C53 Detecting Problematic Casting Defects in Nonferrous Components

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Upon completion of this presentation, participants will have a clear view of the unique defects that can occur in nonferrous castings, especially die castings, which can cause product failure and a serious accident or breakdown. Ways to detect internal defects are described, and participants will be able to seek the high-energy x-ray images that are typically required in both inspection and in forensic engineering.

This presentation will impact the forensic community and/or humanity by creating an awareness of a subtle failure mode that can cause both minor and major incidents and accidents with no prior warning. Being aware of the pre-failure conditions, and with the knowledge that inspection technologies are available, forensic scientists and forensic engineers may be able to avert future failures and reduce both property and human losses.

Product or part failure is often due to crack formation caused by excessive loading or cyclic stress resulting in fatigue. This is seen frequently in nonferrous castings, especially those produced by high-pressure die-casting where porosity and inclusions present ever-present quality issues. The objective of the presentation is to make the forensic engineer aware of the failure modes of such castings, and to impart a strategy for detecting and analyzing porosity and inclusions as causal agents. Practical procedures using x-ray imaging are indicated.

Die casting of nonferrous alloys, especially those of aluminum, zinc, and magnesium, is the manufacturing method of choice when large quantities of near-net-shape product are needed quickly for mass production. Molten metal is injected into steel dies or molds under very high pressure and with fast cycle times. Part failure can be catastrophic when unseen defects concentrate internal stress to initiate cracks that can propagate rapidly. The many factors involved in die-casting create substantial manufacturing and quality assurance challenges. These are described, and failure modes related to manufacturing and inspection processes are identified. Imaging techniques based upon high-power x- ray digitized files offer a way to improve both quality control and forensic engineering analysis after a significant failure. Firearm parts are used as a test case. Automotive examples are also described which illustrate the procedure. Porosity can lead to part rupture under pressure loadings, and can also cause fluid leakage in high-pressure hydraulic lines. Porosity in excess can effectively reduce cross-sectional area and amplify shear stress to create plastic deformation and breakage. Global supply chain practices, especially offshore out-sourcing, make casting failures more likely since some foreign inspection and quality assurance practices may be both opaque and substandard. Some useful remedies are suggested.

It is likely that forensic engineers, more aware of the modes and probabilities of nonferrous casting defects, will be better able to identify resultant failures and to push for remedial action in the manufacturing process. Consumers rely upon manufacturers' claims of high quality, which may not be valid in some supply chains, and failures in some commonplace products may result in injury and death.

Castings, Defects, Failure

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