling him to immediately remove the workpiece from the oven and perform the quality control operations.”

A line ready for the expected increase in productivity

“The takt time of the line is 22 minutes. Each load bar can carry up to two workpieces at a time, depending on their size,” says Ponzinibbio (Fig. 10). “The line was inaugurated in March and started operating in April. It was designed for a capacity of 5 coated booms per day. We are currently working at 50% of its capacity. This means we will be able to smoothly handle the expected increase in the demand for this high-tech agricultural equipment.”

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Figure 10: Each load bar can carry up to two workpieces at a time.