WHAT DOES SALT DO TO CRUDE OIL ?

A DISCUSSION AND THE DEVELOPMENT OF A UNIQUE ANALYTICAL TOOL TO MEASURE SALT CONTENT IN CRUDE

Crude oil is one of the most important fuel sources used globally and, historically, has contributed to over a third of the world's energy consumption. Global demand for crude oil is projected to increase to 96.5 million barrels per day in 2021 compared to the daily oil demand of 86.4 million barrels in 2010 [1]. Crude oil is removed from the ground and sent to a refinery where different parts of the crude oil are separated into usable petroleum products. These petroleum products include gasoline, distillates such as diesel fuel and heating oil, jet fuel, petrochemical feedstocks, waxes, lubricating oils, and asphalt [2].

However, crude oil often contains salts that can result in corrosion when processed through a refinery. The salt found in crude oil is typically in the form of salt crystals dissolved in the water that is emulsified in the crude oil with major portions of the salts being chlorides of sodium, calcium, and magnesium [3]. High concentrations of salt in a crude oil grade will not only cause problems with maintenance and operation but also affect its market value from the additional cost of processing it. It is anticipated that the crude oil desalter's market will grow at a rate of 8.8% CAGR by 2026 [4], creating a high demand and interest in different applications and instruments.

Crude oil is formed from organic matter, typically from the remains of algae, plants, and their decomposition products such as bacteria under anaerobic conditions. After millions of years of intense heat and pressure, these organic remains transform into carbon-rich substances that fuel a wide variety of products today. The main use for petroleum is known to be gasoline, which fuels most cars in the United States, but petroleum is also used to make many more products that we use daily. Most of the petroleum is turned into an energy source and can be used to make heating oil, diesel fuel, jet fuel, and propane [5]. The first step to drilling for oil is knowing where to drill. The extraction of oil from the earth is an expensive endeavor to take and comes with many more complications once the process has begun. Once the crude oil has been extracted from the ground, it does not come out in the form that is readily used [5]. Before it can be used it is sent to refineries where the gas and oil are separated by distillation into fractions with different boiling points which are then further processed [6]. The presence of salts in crude oil is one of the most serious problems confronting petroleum refinery. Although distillation is usually known as the first process in petroleum refineries, testing the salt content in crude oil can help determine whether desalting should take place before the distillation process.

The large concentration of salt in crude oil can contribute to the mechanical clogging of furnace tubes, condensers, and lines by deposition, the corrosion of equipment by the hydrolysis of salts producing hydrogen chloride, and high ash content of still residues throughout the refinery process [7]. Predetermining the salt content in crude oil before the refinery process is an important quick and easy analytical method that can avoid machine failure and high repair cost. Excessive chloride left in the crude oil frequently results in higher corrosion rates in refining units, which can be seen in Figure 1, and has detrimental effects on the catalyst

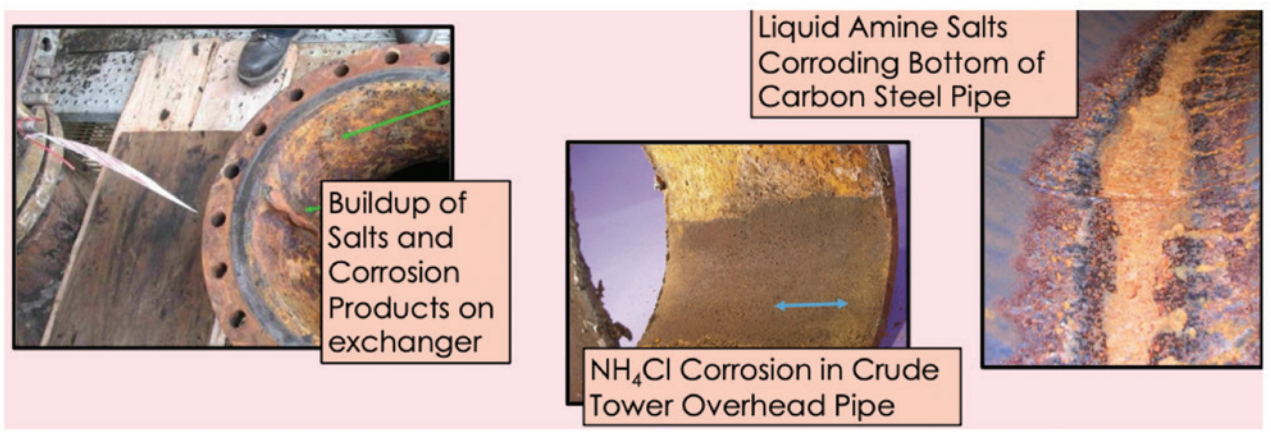

Figure 1: Excessive chloride left in the crude resulting in corrosion of equipment [11]

in these units. The Standard Test Method for Salts in Crude Oil (ASTM D3230-19) [8], is used to determine the approximate chloride content of crude oils, a knowledge of which is important in deciding whether the crude oil needs desalting. The test method measures the conductivity of a solution of crude oil in a mixed alcohol solvent when subjected to electrical stress. The removal of salt from crude oil is recommended for refinery feedstocks if the salt content exceeds 20 PTB (pounds of salt) [9]. The presence of excessive salt presents serious corrosion and scaling problems which makes it essential to test for salt content before refinery processes.

The Koehler K23060 Salt in Crude Analyzer, as seen in Figure 2, has shown remarkable feedback in determining the salt content present within crude oil [10]. The device measures the conductivity of a crude oil solution in a polar solvent when subjected to an alternating electrical current in accordance with the ASTM D3230 test method. Salinity is obtained by comparing the resulting conductance to a calibration curve of known salt mixtures. The first step in operating the K23060 is to complete calibrations for temperature, salt standards, and conductance. Next, the user must place the electrodes and temperature probe into the sample solution for a sample setup. In the sample test, the user must fill out parameters and press acquire to begin the test and wait for it to finish within seconds. The display will present the results for salt concentration, conductance, and temperature [11]. The Koehler K23060 Salt in Crude Analyzer determines salt concentrations in crude oil in a quick and reliable manner to prevent any future complications with equipment or yield during the refinery process.

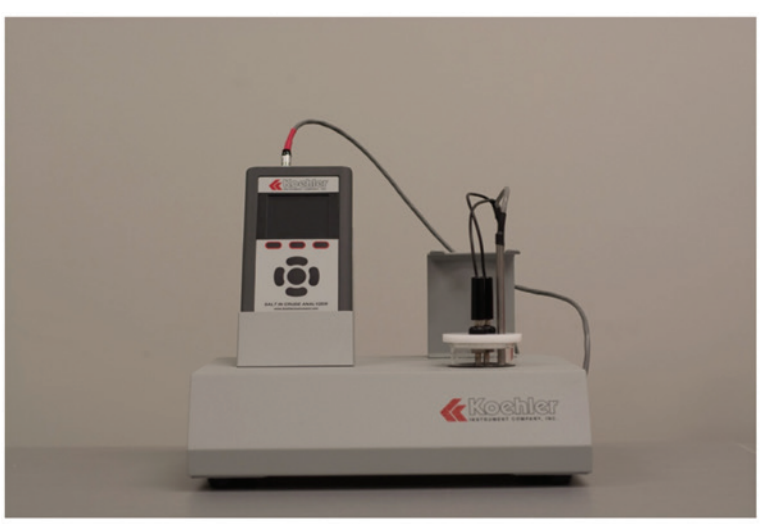

Figure 2: Koehler K23060 Salt in Crude Analyzer [11]

Desalting techniques within crude oil have been well established throughout the years, but continuous monitoring of the salt content is needed for process control and cost reduction of a system. Excessive amounts of chloride salts in crude oil result in higher corrosion rates in refining units that can have detrimental effects on catalyst and equipment. The complications that arise due to dissolved or suspended salts in crude oil, such as fouling and scaling in pipelines and heat exchangers, make it necessary to establish efficient methods to test for salt content. Process and equipment modification in refining begins with the required pre-treatments of heavy crudes to facilitate efficient and cost-effective processes, where salt in crude analyzers are used to address impurities within the oil [12]. Convenient oil pre-treatment analyzers are required to ensure the adequate removal of impurities from heavy crude oils to enhance product quality and reduce operation complications.

References

[1] Published by N. Sönnichsen, and Mar 22. "Global Oil Demand 2006-2021." Statista, 22 Mar. 2021, www.statista.com/statistics/271823/daily-global-crude-oil-demand-since-2006/.

[2] "U.S. Energy Information Administration - EIA - Independent Statistics and Analysis." Oil and Petroleum Products Explained - U.S. Energy Information Administration (EIA), www.eia.gov/energyexplained/oil-and-petroleum-products/.

[3] Mohammed, Qasim. (2016). Determination of salt content in crude oil, turbine oil and

some refinery products volumetrically. Journal of Chemical and Pharmaceutical Sciences. 1. 34-371.

[4] Research and Markets. "Global Crude Oil Desalter Market (2020 to 2026) - by Type, End-Use, Application and Geography." GlobeNewswire News Room, Research and Markets, 21 Apr. 2021, www.globenewswire.com/en/news-release/2021/04/21/2213875/28124/en/Global-Crude-Oil-Desalter-Market-2020-to-2026-by-Type-End-use-Application-and-Geography.html.

[5] "Fossil Energy Study Guide: Oil." Energy.gov, www.energy.gov/sites/prod/files/2013/04/f0/HS_Oil_Studyguide_draft2.pdf.

[6] Lichtarowicz, Marek. Extracting Crude Oil and Natural Gas, www.essentialchemicalindustry.org/processes/extracting-oil-and-natural-gas-fracking.html.

[7] Determination of Salts in Crude Oil, Clarence Neilson, J Stewart Hume, and Bert Lincoln, Industrial & Engineering Chemistry Analytical Edition 1942 14 (6), 464-465, DOI: 10.1021/i560106a006

[8] ASTM D3230-19, Standard Test Method for Salts in Crude Oil

(Electrometric Method), ASTM International, West Conshohocken, PA, 2019, www.astm.org

[9] Abdel-Aal HK, Zohdy K, Abdelkreem M (2018) Waste Management

in Crude Oil Processing: Crude Oil Dehydration and Desalting. Int J Waste Resour 8: 326. doi: 10.4172/2252-5211.1000326

[10] "News & Events." Koehler Instrument Company Inc, koehlerinstrument.com/new-salts-in-crude-analyzer/.

[11] Sarjeel Zaman, Stanley Zhang, Dr. Raj Shah Koehler Instruments Company,

Inc, Salt in Crude Oil Analyzer

[12] Babalola, Faith Uchenna, and Alfred Akpoveta Susu. "Pre-Treatment of Heavy Crude Oils for Refining." IntechOpen, IntechOpen, 18 Dec. 2019, www.intechopen.com/books/processing-of-heavy-crude-oils-challenges-and-opportunities/pre-treatment-of-heavy-crude-oils-for-refining.

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