Pickling and Passivating of Corroded Tanks on Chemical Ship

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The chemical tanker destined for mineral acid transport started exploitation in February 2000. The cargo acid tanks have been constructed from duplex stainless steel 2205. The cargoes that have been shipped were nearly exclusively sulphuric acid and phosphoric acids. Voyages were mostly along the western American coast. Ship designing was not satisfactory. Trace weld leakages in two tanks, cracks of welds connecting main deck with transverse bulkhead of the most corroded tank, a crack in one tank bottom and small openings at transversal bulkhead/bottom weld in one tank were discovered within four years of exploitation. The cargo acid tanks got within these years external reinforcements of some transverse bulkheads and also internal stiffeners. Mineral acid passivation was performed by the constructing company before exploitation started and after each of two repairs. During repairs heavy grinding work to remove rust was done.

Corrosion damages found before pickling/passivation work started

A primary inspection was performed during a short stay of the tanker in Morehead City harbor in the USA.

At the very beginning active electrochemical potential values were measured with 175 True RMS Multimeter FLUKE of certain number of rust covered plates at the top part of some tanks giving results around 500 mV against zinc/zinc sulphate electrode. The measured values suggested that some plates were made from different steel than duplex 2205 and the steel quality was lower compared to duplex 2205 which had typically potential values over 900 mV.

Some of corrosion damages were serious ones that could bring catastrophic effects. Several fragments of the welds were completely rusted; some of them joining plates at the tank ceiling, the other joining walls with the ceiling. Several fragments of the welds were completely covered with rust or a number of rust spots were over or around the welds between the tank ceiling and the walls. Corrosion of plate welds is the most dangerous problem as regards tank tightness. Rust was located mostly around the welds at some distance but in some cases close to the welds. When electrochemical potentials were checked it was found that a few weld segments with the potentials after passivation below 600 mV presented improper welding material quality (Fig. 1).

Fig. 1. Rust left after passivation shows improper weld fragments

In some cases rust from the welds was dispersed around by liquid cargo on over walls or ceilings. This could happen when cargo had dissolved iron and iron oxides (rust) were formed after drying. Some welds joining the ceiling plates were completely covered with heavy rust

and the surrounding surface of the plates was covered with superficial rust.

Corrosion around welds of eye pads, rust stains over top of the walls and over the ceilings in all tanks (15% of the surface covered with rust in the most corroded tank) and some small pits were present. Single shallow pits were under rust spots in places that were heavily ground. Overheated strips after welding supporting elements from external side of transverse corrugated bulkheads started to rust. Thick rust strips at the internal bulkheads were up to 100 mm wide (Fig. 2-3).

Fig. 2. Strips of rust from coming from outside supports welding

Fig. 3. Rust over weld and strip of rust from outside welding

The edge sides of nearly all vertical, bottom or ceiling stiffeners were covered with heavy rust spots (Fig. 4) being a result of improper cutting technology. These edges under rust were smooth. In many cases rust was concentrated at one edge side of the stiffeners. At some stiffeners weld slugs were over welds. The large surfaces of the stiffeners were with no rust at all.

Fig. 4. Rusted edges of supports

Most of the ladder steps were covered with small rust spots coming obviously from imbedded iron external contamination that came through open manholes. All the railings were covered with small rust spots (Fig. 5).

Fig. 5. Rust on ladder steps and railings coming from embedded iron

Both of them steps and vertical angles had potentials over 1000 mV against zinc/zinc sulphate electrode. There was neither rust on the ladder sides (angels having wide surface), nor over ladder welds.

Heavy rust was situated within and around the inspection manhole. The nuts and bolt heads at a single manhole were partly covered with rust.

The slope parts of longitudinal starboard side bulkheads were at some cases covered with rust spots. A single filling pipe was covered with rust spots.

The bad state of steel surfaces showed that latest pickling/passivating process but also exploitation were not properly performed.

The survey on pickling/passivating by ANCORA Co.

An action on rust removal was undertaken by ANCORA Co. five years after the tanker was constructed. The pickling/passivation work by Ancora Co. was done in the Astilleros Braswell International S.A Shipyard in Panama (Fig. 6.) during general repair period.

Fig. 6. The tanker in Braswell International S.A Shipyard in Panama

The cleaning and pickling/passivation were performed by hand spraying of Avesta Welding chemicals transported from the producer in Sweden by air (Fig. 7).

Fig. 7. Chemicals for cleaning, pickling and passivation delivered from Avesta Co. by air

Pressure spraying done with the usage of mobile scaffolding was not easy because of the slopes of some walls above bottoms that restricted an access to corroded constructions, mainly at the corners. The problem was solved by constructing a small platform sticking out from the scaffolding.

Time period for a survey was limited according to the period of mechanical repairs. Atmospheric conditions to carry out work were difficult as during the days temperature in the tanks was increasing to around 60oC because of a sunny weather. The decision was taken to work within tanks during nights, whereas visual control of effects and potential measurements were performed during days.

The tanks and piping systems were passivated with a full success, finding a positive approval from both, the ship owner representative and the technical inspector, Manager of Maritime Consultants, NY USA. The stainless steel surfaces passivated by Ancora were in very good conditions when controlled years later.

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