Dipl.-Ing. Volker Schneidau | Managing Director | www.sentenso.com

Visualization and Analysis of Media Speed

THE SURFACE EFFECTS of a shot peening process are mainly determined by peening media properties and the velocity and direction of the media particles relative to the surface. Because of the difficulties to determine impact velocity and angle, the U.S. engineer, John O. Almen, invented an alternative parameter to characterize the surface impact—the shot peening Intensity. While this parameter has been used for almost 80 years now, modern process control can substantially be supported by means of media speed analysis. Media velocity can be used to quantify the media impact as it represents the real process value. This approach is legitimate if media quality and impact angle can be considered as fully controlled. This is the case if media quality is well maintained and impact angle is reproducible by reliable nozzle alignment or robotized nozzle movement.

Limitations to Intensity Determination

Shot peening Intensity is well established and together with media properties and surface coverage it represents one of the three essential parameters to characterize the shot peening process. Still we have to realize that Intensity can be quite a fuzzy figure. There are several limitations to the Intensity representing the real surface impact:

- Two or three dimensional surface curvatures cannot be represented by a flat Almen test strip which is used for determination.
- In fixtures representing the peened part, Almen test strips and holders interfere with the particle stream and reflection and thus lead to unrealistic impact scenarios.
- Saturation curves used to determine Intensity are tending to being stretched and providing unclear values when media size distribution and media speed distribution is not tight enough.

In shot peening machines with controlled nozzle handling, it is often possible to replace Almen fixtures representing the part by Almen strips being placed on fixed positions in the machine and peened under stable conditions. Still the strips have to be peened in several steps and due to the manual measurement procedure, measurement tolerances, and Almen strip tolerances, errors have to be taken into account.

Another problem is that in process development finding the correct Intensity can be a long-lasting procedure of trial and error, with a lot of manual and costly proceedings.

Once the process has been defined, Intensity verification for repeated production needs less strips but still requires manual operations. Intensity verifications can occupy up to 30% of the machine capacity in complex applications. Even new inventions like the E-strip sensor may support Intensity determination in a limited range of applications but requires sensitive equipment and will not solve the problems mentioned above.

Alternative or Extension to Impact Characterization

The key reason for limited stability of impact characterization by Intensity is its empirical approach. So it is obvious to replace or extend this approach by an analytic method. Provided that media quality is well maintained and the impact angle is controlled by stable part positioning and reliable nozzle arrangement, the media travel speed when reaching the surface is the key figure to determine the impact.

Based on this idea there are several systems in place which analyse the media velocity by means of laser or non-laser particle illumination and photo-electric sensors like in the ISIC from KSA in Germany, the ShotMeter from Progressive in the US, the Tecnar in Canada, or the ShotWatch from Oseir in Finland.

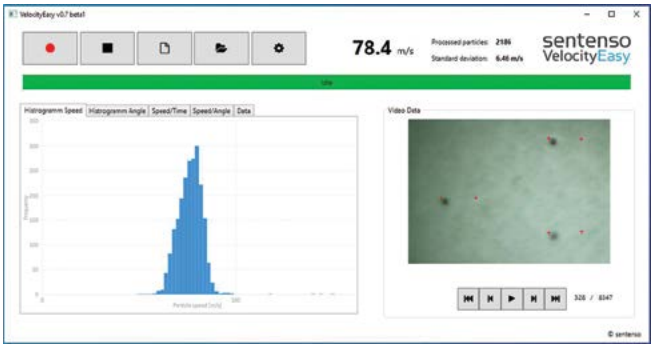
Particle Tracking with High-Speed Camera and VelocityEasy

sentenso Smart Peening Solutions now presents VelocityEasy, a user-friendly software solution for evaluating video images from a high-speed camera. It is now possible to analyse trajectories and to determine particle velocity range with a comparatively simple measurement setup. This setup consists of a high-speed camera with network connection and a high-intensity illumination unit for recording the fast peening particles which are viewed in incident or backlight.

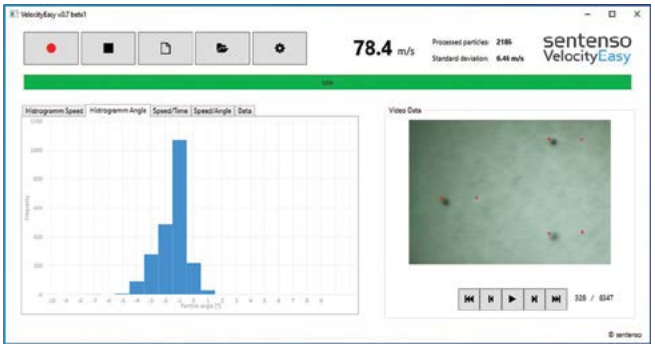
The VelocityEasy measurement setup

The particle tracking features include:

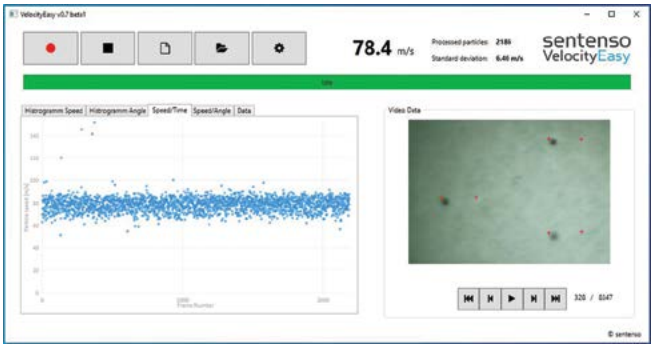
- Visual inspection of particle movements on the video image sequence
- Determination of particle velocity distribution in a histogram
- Determination of particle flight angle distribution in a histogram
- Determination of velocity over recording time in an XY diagram
- Determination of velocity over flight angle in an XY diagram
- Output of measurement data for all detected particles in a log file



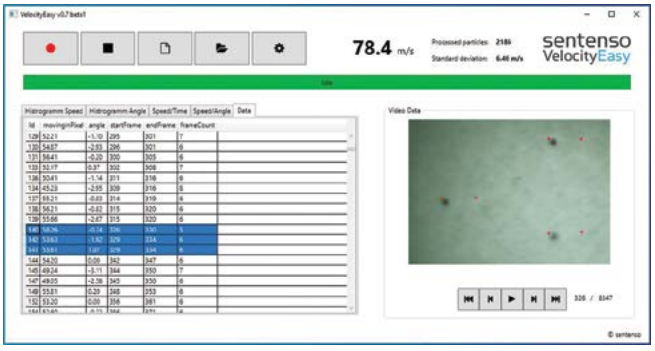
Velocity histogram



Angle histogram



Velocity over time diagram



Data logging

These features allow for a detailed analysis of the shot stream from the nozzle which is not a simple and continuous row of particles, but is characterized by its distribution of velocity and direction which can be statistically determined. This data represents a realistic view on the shot stream variety which provides a variety of impact on the surface and which results in a more or less varying Intensity.

VelocityEasy is installed on a Windows operating system and typically needs about one minute computing time to analyze a high-speed video of 500 milliseconds consisting of 8000 individual frames. The measurement can be repeated at any time when the measurement setup is permanently installed in the peening chamber. It can also be used to adapt the parameter set until the desired result has been achieved.

Process Development

VelocityEasy will enable the process engineer to perform the following steps:

- Analysis of the media particle stream depending on hose and nozzle geometry, media type, air pressure and media flow rate
- Process optimization by appropriate variation of the above-mentioned parameters
- Optimization of nozzle geometry with regard to the peening target
- Matching of the above-mentioned parameters to the shot peening Intensity
- Adjustment of air pressure to achieve desired media velocity
- Verification of shot velocity and trajectory before production

VelocityEasy automatically communicates with suitable high-speed video cameras and reads out the camera settings. The intuitive user interface allows for the setup of the evaluation algorithm and the program control. Video recording, tracking of the detected individual particles, particle marking on the image sequence, evaluation of the recordings as well as the presentation of all measurement results in the form of values and diagrams all take place automatically.

Tracking Data Management

The software also offers extensive additional functions for checking and managing measurement data. These include the integrated video player with the capability for single image analysis, the loading function for existing videos and measurement data sets as well as the debug output with detailed measurement information. The additional functions allow a detailed plausibility check of the results and the subsequent evaluation of existing recordings.

VelocityEasy is prepared for connection to a peening system control. Via the integrated TCP/IP interface, an external system control is enabled to start the software remotely in the current setup and retrieve measurement results. The measurement results can then be further processed within the control system, for example, to check compliance with a desired speed.

sentenso is also ready to supply the associated speed measurement system consisting of an affordable high-speed camera and a measuring channel with lighting unit.

High-speed camera installed on a peening machine window

Outlook

The video-based analysis of media particle movements will ease and improve process development and control because it provides a more differentiated view on the expected surface impact than just an average velocity value. The knowledge of media travel speed and direction can be used to develop correlations between these parameters and the shot peening Intensity. The velocity analysis is not meant to replace Intensity as an empiric figure but can help to avoid excessive Almen strip testings.

For more information and a product video, please go to www.sentenso.com/velocityeasy.html or use the QR code.