HRT PILOT TEST FOR SOUR WATER IN REFINERY

A sour water system in Virginia contains appreciable amounts of hydrocarbon from upstream operations. The hydrocarbon associated with the sour water contains insoluble organic components that precipitate upon cooling and can lead to extensive fouling at the sour water stripper, pumps, valves and other process equipment. This presents a challenge for operations because of the man hours required to clean and repair the equipment. When this equipment is shut down the sour water stream cannot be treated at the waste water plant contributing to high levels of accumulation in the holding tanks. Using the holding tanks for sour water is undesirable because it displaces storage meant for valuable product, equating to a revenue loss. The refiner has elected to validate the viability of Pentair’s Hydrocarbon Recovery Technology (HRT) as a remedy to hydrocarbon contamination of the sour water system. As part of the validation of HRT for particle and hydrocarbon removal from the sour water system, the refiner placed a pilot HRT system in service. The pilot unit was operated for a period of two weeks.

METHODS OF TESTING AND ANALYSIS

HRT was placed on the Tank 700 Sour Water Stream. The inlet was at the discharge of pump J-1678B from a 3/4” GA41 valve off line 6”-SW-1401-A1A2-L5’H-5R. The effluent was routed back to Tank 700 through a 3/4” valve GA41 on line 8”-0-152B-1P1(902). Flow through HRT was regulated at 2 gpm and it was increased to 3 gpm until the demonstration was stopped. The hydrocarbon drain on HRT was dumped manually and measured upon showing evidence of hydrocarbon accumulation. Unit operators recorded the flow, differential pressure across each device, system pressure readings and collected hydrocarbon samples when Pentair personnel were not present.

ANALYSIS BY GAS CHROMATOGRAPHY

Samples were pulled from the Sour Water stream prior to HRT and at the system Outlet. Organic phase samples were taken. These samples were delivered to STAR Labs, where the sour water inlet and outlet were analyzed by gas chromatography for Hydrocarbon Content with Carbon Number. The organic phase sample was analyzed by High Temperature Simulated Distillation.

RESULTS

HRT was placed in service on the Tank 700 Sour Water stream. The system operated with no measured differential pressure across either the Particle Separator or the Organic Separator devices during the days Pentair personnel were on site. After one week the flow rate was increased from 2 gpm to 3 gpm. At shut down the differential pressure of the Particle Separator increased to 7.2 psi and the Organic Separator was 2.4 psi.

Significant amounts of hydrocarbon were removed from the sour water stream. An aliquot of the sample was used to determine the nature of the hydrocarbon contaminant in the system. Simulated distillation of the sample indicates an initial boiling point of 98.6 °F and a final boiling point of 836 °F.

The recovered hydrocarbon was further analyzed to determine carbon number of the component fractions comprising the total liquid. The hydrocarbon represents primarily C6 – C15 components with a small tail of heavier components extending to C30 hydrocarbons.

The inlet to HRT averaged 419 ppmv hydrocarbons (cat naphtha). The outlet hydrocarbon concentration averaged 104 ppmv, providing 315 ppmv, or approximately 112 gallons per day of hydrocarbon recoverable by HRT, based on the sour water flow rate of 8500 barrels per day.

From the presented data, it appears that HRT performed within the design envelope for the Sour Water system. Accordingly, an opportunity exists to significantly reduce the hydrocarbon burden on the plants sour water system contributing to re-occurring sour water stripper shutdowns, equipment fouling and potentially recover significant value through reclamation of cat naphtha from sour water.

PROCESS ECONOMICS

It is apparent that the implementation of HRT using 8500 barrels of sour water processed per day presents a significant opportunity for valuable recovery in operations. The potential economic recovery is greater than $78,000 annually, assuming that the separated hydrocarbon is re-processed.

The economic evaluation assumes recovered value of hydrocarbon only and does not include the additional operational benefits of inhibiting sour water stripper shutdowns, process equipment fouling and process downtime by reducing hydrocarbon entrainment to the sour water system by over 40,000 gallons per year.