

V. Tire Mold Cleaning Methods for CO2 Particle Blasting Technology

Sidewall Spot Cleaning and Automated Total Mold Cleaning - Separate Methods With Different Purposes

Although CO2 particle blasting is most effective in hot molds, at or near cure temperature, it is still not practical to perform total mold cleaning in the press with hand-held cleaning applicators. The environment of the presses and molds is extremely fatiguing and potentially hazardous to a worker performing manual mold cleaning. Temperatures above 300° F, close-in access to critical areas to be cleaned, noise, fumes, limited visibility, etc. all add up to make this task unsuitable for a human being to perform manually.

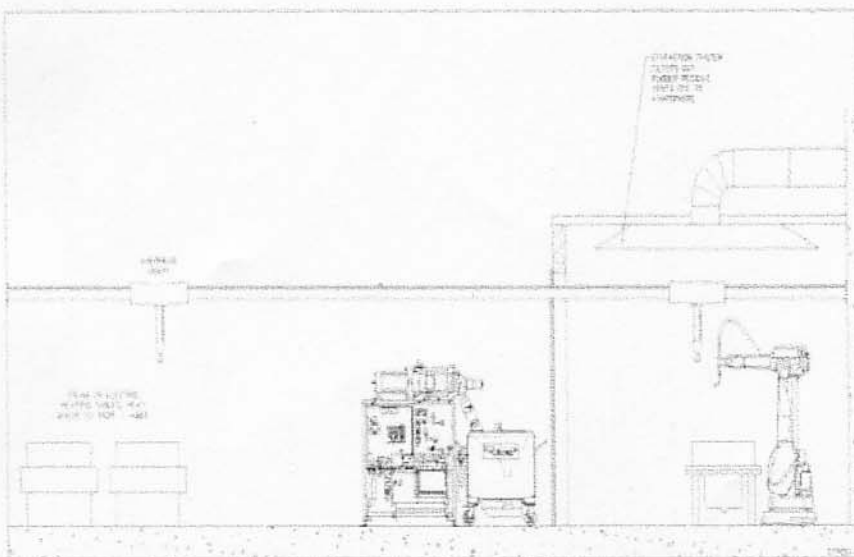
CO2 particle blasting is a "line-of-sight" cleaning technology. Like any blasting method, tread area "shadowing" and missing micro vents in the tread and bead areas are problems with manual mold cleaning in a tire curing press. Furthermore, in presses that open vertically rather than "clam shell" or tilt back type tire curing presses, it is impossible to position the head and torso to see and aim the stream of CO2 particles into all the complex cavities which make up the tread pattern portion of a tire mold, not to mention attempting this while crouching inside a 300° F lower tire mold cavity.

Manual CO2 particle blasting in the press is only suitable for relatively quick spot cleaning of mold sidewalls (D.O.T. lettering, logo, and some sidewall vent clearing). In-the-press sidewall spot cleaning can extend the number of cure cycles until total mold cleaning (pulling the mold) is necessary by a factor of 2 to 3 times. Routine sidewall spot cleaning with CO2 blasting generally allows a tire manufacturer to produce blemish free tires for an entire production run, or until normal press maintenance requires that the mold be removed.

The benefits inherent with CO2 particle blast tire mold cleaning are derived by (1) establishing a manual "sidewall touch-up / cleaning" maintenance routine which keeps the operator's exposure and risk to a minimum, and (2) installing an automated, robotic CO2 particle blast cleaning system for total mold cleaning when the molds are pulled out of the presses for scheduled press maintenance.

A robotic CO2 mold cleaning system is pictured in **Illustration 1**, on the next page. This is a "generic" layout based on an actual operating system. This configuration could vary significantly from one tire manufacturing facility to another. The common requirements are (1) a robot located in a sound-proof, adequately ventilated "booth", (2) a source of 200 + psig clean, dry, compressed air, (3) a means to heat the out-of-press fouled molds to 300° F or higher, (4) a CO2 particle generator (pelletizer) and a CO2 particle blasting system, with a robot adapted nozzle, (5) a means and method to stage the fouled molds for cleaning, move the molds through the system, inspect the molds for complete removal of all fouling, and clearing of all vents or microvents, and stage the molds for reinstallation into the presses.

Elevation View of Robotic Total Tire Mold Cleaning System...



Plan View of Robotic Total Tire Mold Cleaning System...

Trial #	Tire Code	Cycle Time (min:sec)	Threshold Setting (80 dBA)	Threshold Setting (90 dBA)	Nozzle Pressure psi	Pellet Flow Rate (%)
Segmented						
1	P225/50R16	13:53	98.08	97.61	40	55
2	P225/50R16	8:25	97.73	97.14	50	55
3	P225/60R16	7:00	97.49	97.1	60	55
4	P225/60R16	6:49	97.67	97.08	60	55
Two-Piece						
1	LT265/75R16	13:03	86.48	74.37	50	55
2	P275/60R15	8:27	95.93	96.28	55	55
3	P275/60R15	7:50	95.91	96.38	60	55

Table 5. Noise (SPL) Generated While Cleaning Tire Mold Sidewalls with a Single Hose CO2 Pellet Blasting System.

Redeposition of Mold Fouling Residue It is certainly true that the use of solid CO2 as a surface cleaning media creates no significant secondary waste stream. Over time, however, the fouling residue "dust" which leaves the mold surfaces will redeposit on other parts of the presses and machinery, the floor, and even the walls of the curing room. Although redeposited residue build up may take weeks or months to even become noticeable, it is in the best interest of the tire manufacturer to deal with it first hand. To date, the most effective and proven method to curtail residue redeposit is to provide adequately sized (CFM) air extraction hoods or returns close-in to the presses, so that the normal facility air handling system can capture most of the airborne residue particles and bring them to a central filtering station. As discussed earlier, if only mold sidewall maintenance is performed in the press rows, then the amount of airborne residue is dramatically reduced. The bulk of the residue will be captured in the dedicated robotic total mold cleaning system. A less appealing alternative to reduce redeposited residue is a point-of-application effluent capture system. These systems are available from the CO2 tire mold cleaning system suppliers, and can capture residue during the blasting process. They do, however, add bulk and weight to the hand-held nozzles, and require an additional piece of equipment (vacuum system and filter module) which must be moved in and out of the press rows.

VI. Emerging Tire Mold Maintenance Technologies

Coated Molds

The most promising R & D work occurring to reduce mold fouling is the development of "permanent" coatings for aluminum and steel mold surfaces which significantly minimize residue adherence and build-up. Early testing with proprietary coatings applied to production tire molds have shown that the molds can remain unfouled for more cure cycles than identical uncoated molds. When the coated molds eventually accumulate residue build-up, the fouling can be easily removed by CO2 particle blasting, without damaging the coating layer. Once again, with the advent of coated molds, the single hose direct acceleration CO2 particle blast systems will offer the most benefit because these systems can utilize blast nozzles with widths up to six (6) inches wide and at the low pressure and kinetic energy level required for the coated molds. Cleaning coated passenger, light truck, and even large commercial truck and rear farm coated tire molds will be fast and easy at very low noise, air pressure and CO2 pellet flow rates by employing the very wide nozzles available only with single hose systems.

Ventless Molds

A major quality driver in the tire industry is aesthetics, specifically product appearance. The trend today is to produce tires devoid of the "whiskers" produced by vents or microvents. While many customers, especially the Japanese, are pushing the tire industry toward tires free from "whiskers", there is still the majority of consumers who wholeheartedly believe that unless they can see "whiskers" on their tires, they aren't convinced that the tires they are buying haven't been re-capped.

>While ventless molds may address the requirements of OE customers, they may go against the desires and beliefs of those customers in the replacement market. Regardless of what the tire industry does, CO2 particle blasting technology will still remain the preferred way to clean these types of molds for all the reasons previously mentioned in this paper.

Laser Mold Cleaning

Laser tire mold cleaning technology is now available in its "early adopter" stages. This technology has shown adaptability for cleaning the surfaces of passenger and light truck tire molds, even while they are in the press, but it is questionable if it is able to consistently unplug vents or microvents, particularly in the tread and bead areas of molds. Based on current information, the investment required for a press row capable mobile laser system is two to three times that required for an automated CO2 particle blast robotic system, and 25 to 30 times the cost of a portable, manual sidewall spot cleaning CO2 system.

VII. Additional Uses for CO2 Particle Blasting Technology in Tire Manufacturing Facilities - Further Productivity Gains

The very same portable CO2 particle blasting systems which are used primarily for tire mold sidewall spot cleaning have many other proven uses in tire manufacturing facilities. Currently, tire industry users of this technology are applying it to the cleaning and maintenance of Banbury mixers, extruders, tire building machines, cleaning residue build up from load wheels, and general cleaning of the presses during downtime maintenance. Another possibility being explored is white sidewall grinding dust removal. When assessing existing and newly emerging tire mold cleaning technologies, the adaptability of CO2 particle blasting technology to many other aspects of the tire manufacturing process, and the overall favorable impact to product quality and manufacturing productivity, should not be overlooked.

VIII. Summary

From the standpoint of fixed (purchasing the system equipment) and operating (electricity, compressed air, CO2 pellet media) costs, cost-to-benefit ratio studies conducted by major tire manufacturers have proven that CO2 particle blasting technology is currently the best choice for tire mold cleaning.

The single hose "*direct acceleration*" solid CO2 particle blasting system is preferred over a two hose inductive system as the most capable for maintaining tire molds or mold sidewall areas in an un-fouled condition throughout a tire production run. It is the high level of kinetic energy provided which is capable of clearing clogged vents and microvents, and for removing relatively thick residual rubber in the corners of tread sipes and lettering. Further, it is the thermal effect of the CO2 media for quick removal of the glass-like overall fouling residue, that gives the single hose system its "double punch" for quick, efficient, and complete tire mold cleaning.