

Abstract

High vacuum towers in the petrochemical industry are common especially in crude refineries. They operate in deep vacuum, usually around 98kPa and very high temperatures in the region of 400°C. They perform a critical role in the crude processing plants in which vaporised crude oil from heaters is fed into these vessels to produce products such as vacuum residue, heavy vacuum gas oil, light vacuum gas oil and so forth under this deep vacuum environment.

This specific vacuum tower under review suffered severe localised internal corrosion on the upper section just above the conical section. The conical section of the column together with the bottom section are constructed from carbon steel which is clad with stainless steel to mitigate against naphthenic acid corrosion attack. Unfortunately, the top section does not have this cladding even though temperature profile in the region indicated that naphthenic acid corrosion would still be active.

Literature review undertaken revealed the various forms of failures under corrosion, the most prominent being stress corrosion and corrosion fatigue. It was established that there were not cracks in the structure during inspections and that the most likely failure mechanism under corrosion would be buckling of the structure due to the negative internal pressure and the weight of the structure above the local thin area.

A numerical model was developed to simulate behaviour of the structure under all the applicable loads with the different scenarios being imposed onto the model, for example, varying the thickness of the thinned region to estimate failure. The predicted remaining life was only 18 months from the last inspection where buckling failure is expected to occur at a thickness less than 6.7mm.

Based on the results, a complete overhaul of the maintenance strategy is recommended which include immediately using on stream measuring techniques to predict wall thickness, review corrosion control documents to ensure proper material selection to prevent naphthenic acid corrosion, develop inspection strategies for high vacuum towers based on actual data and unique to each piece of equipment and finally ensure crude diet selection is supported by a technical review on the impact to process equipment.

In conclusion, life and failure prevention recommendations are specified to achieve objective.