

Failure Investigation from Chemist' Point of View

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Synopsis

Little did I know much about failure investigation when I completed my first/second Chemistry Degree. Three years have passed since I joined corrosion industry, and it appears that this 'detective' work is a very niche area to explore. Assessment of materials related to failure is commonly practiced in industries involving offshore platform, onshore facility, power plant and oil palm mill where the integrity of assets is of particular importance. This article excludes failure investigation in polymer and semi-conductor, although they are similar in some ways.

What is failure investigation all about?

Failure may originate from single or combination phenomena of corrosion, fatigue, stress, microbial attack (i.e. microbially influenced corrosion) and chemical attack (i.e. chloride, hydrogen sulfide precipitation, hydrogen embrittlement). The investigation is generally aimed at preventing (a) recurrence, (b) damage to assets and environment, (c) loss of lives, and sometimes at improving knowledge. In the nut shell, failure investigation utilizes non-destructive and destructive testing in order to understand the root cause of failure.

Where is the occurrence of failure?

Common metal failure can be found in boiler tubes, heat exchanger plates, insulated and non-insulated pipes, all types of valves and flanges internally or externally, bolts & nuts, welded joints and turbine blades.

Who can be investigator?

Unlike other areas of expertise (welding, blasting and painting, corrosion, etc.) that requires rigorous training and certification, there is no specific certification ever outlined to become a failure investigator. However at work site, one may need certifications such as OGSP (oil and gas safety passport), AESP (authorized entrant and standby person), OPITO BOSIET (basic offshore safety induction and emergency training), API 510 (pressure vessel inspector), API 570 (piping inspector) and API 571 (corrosion and materials). A failure investigator with academic background and above-mentioned certifications can either work independently or could pair up with metallurgist, chemist and (civil / me-

chanical / chemical / material / corrosion) engineer. The common ground that these experts must possess is their abilities to (1) understand how the materials behave in certain conditions (involving different processes and specific environment), (2) possess the skills to operate, analyze and troubleshoot various scientific instruments, and at times (3) understand human behavior. Since most of the failure on offshore platform is related to corrosion where harsh environment and complex processes are in place, the understanding of metal (metallurgy) and fracture mechanics is crucial. When the selection of material in specific process is wrong, failure investigation shall not proceed.

What are the challenges?

Every project has its own set of challenges. Time is an indispensable factor when a project leader chases for project completion. Insufficient time given to failure investigator could lead to deterioration quality of investigation. Placement of the right expertise also determines the quality of investigation. It should be noted that each investigation shall be treated exclusively and not just as a common procedure. Some cases require simple visual examination while others may require more complex surface analysis (i.e. scanning electron microscopy coupled with electron backscattered diffraction, electron diffraction x-ray, x-ray photoelectron spectroscopy, Auger electron spectroscopy, time-of-flight secondary ion mass spectrometry, etc.). The extent of investigation sometime goes up to computational modeling. The complexity of scientific instruments demands high maintenance cost and well-trained operator. In addition to the above-discussed limitations, a failure investigator usually needs to gather enough background information (i.e. P&ID drawings, service history, safety data sheet, process and environmental conditions) in order to support their analyses. Unfortunately, this information is not easily accessible from the client.



Dr. Yoga Sugama Salim graduated from the Universiti Malaya in 2016 (Ph.D., Polymer Chemistry) and Université de Rouen in 2015 (M.Sc., Physics, Mechanics, Engineering Sciences, Engineering and Materials Testing). He is currently working as Failure Analysis & Technology Solutions Specialist. He has over 9 years of combination experience in biodegradable polymers, fermentation technology, thermal and mechanical properties and failure investigation. His research interest is devoted to materials characterization. He was appointed as the member of Industry Expert Advisory Panel (IEAP) for M.Sc. Research at Universiti Tunku Abdul Rahman (2016-2019), editorial board for Materials Mind magazine published by the Institute of Materials, Malaysia (IMM) (2016-2018), member of IMM corrosion

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