Introduction to Green Manufacturing

by Kumar Balan
Wheelabrator Group

A significant shift in manufacturing techniques is being noticed in developed economies all over the world. Smarter and leaner production techniques have displaced inefficient means of production. On a more noticeable level, hybrid vehicles are beginning to populate our roads. The term 'Green Manufacturing' has established itself in the vocabulary of engineers and manufacturing professionals.

What does this mean?

Green Manufacturing is generically defined as 'elimination of waste by re-defining the existing production process or system'. Several other jargons such as 'end-of-line management' mean the same thing. We have all come across company examples that take their problem solving approach to the next level and develop innovative techniques towards effective solutions. Such solutions result in cost savings from reduced work handling, effluent control, process automation, etc. All these efforts are applications of green manufacturing.

This manufacturing concept is not just restricted to addressing the social and environmental impact of a pollution-centric process. Green manufacturing addresses process redundancy, ergonomics and cost implications due to faulty methods of producing goods. Faster and cheaper are no longer the only two criteria in manufacturing a product or evaluating an existing process line. Several other factors such as materials used in manufacture, generation of waste, effluents and their treatment (or possible elimination), life of the product and finally, treatment of the product after its useful life are all important considerations.

How does this relate to the blast cleaning and shot peening industries? Surprisingly, in many important ways! Right from the early days of blast cleaning components, this process has unfailingly generated dust. Every responsible blast equipment manufacturer and operator has, with a great deal of concern, adopted traditional and innovative means to contain, filter and dispose off this dust. This, at the grassroots level, has been our initiation into green manufacturing. History has shown the effectiveness of this process and its implementation in several industry sectors to clean, etch, de-burr and strengthen metal components.

Further development of the technique of blast cleaning resulted in the creation of standards of cleaning and parameters of peening, eventually increasing the application base. There are very few manufactured components that, at one time during their manufacturing process, have not been through a blast machine!

Green manufacturing as it relates to blast machines

Blast machine (cleaning and peening) users will gladly share their experience pertaining to their machines and maintenance aspects. It isn't uncommon to hear comments such as, 'we blast it because our customers insist that we do'. As disturbing as that sometimes sounds to a blast machine manufacturer, it's not far from the truth. However, on further exploration, the true purpose gets clearer.

Casting defects that could have led to scrap parts, potential rejected parts from the customer or even defective finished goods that fail prematurely get revealed at an early stage due to blasting. Premature tool wear is avoided by presenting a blast cleaned part to a machining center. With shot peening, the life of critical aerospace components is enhanced. Closer to home, in the automotive sector, components achieve greater strength when peened, permitting the use of lighter (stronger) components, reducing weight and improving mileage while maintaining reliability. Therefore, users of blast cleaning and shot peening processes play a very important role in everyday life instances.

So, how do all these relate to green manufacturing?
With the above background, consider the following in a macroeconomic environment:

Processing parts through a blast machine reduces incidences of waste in downstream production where these parts are required. Increased life of shot peened components has a direct bearing on eliminating short lived parts that are relegated to waste sites. (It is worth noting that several re-manufacturers of auto components process stators and alternators through a blast machine to clean them prior to re-building for supply to the aftermarket auto industry.)

A clean part offers better bonding, whether it is paint, adhesives or any such coating when compared to a part that hasn't been blasted. The savings in paint and other materials are significant, especially in high-volume environments. Preservation lines, commonly found in shipyards and large metal processing facilities, consist of a pre-heater and blast machine upstream to the paint booth. Plates and profiles are treated through the blast machine and cleaned to a near-white or white metal finish to ensure uniform paint adhesion and consistent dry film thickness (DFT).

Blast cleaning techniques, both manual and automated, are used globally by new and re-conditioned railcar manufacturers. End goals are the same – to minimize paint usage for economical operation. Also included as a goal is the reduction of volatile organic carbons (VOCs) and paint effluents. Hot rolled steel strips are cleaned in a series of blast machines for descaling purposes – a process that could have alternatively been carried out in a series of acid filled tanks, resulting in severe environmental impact when treating the effluent.

Blast cleaning and shot peening
Though the latter is sometimes used when carrying out the former, the differences between blast cleaning and shot peening, and their results are quite significant. Blast cleaning is just that, cleaning a component that has either rust, scale or some such impurity, with an effort to prepare the surface for a future coating stage. The effects are verified by purely visual means specified by SSPC (Society for Protective Coatings).

In comparison, shot peening is a clearly defined process with quantitative results. Components are peened to obtain specific results of intensity and coverage. The subjectivity of results obtained in a cleaning operation is absent in shot peening. Intensity results are checked using Almen strips and then used to plot a saturation curve. Additionally, the process is specification driven by the OEMs in aerospace and automotive. Parameters such as media size, hardness are also stipulated by the OEM.

Cleaning is an art, peening is a science!
Blast cleaning and shot peening can be carried out using either centrifugal blast wheels or compressed air nozzles, depending on the application. Centrifugal wheels are used when processing large surface areas and for higher productivity. Nozzles are used when targeting specific areas in the part and when using non-ferrous media.

So, how does this discussion relate to green manufacturing?
Whether with compressed air nozzles or blast wheels, shot peening requires monitoring and closed feedback loops for critical process parameters such as media velocity and media flow. Except for media velocity, which is controlled by varying the wheel speed in a wheelblast machine, and compressed air pressure in a nozzle machine, other parameters are monitored and controlled using common components in both types of media propulsion systems.

With these controls in place, the wheel or the nozzle receives only the right amount of shot required for peening. This means less waste by way of shot breakdown and reduced dust generation.

In a wheelblast machine, this means the right amperage is drawn and therefore effective utilization of power. Closed feedback loop to ensure optimum shot velocity eliminates waste of compressed air (and the power to generate it). Classification of shot size (using vibratory classifier) and separation of non-rounds in case of steel shot (using spiral separator) result in the correct media type in the machine. This eliminates incidences of re-work.

Peening results are required to be consistent and repeatable. Control of process parameters makes this goal possible and renders the process inherently 'green" in nature.

The discussions so far have revolved around how blast cleaning and shot peening are inherently green. In order to refine this discussion, it is important to consider the following points in the routine use of this process that will maintain its 'green' nature.

Some cleaning and peening processes dictate the use of non-ferrous media such as aluminum oxide, silicon carbide and glass beads. While the first two are more aggressive in their cleaning nature than glass beads, they also breakdown faster and wear cabinet and nozzle parts much quicker than other non-ferrous media. Unless dictated by the process, it is advisable to first try out metallic media such as steel shot or cut wire as alternatives. Ferrous media breaks down at a rate of 0.01% while aluminum oxide under the same process parameters experiences a 7% breakdown rate! Choice of media should be carefully evaluated. What appears as a short term gain may not continue to be so in the longer term.

Conditioned cut wire (CCW) displays greater consistency in size, density, hardness and acceptable shape than cast steel shot. Defect free internal structure results in greater durability. Dust generation with CCW is the lowest among comparable blast media. CCW is rapidly being employed as the peening media of choice in critical peening applications because of these qualities.

Blast wheel setting (control cage settings determine the point where the media exits the blast wheel housing) is critical in ensuring that the blast media targets and hits the required area rather than blasting areas of the cabinet resulting in uneven wear and wasted energy.

Blast nozzles that are automatically manipulated increase their effectiveness by maximizing their blast pattern in required areas.

Hybrid machines eliminate the need for two separate machines in applications where large surfaces as well as specific areas need to be addressed. The cost savings and savings in utilities and operations need little elaboration.

Blast machines and ventilation

Blasting processes, whether with ferrous or non-ferrous media, generate a lot of dust. Sources of dust include (a) breakdown of blast media and (b) scale or other contaminants dislodged from the component being blasted. By design, blast machines have to be ventilated and the dust filtered in order to avoid contamination of ambient air.

Collectors are available in two types – dry and wet. Dry collectors with cartridge style filters and bag houses with bag (sock) style filters are more commonly used. Wet collectors are required when filtering ventilation air that contains certain hazardous material with a propensity for fire or explosion.

Filtration of dust in itself is a process related to green manufacturing. Further, the following points will help optimize this process:

- A pre-collector (such as drop-out box, cyclone and abrasive trap) to reduce dust loading and reduce the chances of explosion when filtering dust that is explosive in nature
- Design of ventilation system (ventilation volume and static pressure) as per universally accepted standards such as ACGIH (American Conference of Industrial Hygienists)
- Ensure that there are no leaks in the ventilation ducting
- Conduct routine air movement measurements (velocity and flow)

Other developments leading to green manufacturing goals in blast machines

Airblast rooms are the most commonly used manual blast machines. Such rooms employ both full floor and partial floor media reclaim systems. Reclaim systems are comprised of screws and belt and bucket elevators which are driven by gearmotors of different power ratings.

In a typical airblast room with a full floor reclaim system, all the screws and bucket elevator are always in operation. However, the media flow rate generated by even multiple operators blasting simultaneously doesn't warrant operation of the reclaim system continuously. The following could be considered and evaluated for suitability:

- Partial floor reclaim systems if the production rate isn't very high and a certain amount of manual labor is acceptable
- An 'abrasive on demand' system where the reclaim system operates as needed. A sensor in the media storage hopper senses the level of media and when low, actuates the motors in the reclaim system to turn the lower reclaim system to transfer abrasive to the upper storage hopper area and thereafter to the blast tank. This arrangement results in optimum power usage and reduces wear on reclaim system components.

The future of blast machines in a 'green' manufacturing environment

As green manufacturing gains greater levels of credence, blast machine manufacturers start exploring avenues to augment the production environment with better suited machines. Some of these initiatives include:

- Monitoring power and peak demand of motors with an effort to effectively manage energy (this is particularly important when operating a machine with multiple blast wheels and high HP motors).
- Human Machine Interfaces (HMI) that are highly intuitive and provide real-time information.
- Vibration monitoring to predict behavior and maintenance requirement for bearings and other wear items.
- Sound insulation techniques using sound curtains and other innovative materials (ergonomic operation).
- Reduction in abrasive leakage using aircraft-type profile seals around the door openings.

In summary, green manufacturing is more than a social cause. The benefits of adopting this technique and related costs are easily justified considering the benefits of adoption. In our own scale, in the blast cleaning and shot peening universe, let's innovate and set a precedent for downstream and upstream processes.