Partial cleaning and surface processing of parts for E-mobility

The trend shift toward electromobility and other developments in the automotive sector have an impact on part cleaning as well. To meet altered requirements, adapted cleaning solutions are needed. In this article, Ecoclean presents a "toolkit" for the predominantly dry, partial and automated cleaning and activation of surfaces.

Over the last decades, part cleaning in the automotive industry used to be mainly about removing particles from components associated either directly or indirectly with the combustion engine drivetrain. In this field, demands on technical cleanliness are effectively met with the aid of diverse wet-chemical, and mostly aqueous, cleaning processes. However, increasing drivetrain electrification and the growing use of driver assistance systems all the way to self-driving vehicles, as well as environmental aspects such as reductions in particulate emissions, not merely bring a change in parts and components but are also transforming part cleaning tasks.

Altered requirements on cleanliness and cleaning

Thus, technical cleanliness on e-motor and battery assembly lines is increasingly gaining in importance. In both applications, metal particles may cause short-circuiting or impair the performance of the electric drive system during subsequent operation. But more exacting demands on particulate cleanliness are also emerging with regard to non-metallic contaminants. Even

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fibers may, after all, become electrically conductive by absorbing moisture later on in service.

Over and above the foregoing, clearly more emphasis is placed on film-type and/or chemical contamination today. The pivotal criterion here is the surface tension needed for downstream adhesive bonding, sealing or coating operations. Moreover, there are cleanliness aspects that are unrelated to the vehicle drive type, resulting rather from the use of more lightweight materials or new production methods, e.g., additive manufacturing. All of these cleaning tasks have something in common, viz., the fact that particulate and/or film-type contaminants interfere with the assembly process and massively affect the quality or performance parameters of the parts concerned.

Understandably, therefore, wet-chemical cleaning processes are mostly no longer the method of choice. Moreover, current product and process developments call for cleaning methods that can be integrated into production and assembly lines with maximum ease. In other words, they must be able to ensure effective automated parts cleaning within programmed cycle times to defined cleanliness specifications, and they must do so reliably and at minimum cost and effort. With many parts, high-quality partial cleaning of critical areas will suffice to ensure the necessary quality of the next production process or full component functionality, respectively.

Integration of diverse processes into one system

In response to evolved requirements in automotive manufacturing and its supplier industries, Ecoclean has developed a dry cleaning 'toolkit' for carrying out predominantly dry, selective part cleaning processes. Supporting the implementation of technically and economically optimized machine designs for diverse requirements to customer specifications, the toolkit's distinct treatment tools such as EcoCair, atmospheric-pressure plasma, CO_2 snow blasting and laser, as well as EcoChydroclean and EcoCbooster, can be employed either individually or in combination with one another.

In the case of metal parts made by 3D printing, which sometimes exhibit very complex geometries, one frequent approach is to combine dry cleaning with a subsequent aqueous cleaning process.
The ability to develop a reliable and efficient cleaning concept is essentially dependent on understanding the customer's overall production and assembly workflow. Process development and validation will then follow on the basis of cleaning trials with authentic parts in the equipment manufacturer's (or his partner's) Technology Center. Another key aspect in designing the various tailor-made equipment solutions is to avoid recontamination of the cleaned parts by vagabonding particles in the cleaning chamber.

Dry and selective cleaning

Cleaning with reconditioned compressed air may, at first glance, seem to be a fairly "simple" dry process variety. However, the quality of this cleaning treatment hinges on the conditions of application. Flow simulations for controlling the airflow from the envisaged nozzles help to achieve optimum application conditions and hence, the best possible cleaning effect. Based on the results, an adapted nozzle body meeting different nozzle functions will be designed for additive manufacturing. The removal of particles produced in creating the hairpins in stator manufacturing and during the assembly of electric motors is a classic task for a dry partial cleaning process using a combination of compressed air and vacuum technology, much like the selective cleaning of power electronics components.
Atmospheric-pressure plasma technology supports both general surface cleaning and contour-hugging, in-depth cleaning operations. The plasma source preferably employed by Ecoclean, relying on the dielectrically impeded surface discharge principle, produces a so-called "cold" plasma (30 to 60°C) and uses the substrate as bridging medium on electrically conductive materials. This makes it possible to clean and activate temperature-sensitive materials such as plastics, e.g., prior to adhesive bonding, and to treat complex geometries comprising undercuts. The range of applications for atmospheric-pressure plasma systems also includes the partial fine-cleaning and activation

of sealing surfaces on large battery housings before the sealing compound is applied.

CO_2 snow blasting, given its different active principles and easy control of the particle jet, is useful for the selective removal of both particulate and film-type contamination. The method is employed, e.g., for dry and partial cleaning of inverters. Here, cleanliness specifications call for particle sizes of less than 100 micrometers for instance. A further application consists in the removal of microburrs from housings for multi-matrix LED headlights. Made of polycarbonate, these components receive a final coating of protective varnish to avoid scratches and prevent the resulting disturbing light effects. Ahead of this coating step, a plasma-based activation process that raises the surface tension by approx. 25 mN/m is integrated into the production line.

With laser technology, the effect on metallic substrates is achieved by evaporating the layer or coating. The surface can also be roughened or textured as needed by changing the laser parameters accordingly. Typical applications of this method include, e.g., partial cleaning or paint stripping and surface roughening as a pre-treatment for adhesive bonding or sealing. Partial decoating, for instance, may also be performed to create grounding contact points.

Partial cleaning and activation with water

EcoChydroclean is a cleaning process based on the use of steam. It allows the partial removal of contaminants (both particulate and film/chemical types) from metallic and plastic components. This technology is used, e.g., for after-treatment of a sealing surface on a part that has already undergone aqueous cleaning. The surface tension on the sealing face amounts to between 30 and 35 mN/m after the aqueous cleaning operation. It is then raised to between 55 and 60 mN/m by the short steam treatment performed directly before the liquid sealant is applied.

EcoCbooster technology relies on high-pressure water blasting without any addition of abrasive agents. By means of ultrasound, the prestressed column of water is transformed into a high-frequency pulsating jet. As it impinges on a

surface, it creates a controlled cavitation effect that produces a stochastic topography on the substrate's surface within a clearly defined working range. This property is used, among other things, to selectively activate brake disks in an effective manner before they are coated by thermal spraying or thin film technology. The treatment reproducibly creates roughnesses from as low as a few micrometers through to Ra 200 µm and more on virtually all metallic materials and alloys. In conjunction with the stochastic negative texture of the surface, this property ensures that the coating material will optimally engage the brake disc substrate. This in turn boosts the brake disk's long-term corrosion or wear resistance and visual appearance. At the same time, the coating reduces the release of particulate matter during braking by up to 90% compared to a conventional grey cast iron brake disk. This makes the EcoCbooster a "clean" alternative to dry blasting processes in many cases.

Automation and integration into the production line

The automation and integration into new or existing production and assembly lines will likewise be adapted optimally to specific requirements and conditions. This may involve the realization of robotic solutions as well as of SCARA handling systems, CNC linear units or delta robots.

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The SBS Ecoclean Group (formerly Dürr Ecoclean) develops, produces and markets forward-looking machinery, systems and services for industrial part cleaning and surface treatment applications. Its globally leading solutions help companies around the world in conducting efficient and sustainable manufacturing to high quality standards. The client base comes from the automotive industry and its suppliers in addition to a broad range of market sectors ranging from medical equipment, micro technology and precision devices through mechanical and optical engineering to power systems and aircraft industry. Ecoclean's success is based on innovation, cutting-edge

technology, sustainability, closeness to the customer, diversity and respect. The Group employs a workforce of about 900 people at its twelve sites in nine countries worldwide.

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