

NIST analysis helps the US Chemical Safety Board pinpoint root cause of pressure vessel failure

January 8 2014, by Jim Fekete



NDK Crystal damage after the incident. The force of the explosion blew out most of the wall panels. Credit: CSB

In 2009, a violent rupture of a 50-foot pressure vessel used to produce synthetic crystals at the NDK Crystal facility in Belvidere, Illinois fatally injured a member of the public and caused significant property damage to the plant itself and the surrounding area. In response to the accident, scientists from NIST's Material Measurement Laboratory were approached by the U. S. Chemical and Hazardous Material Safety Board (CSB) to review data and assist in identifying the failure mechanism. The review found strong evidence of stress corrosion cracking (SCC) on and near the inner diameter of the vessel fragment, and a reduction in material toughness during service. This combination likely resulted in a flaw reaching critical size, causing the catastrophic failure. The results were included in CSB's recently published final report on the incident investigation.

In order to reach its conclusions, NIST scientists reviewed over 1000 pages of documents, including chemical and mechanical property data, micrographs, material standards, code documents and results from ultrasonic examinations. The NIST review identified stress corrosion cracking as the most likely cause of the extensive cracking found in the [vessel](#). The review also revealed possible reduction in [fracture toughness](#) caused by temper embrittlement in the failed vessel, based on comparisons of Charpy impact test data after fabrication and after failure. In addition, NIST provided a fracture mechanics analysis which concluded that though the vessel entered service in a safe condition, the SCC-caused cracking, along with the reduction in fracture toughness of the steel, resulted in the vessel reaching a critical stress intensity, and subsequent catastrophic failure.

CSB's mission is the investigation of industrial accidents and determination of their root cause, in order to recommend changes to safety procedures, codes and standards, resulting in safer plants, workers and communities. As part of CSB's network of experts, NIST provides expert, independent technical analysis based on its many years of

research in structural [materials](#) reliability. CSB expects to continue engaging NIST in investigations where material failure is suspected of playing a role.

Provided by National Institute of Standards and Technology

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