Corrosion Under Insulation: Risk Based Inspection Approach

Reported by: Mohebbi Hamed
(National Association of Corrosion Engineers (NACE) and Japan Welding Engineering Society (JWES)

Corrosion under insulation (CUI) is a serious threat to integrity of piping and pressure systems in onshore/offshore installation and processing plant. In the context of piping, CUI can be considered as a greater risk for smaller boar and thin walled pipes than larger diameter and thicker section thickness. Carbon steel (CS) and some stainless steel (SS) such as austenitic SS type 300, super austenitic SS, duplex/ super duplex SS and their associate fusion welded joints are susceptible to CUI threat. Deterioration mechanism and failure mode, however is different between CS and SS. The failure mode of CS is mainly associated with pitting and only a low risk of stress corrosion cracking (SCC) at nitride containing environment, while for SS there is a high risk of SCC when chloride present in the environment at temperature above 60C° and pitting corrosion. CUI is responsible for a high portion of incidents of piping leak in the industry and in particular in the refinery and processing plants. Therefore for operators of the plants ability to manage CUI and carry out a focused and targeted maintenance and replacement strategy is of very important. This requires a thorough understanding of factors influencing CUI coupled with an adequate inspection regime in order to identify susceptible lines and their locations that require attention and prioritise the maintenance services based on the level of associated risk. With the current industry trend for application of risk based inspection (RBI) an understanding of service condition of the base metal as well as weldment is essential. Although the most effective way to determine and establish the condition of the underlying pipe/ material remains to be de-lagging and striping of the insulation, this however will be resource exhausting and expensive exercise. There are a range of non-destructive examination (NDE) techniques that can be utilized as initial screening to confirm CUI affected areas without removal of insulation. Infrared thermography, profile radiography and pulse eddy current have proven to be very effective. It should be noted that each NDE techniques has its own limitations, reliability of which in terms of detection probability and the accuracy of measurement is subject of debate. Use of each technique in isolation may not adequately identify the extent of the CUI due to their limitation and should be practiced by cautious. Although NDE techniques indicate CUI affected areas, however to efficiently quantify the extent of CUI within the inspection time window and resources available for large number of lines in a range of wall thicknesses and diameters has proven to be very challenging. This puts an emphasis on employment of adequate technique for initial screening level followed by more detailed inspection. This is especially the case where effort is placed to cover large areas of insulated pipes in refining and processing environment. Given that highest incident of leaks is related to CUI (in opposed to hydrocarbon related corrosion on the process lines) it is of importance to have structured approach in the management and maintenance of the CUI in the industry. Implementing RBI for the management of CUT the following steps shall be practiced and put in to place.

1) Register and document all insulated pipework and vessels shall in asset registry data base. Make sure all the modification and subsequent new lines has also been captured.
2) Challenge the presence of insulation and if unnecessary consider removing them. In most cases it is not part of process requirement and can be removed and the concern can be address through other means (e.g. caging).
3) Asses pipework and vessels with respect to identified risk (Consequence x Probability). An accurate risk assessment requires factors such as process, environment and materials shall be taken in to account.
4) Asses the condition of insulated pipework and vessels and establish if there laminated or weathering is intact or damaged. This has profound effect on the CUI damage.
5) Decide on level of inspection and plan appropriate inspection of entire insulated pipes and vessel based on the calculated risk. Consider inspection techniques that do not require removal of insulation at screening level. Subsequently if required consider inspection techniques that require partial removal of the insulation rather than full de-lagging.
6) Address root cause of the problem when repair is carried out to avoid pre-mature failure. Avoid like-in-like replacement if the root cause of the problem was inadequate materials.
7) Capture lesson learnt and feed it back for risk assessment of other lines. This is very important as it help with more effective risk assessment of lines with similar condition, which might not have initially assigned with appropriate