Application Note AN-PAN-1014

Online determination of salt in crude oil by automated process analysis

Crude oil is a highly complex mixture of hydrocarbons which contains different organic and inorganic impurities (e.g., water and inorganic salts). Excessive amounts of salt in crude oil results in higher corrosion rates in refining units and has a detrimental effect on the catalysts used. Therefore, salt needs to be removed from crude oils prior to refining, in a process known as desalting.

Desalting techniques are well established, but continuous monitoring of the salt content in crude oil is needed for process control and cost reduction.

This Process Application Note is focused on monitoring the salt content in crude oil using the ADI 2045TI Ex proof Analyzer from Metrohm Process Analytics equipped with special heavy-duty sampling devices. This online analysis solution ensures a safe working environment for operators, avoids corrosion from excess salt in crude, and increases profitability of the desalting process.

Crude oil is extracted from wells which contain water, gases, and inorganic salts (either dissolved or suspended). These salts can lead to downstream fouling and corrosion of heat exchangers and distillation overhead systems. Furthermore, salts are detrimental for catalysts in the downstream conversion processes.

Salt is removed from crude oil via two major methods: chemical and electrostatic separation. The most commonly applied method is electrical desalting [1]. Both of these methods use hot water as the extraction agent.

Excess water has to be removed first, therefore desalting takes place before distillation. After preheating to 115–150 °C, the oily feedstock is mixed with water in order to dissolve and wash out the salts. The water must then be separated from the oil feedstock in a separating vessel by adding demulsifier chemicals to break up the emulsion and in addition, by applying a high-potential electric field (via electrostatic grids) across the settling vessel to coalesce the polar saltwater droplets (Figure 1b). The wash water (brine) containing dissolved hydrocarbons, free oil, dissolved salts, and suspended solids, is treated further in an effluent treatment plant. Efforts are made in the industry to reduce water content of the desalted crude to less than 0.3%.

Traditionally, the desalting process (Figure 1a) can be monitored by laboratory pH analysis. This method helps to determine the speed of phase separation between the two phases (water-oil). However, this methodology does not provide timely results and requires human intervention to implement the laboratory analysis results into the process. Online process analysis allows constant monitoring of crude oil quality without long waiting times in the laboratory, providing more accurate and representative results directly to the control room.

INTRODUCTION

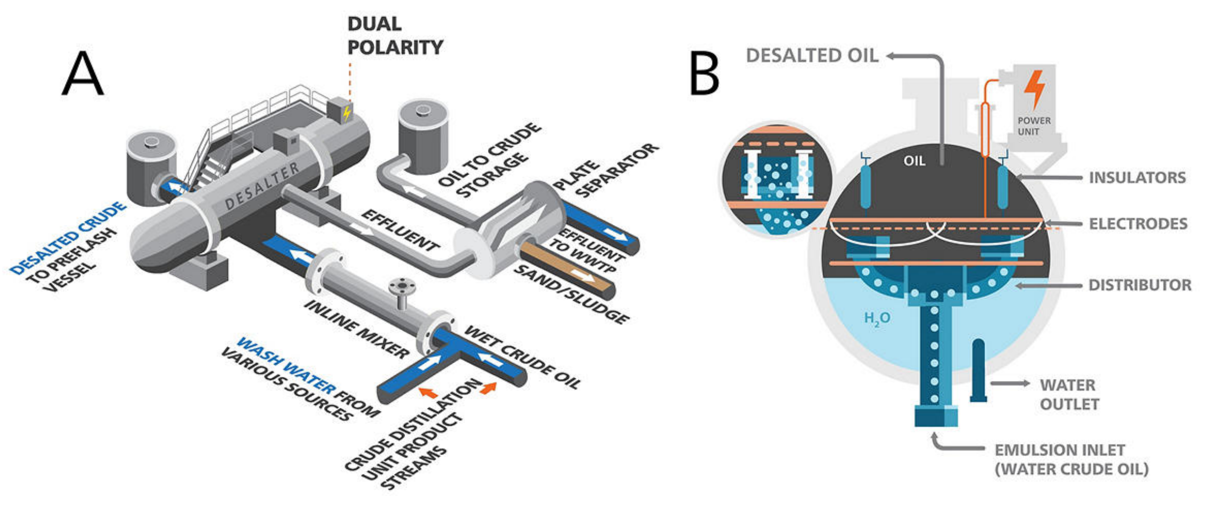

Figure 1. (a) Schematic diagram of a typical crude oil desalter process. (b) Cross-sectional view of a crude oil desalter.

Additionally, testing of crude and refined oil products is demanding and requires precise and reliable analysis to meet regulatory demands. Metrohm Process Analytics is actively involved with international standard bodies to help drive method development. The ADI 2045TI Ex proof Analzyer (Figure 2) can monitor chloride in the crude after desalting according to ASTM D3230 testing procedures.

APPLICATION

Chloride is analyzed with conductivity detection as described in ASTM D3230 with the ADI 2045TI Ex proof Analyzer (Figure 2).

Figure 2. ADI 2045TI Ex proof (ATEX) Analyzer.

Table 1. Typical chloride concentration range in crude oil according to ASTM guidelines

Components	Range (mg/kg)
Chloride	0–500

CONCLUSION

Monitoring the chloride in crude oil before and after the desalting process is necessary to check the process efficiency and to overcome corrosion problems downstream. Since the sample take-off point is typically located in a hazardous environment, the ADI 2045TI Ex proof Analyzer is designed and equipped to meet directive 94/9EC (ATEX95). No «hot work permits» are needed for maintenance and the analyzer can be remotely controlled.

REMARKS

Other measurement techniques can apply for low economy grade crudes like the Standard Test Method for Salt in Crude Oils (Potentiometric Method) ASTM D6470. Karl Fischer titration can be applied for moisture/water content determination as an additional parameter in the desalter.

RELATED ASTM METHODS

- ASTM D3230: Standard Test Method for Salts in Crude Oil (Electrometric Method)
- ASTM D6470: Standard Test Method for Salt in Crude Oils (Potentiometric Method)

RELATED APPLICATION NOTES

AN-PAN-1001 Hydrogen sulfide and ammonia in sour water

AN-PAN-1026 Mercaptans and hydrogen sulfide in raw oil in accordance with ASTM D3227 and UOP163

AN-PAN-1047 Inline monitoring of water content in naphtha fractions by NIRS

BENEFITS FOR ONLINE DESALTING ANALYSIS

- **No «hot work permits»** are needed for maintenance, and the analyzer can be remotely controlled
- **Safe production** due to near «real-time» monitoring and no exposure of operator to chemical reagents
- Greater and faster **return on investment (ROI)**
- **More savings** per measurement, making results more cost-effective
- **Increased product throughput**, reproducibility, production rates, and profitability

REFERENCE

1. Al-Otaibi, M. B.; Elkamel, A.; Nassehi, V.; Abdul-Wahab, S. A. A Computational Intelligence Based Approach for the Analysis and Optimization of a Crude Oil Desalting and Dehydration Process. *Energy Fuels* **2005**, *19* (6),2526–2534. https://doi.org/10.1021/ef050132j.

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CONFIGURATION

ADI 2045TI Ex proof Analyzer

The ADI 2045TI Ex proof Process Analyzer is used in hazardous environments where explosion proof protection is a critical safety requirement. The analyzer fulfills EU Directives 94/9/EC (ATEX95) and is certified for Zone-1 and Zone-2 areas. The analyzer design combines a purge/pressurization system with intrinsic safety electronic devices. The air purging phase and permanent overpressure prevents any potentially explosive atmosphere in the ambient air from entering the analyzer enclosure. The analyzer smart design avoids the need for purging large analyzer shelters and can be located at the production line in the hazardous zone.

Titration, Karl Fischer titration, photometry, measurements with ion selective electrodes, and direct measurements are all possible with this Ex-p version.