Technical

Laser technology dedicated to mold cleaning

By Matthieu Wolff
Rep International

The first cause of mold fouling is linked to the compound used for the transformation (either in injection or compression), the type of the rubber and its recipe. The quantity of oil used in the compound recipe increases also the fouling.

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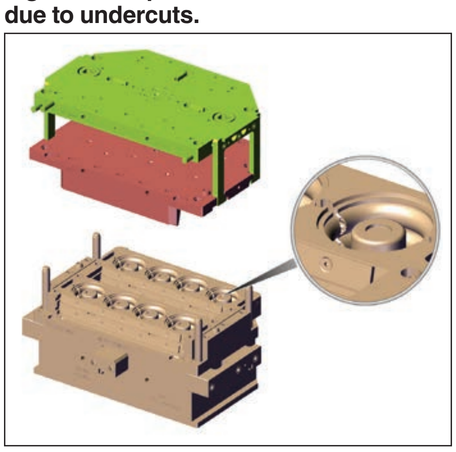
The molding conditions are the second cause of fouling. These consist of mold temperature, compound preparation temperature (set value and self-heating in the injection unit) and the self-heating of the compound through the runners during the injection phase.

Mold fouling also can be linked to the mold design and manufacturing depending on the type of steels used, surface conditions, surface treatments like chroming, geometry of the cavities that could be a simple or a more complex shape, position of the feeding point(s) and the parting lines, and the presence of vents and removing of the air by vacuum.

Fig. 1: Fouled cavity.

Fig. 2: Example of mold difficult to clean due to undercuts.



Like the mold, the part to be molded can also impact the mold fouling, of course because of its shape that can be more or less complex, but also with the possible use of inserts and therefore the use of bonding agents that could migrate from the inserts to the mold cavities.

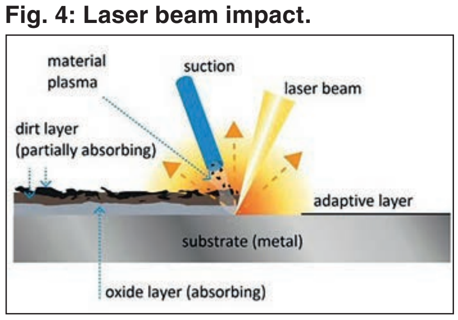
Finally, working conditions are the last possible cause of mold fouling, which include demolding agents used to make the demolding easier, undercuring of rubber parts will increase the fouling and use of demolding tools can also boost the fouling as there is a natural bonding on bronze and brass.

Mold fouling can either be generalized to the whole working surface of the mold or it can be always located in the same area of the cavity. The main consequence of mold fouling is to mark the "skin" of the molded part.

As a secondary result, the part may stick in the cavity. In the case of an automatic demolding (via a kit, brushes or a gripper) this sticking comportment increase can degrade the working conditions in automatic mode (cycle time increase, possible operator intervention, etc.).

Fig. 3: Example of part (gas mask) with some undercuts and metallic inserts.

Fig. 4: Laser beam impact.



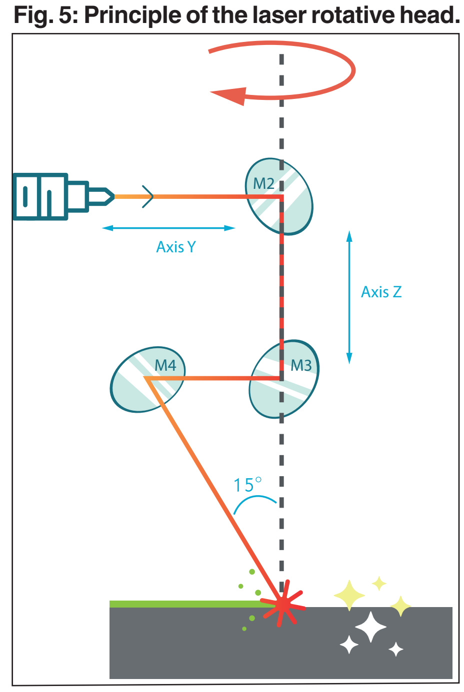
Mold cleaning

The frequency of mold cleaning is difficult to define. Depending on the type of compound used and its formula, the type of mold and also the characteristics of the final parts to be produced (appearance parts, flashless parts, etc.); the frequency of mold cleaning shall be varying—at each shift change or once a week, but usually not less than once a month.

The following orientations have been followed over the years and brought improvements:

• Ultrasonic bath: This is the most widely used method in several sectors to clean equipment. The process strips off undesired material in a non-aggressive manner. However, it is very costly and polluting. It requires the use of chemical additives (anti-grease agents, concentrated detergents, anti-corrosives, deoxidizers, etc.) This method presents risks to the health of the worker and for the environment. This also makes ultrasonic cleaning quite expensive.

Fig. 5: Principle of the laser rotative head.



The author

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He graduated from the National Institute of Applied Science in Strasbourg, France, with a degree in plastics and olymer engineering

Rep International is press manufacturer for the thermoplastic, polymer and rubber industry. The group has seven subsidiaries, with about 13,000 injection molding machines installed in 57 countries.

The use of ultrasonic cleaning also negatively impacts the user's production, because the process is time-consuming, requiring several steps: creation of a high-frequency wave; fluctuations between high and low pressure; appearance of miniscule bubbles during the low pressure periods, known as cavitation; and implosion of these bubbles upon contact with submerged surfaces during high pressure periods.

Additionally, some molds must be disassembled to allow them to be cleaned. Moreover, this process can only be used on cooled molds. The production will only restart after the mold has been cooled, cleaned, and reheated once more. At the end of cleaning, it is also necessary to plan time for the mold to dry.

• Cleaning by projection: Several different materials can be projected onto an injection mold in order to clean it, like sandblasting, plastic balls, dry ice, etc. This process needs a low initial cost, but it requires costly consumables that are difficult to store.

Projection technology is slow and, just as with ultrasonic cleaning, it only works with cooled molds. This equipment is operated manually, which results in high labor cost. The latest evolu-

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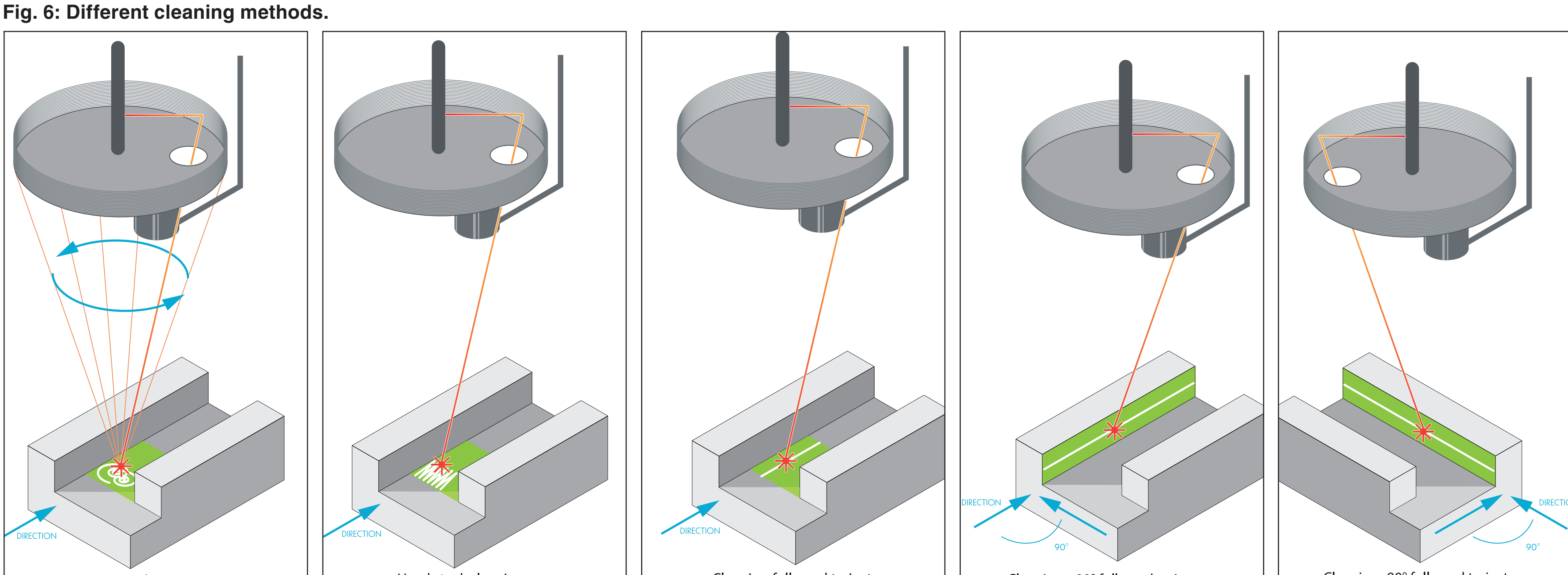
Fig. 6: Different cleaning methods.



Flow Dry buys Ohio injection molding company

By Steve Toloken
Plastics News

BROOKVILLE, Ohio—Flow Dry Technology, a Brookville-based maker of adsorbent products, has acquired a small injection molding company that was a key supplier, in a bid to expand its offerings in thermal systems in automotive and other markets.

Flow Dry said the purchase of Elliott Manufacturing Co., also in Brookville, is its first acquisition of plastics molding capability.

It announced the deal Aug. 2 and noted that EMC has been a supplier of Flow Dry since 1986.

"This is a very strategic acquisition for us," President and CEO Rahul Deshmukh said. "Their injection molding capability and expertise perfectly complement our vertical integration growth strategy."

EMC's material expertise includes engineering grade thermoplastics, filled nylons, and molded rubber among others. The company manufactures a wide variety of plastic injection molded parts, as well as partial and complete assemblies for the automotive, aerospace, medical and consumer products industries on a wide range of molding machines ranging from 33 to 275 tons.

Flow Dry's products, which absorb moisture in air conditioning systems, are used in 8 of 10 cars in the U.S. and Europe, and are in the supply chain of all the major global car makers, he said. Deshmukh sees the acquisition as a path to provide more complete assembly solutions to its Tier 1 automotive customers and others, and grow in a niche where it already has a large global market share.

"Instead of giving them just a component, we can give them a full assembly," Deshmukh said. "Now we can expand beyond the desiccant and filter and the plug to other plastic components in the thermal systems."

Flow Dry has more than 200 employees globally, and has factories in Zhangjiagang, China, near Shanghai, and in Hungary. More than 50 percent of Flow Dry's sales come from outside North America, he said.

Deshmukh declined to reveal terms of the purchase but said all EMC employees except the Elliott family, who started the company in 1973, will remain. Milton Elliott will stay on for a year during the transition, he said.

Deshmukh said a "big piece" of EMC's sales went to Flow Dry.

Flow Dry is adding people to the EMC operation and wants to grow that business, he said. It's also looking at other acquisitions, Deshmukh said.

"The car makers are pushing more and more demands on their Tier 1s, who are our customers," he said. "The goal is to use this as a nucleus to grow the business."

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tion of the projection technique is the use of dry ice which is not abrasive. Nevertheless, prolonged use of dry ice results in heavy humidity, which can lead to the oxidation of molds. This process is also very noisy (over 105 decibels), and therefore requires the use of hearing protection equipment.

• Portable laser cleaning: Theoretically it's easy to be used on site as the equipment is portable. But it requires important individual protections and a protection of the zone to be cleaned. There is also an important risk for the operator and all other people close to the cleaning area. This equipment is operated manually, which results in higher labor costs.

The use of a portable laser doesn't allow for a regular scanning of the cleaning area (variable distance between laser and contact surface, longer paths in some areas, omission of some areas, etc.).

Laser cleaning is a non-destructive method that only impacts the pollutant and does not degrade the substrate. When the beam strikes the material to be cleaned, it creates highly compressed plasma, which relaxes by creating a shock wave. This sudden expansion volume ejects the dirt. The fast pulse (10ns) prevents thermal effects from taking shape.

Improved laser cleaning

The idea is to benefit from the above mentioned advantages of laser cleaning with the following improvements:

• Laser in a closed enclosure for safety purposed;

• Regular scanning of the cleaning area and repeatability thanks to preprogramming of the laser path via a DXF file (CAD drawings); and

• A mobile machine mounted on wheels.

The laser beam of the machine is supplied by a movable rotary head and plane mirrors allowing for a maximum reflection of 1064 nm. The cleaning head moves along 2 axes: the X axis and the Y axis. The cleaning head can move along a 575mm X axis and a 420mm Y axis.

At the rotary head, the beam is redirected to the mold (Z axis). One specificity resides in the movable head because it allows the laser beam to reach the mold with an incidence of approximately 15° around axis Z.

Different cleaning methods can be used, depending on the type of mold and dirt levels. The cleaning modes are:

• Rotating cleaning: To clean with all orientations of the beam;

• Head stuck cleaning: To clean with a fixed and predefined orientation;

• Cleaning followed trajectory: The orientation of the head follows the path, ideal for cleaning the bottom of a groove with precision;

• Cleaning + 90° trajectory followed: The orientation of the head cleans accurately one side of a groove; and

• Cleaning path -90° followed: the orientation of the head cleans precisely the second side of a groove.

Laser cleaning can be used to clean rubber and gas fouling, to remove demolding/release agents fouling and also to remove the corrosion of the mold, without damaging the surface treatments of the molds.

Process parameters to achieve for a good and quick cleaning are first the cleaning method, and then the laser power and the laser speed displacement (**Table 1, 2**).

Conclusion

All people from the rubber field are confronted to mold fouling issues. There are different ways to clean the molds starting from the use of simple manual tools (like brass polish or brass rods) which remains a long process to some more industrial processes as described just before.

Compared to the other solutions, the mold laser cleaning machine has the advantage of being a reliable, quick, safe and eco-friendly solution with a quick return on investment for mold cleaning. It provides rubber manufacturers with reduced operating cost, a no consumable, automatic cycle with reduced manpower.

Production shutdown times are reduced because there is no need to cool down the molds and then heat them again. Plus the possibly exists to program a faster cycle by cleaning only some dedicated and fouled areas and therefore to space out the complete cleaning of the mold.

Installation costs also are reduced because there are no chemical materials to handle and secure. The process is silent, eliminating the need for noise protection. And the process is compact and mobile reducing the amount of floor space required to implement.

Rep International now offers a machine that satisfies such requirements, called REP MLC500 by Laselec. It allows cleaning hot molds and reusing them directly inside the press. The MLC500 is suited for sealing applications and is equipped with a rotating head used for the cleaning of a targeted area.

Fig. 7: Laser cleaning examples.

Table 1: O-ring mold 150 cavities.

- Mold 500x500 mm, two plates
- Steel: C45
- Type of fouling: EPDM rubber
- Cleaning method: rotating cleaning
- Laser speed: 12 mm/s
- Laser power: 13 W
- Cleaning time for the two plates: 30′

Table 2: Metal/rubber part mold 8 cavities.

- Mold 510x630 mm
- Steel: stainless steel
- Type of fouling: rubber + release agent fouling
- Cleaning method: rotating cleaning
- Laser speed: 50 mm/s
- Laser power: 13 W
- Cleaning time for the whole cavity plate: 11′

Fig. 8: O-ring mold cleaning.

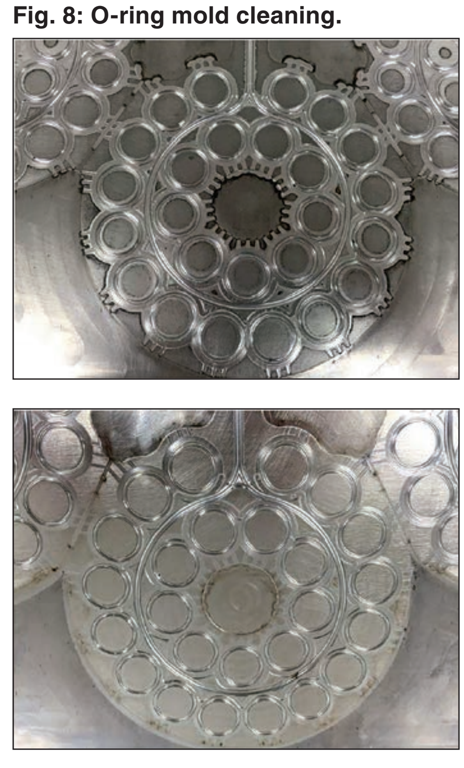

Fig. 9: Laser cleaning example – Half cavity cleaned.

Fig. 10: REP MLC500byLaselec.