RESONIC RESEARCH

1161 Calle Suerte, Suite G Camarillo, CA 93012, USA
www.resonic.com (805) 987-4040

Remanufactured Engine Valve Stem Inspection

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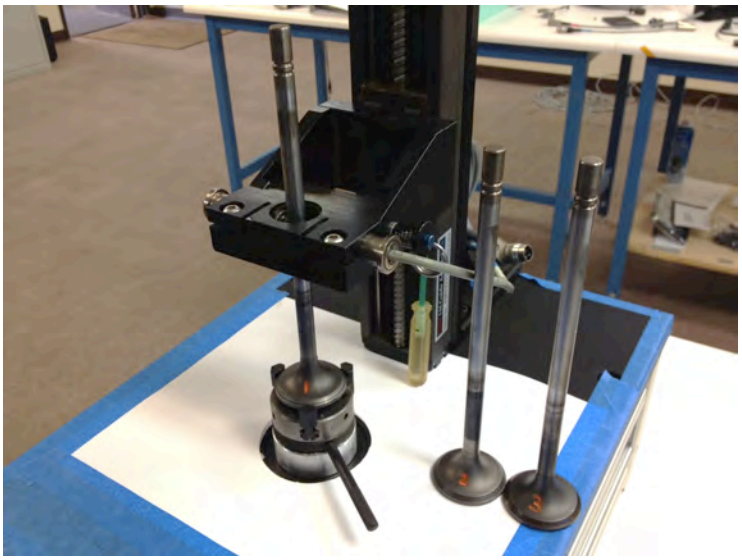
Grain growth and structural defect detection with Electromagnetic Acoustic Resonance

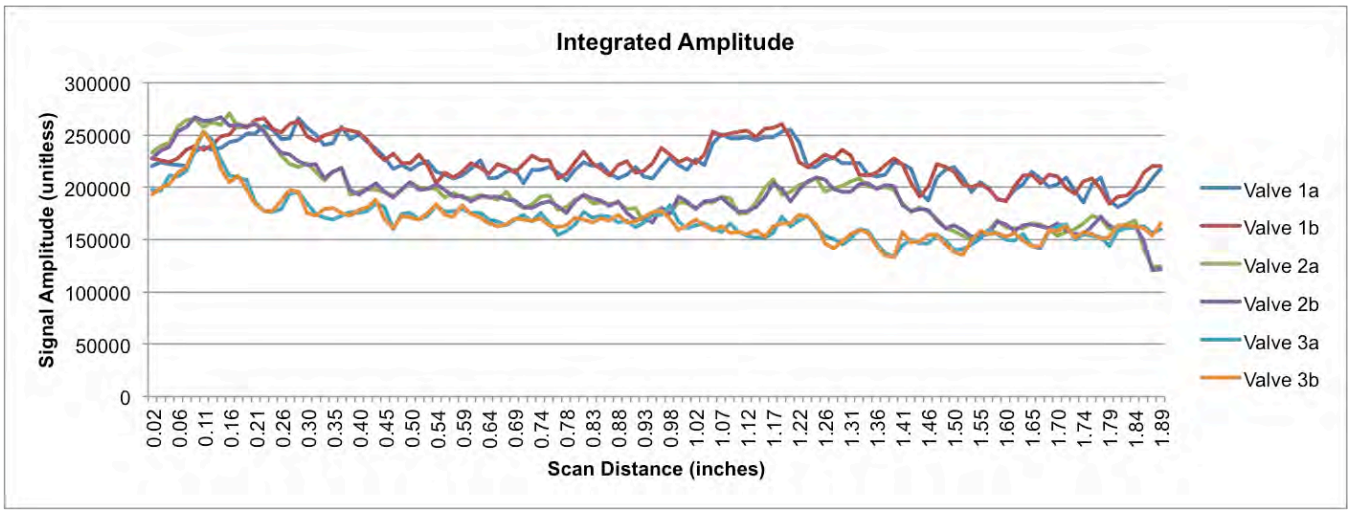
Anthony Caspary, Business Development
Anthony.caspary@resonic.com

Three engine valve samples were evaluated in their austenitic steel regions using electromagnetic acoustic resonance for evidence of suspected enlarged grain size. Differences in grain growth were detected between the three valves based on the amplitude response of the test as would be expected with an ultrasonic measurement. Overall higher amplitude was found on the one valve (#1) that was considered "acceptable" by the customer and lower amplitude was found on the two valves (#2 & #3) that were considered "bad". Multiple scans of the same part showed excellent repeatability in test output.

Samples Tested:
Type: diesel exhaust valves
Stem dia: 9.5mm
Stem length: 7" overall, 4.5" ferritic steel (tip section), 2.5" stainless steel (head section)



Test Setup
Data was collected using two pencil probe type EMAT transducers, one driver and one receiver, that were directly opposed and symmetric around the valve stem. The sensors were mechanically actuated inside of a rigid plastic holding fixture axially down along the length of the stem with approximately .008-.010" liftoff distance between sensors and the valve stem OD. 118 consecutive data points were collected continuously starting below the friction weld and covering the next 1.88" stem toward the fillet. This data collection cycle took 0.9 seconds. Each of the three valves was scanned twice with a 90 degree rotational difference between the two scans.



Results

Integrated amplitude is higher with smaller grain size. Valve number 1, the "good" valve with acceptable grain structure, shows higher overall integrated amplitude in its two scans then the other two valves. The bumpiness of the scan data suggests that there is some inconsistency in grain size along the nearly 2" long valve section that was tested but valve 1 likely has significantly less age related grain growth. Of the bad valve scans, valve number 2 may have smaller grain size than valve number 3. One final observation is that all three valves tend to show a decrease in integrated amplitude nearer to the valve head. This may be consistent with the material's exposure to heat from combustion exhaust and thus the growth of grain size in the most severe heat affected areas.

It is also worth noting that there is no evidence of any cracks or structural defects in the tested stem areas which would manifest themselves as sharp and dramatic drops in signal amplitude.

For more explanation of any of these points or for more information about the mechanics of the test, please feel free to contact us.