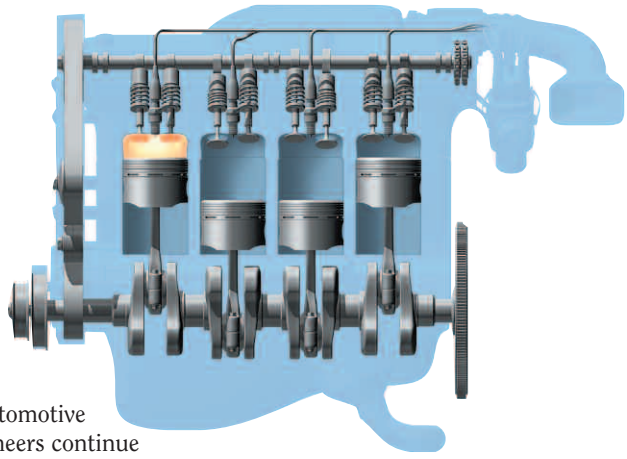
Specialty Automotive Peening Applications

by Kumar Balan



Automotive engineers continue to rely upon the benefits of shot peening to enhance the useful life of parts they design for cars, trucks and other vehicles of common use. An extension of this utility can also been seen in design of stationary engine components. Commonly, the following components in an automobile are shot peened.

- Crankshafts (descaling and peening)
- Connecting Rods (peening)
- Transmission gears and other shafts
- Ring gears, pinions, sun and planetary gears
- Leaf and coil springs

A large volume of automotive parts, manufactured as castings, forgings, machined components and weldments are also processed in different styles of blast machines to remove scales, burrs and other non-desirable visual surface characteristics.

With shot peening, users have experienced life increases from 600% in case of leaf springs to 1500% for transmission gears.[1] With specific reference to crankshafts, life increases of about 900% have been achieved with shot peening. Needless to say, fatigue life enhancements brought about by the process offer a multitude of advantages. Parts can be designed smaller, lighter and expensive materials can be substituted with lower cost alternatives.

Crankshaft Manufacturing – Blast Cleaning

Heat treated crankshafts are blast cleaned to remove surface scales as part of the manufacturing process. Crankshafts are loaded between spinning rollers that expose the part to multiple blast wheels while traveling under the blast stream. A combination of complex angles created by this relative motion cleans the entire outside diameter of the crankshaft.

The size of the crankshaft determines the type of machine it is processed in. For larger engines, with crankshaft sizes up to 30" (762 mm) diameter x 20'. (6096 mm) long, the part is loaded between a set of rollers mounted on a work car (as seen in inset). Various arrangements are possible to present the part to the wheel. Depending on space constraints in the user's production facility, the work car could be moved under the blast wheel, or the wheel(s) could be moved over the stationary work car. In either case, the crankshaft is steadily rotated while being cleaned.

Smaller crankshafts, typically in the size range of 6" to 8" (152 mm to 203 mm) diameter x 36" (914 mm) are processed in spinner hanger style machines. One or two such crankshafts are suspended from a hanger hook and processed through a blast cabinet with multiple blast wheels. The hanger spins inside the blast cabinet and provides exposure to the parts being processed inline. This arrangement presents higher productivity than batch style machines used for heavier crankshafts.

In either arrangement, the process is very effective in cleaning heavy annealing scales to a production rate of about 250 parts per hour in a spinner hanger style machine.

Though not as critical as would be in shot peening applications, modern blast cleaning machines for crankshafts are monitored for different process variables in order to maintain cleaning quality.

Shot Peening of Crankshafts

The general equipment design prevails whether a crankshaft is blast cleaned or shot peened.

However, when shot peening crankshafts the purpose and goal is more defined than simply inspecting the outside area for cleanliness (descaling). Shot peening induces favorable compressive stresses on the part thereby enhancing its useful life. The measurement of this stress is calibrated in the form of "Almen Intensity" on multiple Almen strips located at various areas along the crankshaft. Coverage, which is the amount of exposure seen on the surface of a crankshaft during peening, is also usually defined by the crankshaft designer and could be in the range of 100% to 200% and sometimes higher depending on the application where this crankshaft is employed.

Though the entire crankshaft is processed in a peening machine without the need for masking any specific areas, highly stressed areas that are critical in failure analyses are those where the intensity is measured. Almen blocks fitted with test strips are mounted in areas of maximum fatigue concentration such as fillets adjoining the ends of bearings on the main and crank journals (root portion of shaft and connecting rod attachment).

Given the hardness of crankshafts and desired induction of compressive stress, hard shot (50 to 55 HRC) in the size range of S 280 to S 330 (0.7 mm to 0.84 mm) is used for peening. This produces Almen intensity in the range of 0.008 to 0.010 C (0.025 on the A scale).

When compared to blast cleaning, shot peening assumes greater process criticality. The following process parameters are monitored in crankshaft peening applications:

- Media flow rate (using flow control valves such as MagnaValves from Electronics Inc.)

- Wheel speed (and thereby shot velocity and intensity) using variable frequency drives on blast wheel motors
- Variable travel speed for work car (or blast wheel traverse)
- Variable rotational speed for part spinner rollers
- Shot size control (using vibratory classifier)
- Blast wheel size used for such applications is in the range of 19.5" diameter (495 mm) and higher

Other Automotive Peening Applications

This discussion will remain incomplete if no mention is made about peening techniques for other parts of the automobile that experience cyclic working stresses. Some of these areas and peening solutions include:

- Ring gears and pinions are peened to induce compressive stress in the tooth root areas with exposure on the drive and coast faces. Peening is carried out in air type or wheel type machines
- Leaf springs are peened in centrifugal wheel type machines in an inline orientation. In some cases, leaf springs are pre-stressed and then peened to further enhance their useful life
- Coil springs are peened in a wheel type machine with vertical fingers to convey the springs through the machine and spinner rollers to rotate them under the blast stream
- Torsion bars are peened in the vertical orientation in a spinner hanger style machine

Conclusion

Awareness of the benefits of shot peening has certainly grown from the blacksmith hammering a piece of leafspring to impart better wear characteristics. Contemporary shot peening machines have sophisticated computer controls that monitor the process to ensure repeatable and consistent results. Such systems ensure tighter control over the process, resulting in alarms for non-critical faults and shut-down commands during occurrence of critical faults in the machine. Peening equipment designers are highly cognizant of the importance of such checks and non-compromising product quality that their customers are faced with in their manufacturing process. Peening equipment design is therefore geared to partner with other sophisticated manufacturing equipment in an auto parts manufacturing plant.

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[1] Shot Peening – An Ancient Art and a Modern Process (published by Wheelabrator Corporation)

Kumar Balan is a Product Engineer with Wheelabrator Group Equipment/Process Design & Specification Conformance. We commend Mr. Balan for advancing proper shot peening practices to the industry.