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BakerRisk Laboratory Analytical and Testing Methods Webinar Questions & Answers

The following participant questions were asked during the BakerRisk Webinar ***"What to know about Laboratory Analytical and Testing Methods – Expert Insights and Other Considerations for Forensic Investigations and Failure Analysis and Prevention"*** presented by Dr. Sean Berg on April 25, 2023. To continue the discourse, BakerRisk has provided responses to questions asked by attendees or to those who have otherwise expressed interest in the webinar.

If you would like additional clarification on any of the questions below, or if you have new questions, please reach out to BakerRisk (TechSupport@BakerRisk.com) and we would be happy to speak with you.

Q1: Did the heater failure happen due to cyclic operating cycles that breach the operating windows?

A1: The heater did fail as a result of cyclic operation, but this was not the only precipitating factor resulting in the failure, nor the primary failure mechanism, which was determined to be caustic embrittlement. The operation was not outside of the operating windows and there was no upset condition. However, what was found through our investigation was that condensation was forming on one side of the heater coil where the cracking was concentrated. It was later determined that there was an environmental contaminant containing potassium (alkali element) that dissolved into the condensation forming caustic and resulting in caustic embrittlement. The temperature range through which this event was occurring, and the material type indicated the right conditions for caustic embrittlement. The daily cyclic operation went from ambient to very hot (evaporating the condensation), but the cooling period is what created the condensation and caustic, which was determined to be the cause and the failure mechanism.

Q2: Does BakerRisk send people to the site for investigations, and are your site visits limited to the United States?

A2: We absolutely send engineers and consultants to sites. There are times when we do recommend a site visit in the course of a cause and origin investigation. We are an international company with international offices to serve every continent.

Q3: Could you please explain a little more about the method of life prediction of components based on crack propagation? What method or software do you use for that?

A3: The software used was NASGRO, which is a fatigue crack propagation computational software developed by Southwest Research Institute (SwRI). The methods are in accordance with methods established by ASME Sec. VIII Div. 3 KD-4, and API 579-1/ASME FFS-1.

Q4: How similar is metals testing to plastics testing, and can the BakerRisk lab handle more than metallurgical failure analysis?

A4: Our laboratory at BakerRisk can handle ALL classes of materials including plastics, polymers, elastomers, composites, ceramics, glass, and many others. We are a materials engineering laboratory, not just a metallurgical laboratory. The testing methods used for evaluation differ largely due to the properties of the material of interest, e.g., electrically conductive vs. non-conductive, chemical bonding and crystal structure of the material, etc. Metals are electrically conductive and lend themselves very well to analysis using electron microscopy for high magnification imaging and spot chemical analysis using energy dispersive x-ray spectroscopy. They can be chemically analyzed using optical emission spectroscopy because of their structure. However, electrically nonconductive materials require different methods for such data gathering as chemical analysis and microanalysis. In these cases because of the chemical bonding and molecular structures of such materials as plastics, polymers, and elastomers, which are infrared (IR) active, infrared spectroscopy can be used for evaluating the material of interest.

Q5: What is the role of a third-party lab? If they are recommended or retained by a particular party, does this create a conflict?

A5: The role of a third-party lab can take multiple forms. One role of a third-party lab could be to provide a space and lab equipment for examination of artifacts and items of evidence by experts and representatives of parties to litigation or a pre-litigation matter. Engineers, scientists, and technicians in this role would be taking direction from other experts as to non-destructive and destructive methods to examine said evidence. In this case the third-party lab provides no input to the examination process and is completely at the direction of the representatives of the parties involved in the particular matter of interest. Another role of the third-party lab could be to independently conduct an investigation and laboratory examination related to a failure incident that occurred. In this role the third-party lab may be responsible for scene examination, evidence collection, laboratory analysis, etc. and their role is to act as an impartial and unbiased outsider to determine cause and origin, and potentially root cause analysis. In this role, there may be multiple parties involved or parties that may an interest in the failure or incident, but these parties have agreed to allow the third-party lab to be the principal investigator who will render findings as to the cause and origin of the failure or incident.

Q6: **Is it possible to safely operate with cracks outside of the refining business, and if so, why?**

A6: The answer is it is possible, but with some caveats. The cracking initiation and progression mechanisms must be determined. Stress and loading cycles, and the potential effect on material fracture toughness, must be ascertained. Often, conservative assumptions can be made about the material fracture toughness (lower-shelf approximations of toughness), or using available data to predict the crack growth rates in environments promoting environmentally assisted cracking. Many of the same mechanisms seen in refining are also seen in the petro-chem and chemical processing industries, and these mechanisms are well understood. As such, if there is sufficient information about the cracking, then methods discussed in API 579-1/ASME FFS-1 can be successfully used to aid in setting inspection intervals and determining run/repair/replace on assets in these other applications.