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Integrating plasma treatment systems into the manufacturing process

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For manufacturers of products that require a plasma treatment step for cleaning and decontamination, surface conditioning or to promote adhesion, specifying and integrating the required equipment to automate the process can be daunting.

To start, many engineers only have a working understanding of plasma treatments.

Plasma is a state of matter, like a solid, liquid, or gas. When enough energy is added to a gas it becomes ionised into a plasma state. The collective properties of these active ingredients can be controlled to clean, activate, chemically graft and deposit a wide range of chemistries.

However, even when plasma treatment is identified as a critical step in the manufacturing process, specifying and integrating the "tools" required (as the equipment is called) can be even more challenging.

With so many applications and sizes of parts to be processed, standard off-the-shelf vacuum chamber solutions often do not suffice. In addition, as plasma treatment is increasingly integrated into existing production systems, so does the need to eliminate manual operations in favour of automated, "hands-off" production systems.

Fortunately, today this does not necessarily mean purchasing a custom tool. Leading plasma equipment providers can semi-customise existing mature tools and technology to accommodate new or non-standard parts. This includes providing the necessary robotics for high throughput, automated loading and processing.

"At least once a week we talk with customers about some sort of customisation of our existing standardised systems," says Walt Roloson, R&D Engineering Manager at PVA TePla, a company that designs and manufactures plasma systems. "I would estimate 60 percent of the equipment we deliver has gone through some degree of customisation."

According to Roloson, a prime example occurred when PVA TePla was approached in November of 2017 by IMA Automation Medtech, a Swiss company that designs turnkey automated assembly lines for medical devices. The request was to specify a system that would replace an older, existing plasma treatment system that required manual loading with an automated solution.

The small vacuum plasma chamber would be used to treat several "pallets" of 4-5cm items in an automated batch process. The parts were being treated with plasma as a critical surface activation step prior to the application of a coating.

Each 12" x 12" aluminum pallet held three hundred items and the requirement specified a processing time of less than eight minutes from initial loading to unloading.

The system was actually part of a larger manufacturing cell designed by IMA Automation Medtech that included a flexfeed device for loading packaged parts into the "pallets" on the front end, followed by the plasma treatment, coating, curing and then another coating/curing step.

For this project, the customer decided not to return to the original equipment provider.

"The customer was looking for a new plasma treatment solution that was not the original brand, so we were asked to find another vendor to provide a system that could be integrated into the automated line," says Ruben De Araujo, a Process Engineer for IMA Automation Medtech.

IMA Automation Medtech also wanted a plasma equipment provider that was willing to pre-test the tool to validate performance prior to delivery.

"We wanted the equipment supplier to test parts to give us confidence purchasing the system," explains De Araujo. "We were also looking for a company that was established enough to support the customer in Europe, because the line will be installed there."

After researching leading companies in the industry, IMA Automation Medtech decided PVA TePla met the requirements.

"PVA was willing to customise the equipment to fulfill our requirements," says De Araujo.

According to PVA TePla's Roloson, the initial specifications sent by IMA Automation Medtech were several pages long, complete with CAD drawings. However, as a one-off unit, the original equipment had many custom elements such as a conveyorised track that transported the pallets in and out of the vacuum chamber.

"We had never built anything like it, so it would have been a completely custom solution if we had to match it," says Roloson. "However, the general concept of automatically loading and unloading pallets with pick-and-place robots and treating parts in batches we have done many times."

To meet the requirements, PVA TePla proposed a semi-customised version of one of its smaller production-level vacuum chamber tools, because, "it could process pallets in batches and we

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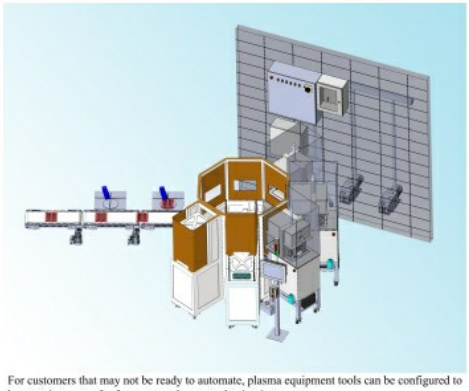
already had a kit to add robotics to it," says Roloson.

Roloson says IMA Automation Medtech had approached other plasma treatment equipment providers as well, but the quotes for a completely custom system were exorbitant. By going with a standard tool instead, and having it customised, the customer ultimately saved both time and money.

Whereas a custom system from scratch could require as much as 400-450 hours of engineering, a semi-customised system is typically less than half of that amount. Plasma equipment suppliers can also purchase components such as chambers, electrodes and pumps in bulk, often at discounted rates.

"The price for semi-customising a standard model is just a much better value overall because most of the engineering is already figured out," explains Roloson.



For customers that may not be ready to automate, plasma equipment tools can be configured to keep options open for future upgrades as production increases.

Software customisation

For the project with IMA Automation Medtech, Roloson says the most significant request was alterations to the communication and control software.

As a company that supplies automated systems to the pharmaceutical, food and medical industries, IMA Automation Medtech must comply with Title 21 CFR Part 11 regulations established by the Food and Drug Administration (FDA) for electronic records.

Part 11 requires companies to implement controls, including audits, system validations, audit trails, electronic signatures and documentation for software and systems involved in processing electronic data.

With this in mind, IMA Automation Medtech decided not to send information through standard RS-232 or Ethernet connections and instead opted to utilise a PLC-based communications and control system, both for security and to work with the other component parts of the automated line.

"Regarding the software interface to the rest of our machine, we decided the PVA TePla system should communicate with our PLCs in a way that we were sure that the data that is collected is secure," says De Araujo.

Although PVA TePla's standard systems are designed to facilitate Part 11 compliance, standard models are PC-based. To meet IMA Automation Medtech's requirement, the company's in house computer software and control engineer altered the system to communicate via PLC with digital output signals designed to read as binary code.

In this way, the PLCs could send treatment "recipes" and process the "answer values" as well as control the automated loading and chamber door opening elements. Internet communication is only used for sending batch processing data to an SQL server.

"Now we have this great dialogue PLC module for the communication with our interface," says De Araujo. "This is a very simple and secure way to communicate."

Hardware modifications

Some hardware modifications were required as well. With PVA TePla's equipment, the vacuum ports are typically located at the back of each unit. However, to match the existing system that was being replaced, IMA Automation Medtech wanted the vacuum ports at the bottom of the chamber.

The port placement was also important because it affected the flow of ionised gas over the parts. In this case, the customer was concerned about the treatment on the innerside of each part, something that was occasionally difficult with the original equipment.

By relocating the vacuum port at the bottom of the chamber, however, contact angle goniometry tests demonstrated the surface conditioning had improved.

"We did tests on the [processed part] samples they provided and the contact angle was excellent," explains De Araujo. "It was better than what the customer was getting before from the old tool port."

IMA Automation Medtech also required a special dry vacuum pump, due to the system's location in the cleanroom. The dry vacuum pumps were air-cooled as well, which eliminated the need for water pipes to cool it down.

Finally, a "slow vent" design was required to ensure the heat in the chamber does not damage the sensitive parts. Slowing the venting process ensures the insertion of air into the system at atmospheric pressure is slowed to reduce the heating effect.

Automating for the future

For those customers that may not be ready to automate, plasma equipment tools can be configured to keep options open for future upgrades as production increases.

"Some customers purchase a manual batch tool with the idea that at some point, they are going to have to automate," says PVA TePla's Roloson. "If they have a tool with our standard software, we can add a robotic interface and modify it so there is an automatic door and atmosphere switch, and it can become fully automated."

If production levels increase to even higher levels, a high throughput system can be designed by creating a cluster of plasma tools served by a single universal robot in the centre. In this way, five or six chambers can be grouped in a cluster.

"The elegance of the automated plasma treatment solutions that are available today is a new customer can leverage existing technology and know-how, as opposed to having to pay to create something that is entirely new," says Roloson.

For more information, contact PVA TePla America at 951-371-2500 or 800-527-5667 or visit www.pvateplaamerica.com.

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