Dynamic visual desalting simulation

Keith L. Gawrys*, Thomas A. Oliver

Nalco Company, 7705 Hwy. 90-A Sugar Land, TX 77478
(corresponding author: klgawrys@nalco.com)*

Emulsion breaker product selection for refinery desalting applications is generally determined by a batch electrostatic coalescence method (a.k.a. portable electric desalting or PED testing). The PED test is a static test in which a water-in-oil emulsion is prepared by blending a fixed volume of water and crude oil under controlled conditions. The emulsions are resolved with the assistance of constant heating and intermittent application of an electric field. The resolution of the emulsion is observed as the volume of water resolved in a centrifuge tube at fixed intervals during the testing.

The PED test method is useful for comparing the relative efficacy of emulsion breaker formulations to dehydrate crude oil, but has limited or no ability to predict other key performance indicators for desalting—such as salt removal efficiency, solids removal efficiency, brine effluent quality, and interfacial rag quality.

Nalco Downstream Research has constructed laboratory scale desalting equipment to simulate challenging process conditions observed at refineries. The Dynamic Visual Desalter (DVD) generates water-in-oil emulsions under flow conditions. The emulsion is subsequently separated in the presence of elevated temperatures (up to 250°F), elevated pressures (up to 150 psig), electric fields (0 – 6000 VAC), and chemical demulsifiers. The desalting cell is equipped with a glass window to observe the interfacial rag layer.

A flow diagram for the desalter simulation equipment is shown in Fig. 1. Chemically treated or untreated raw crude oil is fed by gear pump (~ 50 mL/min) to a preheat unit and then is combined with a water feed (~ 2.5 mL/min) at the header of the mixing device. The mixing device uses the impeller action of a centrifugal pump to generate an emulsion. The pump is rheostat-controlled to allow adjustment of the droplet size distribution. The combined water-in-oil stream is sent to a desalting cell (670 mL) where phase separation takes place. The "hot" electrode of the grid system is fixed approximately 6 in. from the top of the desalting cell and is separated from the ground electrode by 1 in. spacing. Effluent brine is removed by a needle valve at the bottom of the desalter. The desalted crude is removed through a pressure relief valve (150 psig) at the top of the desalter. Typical crude oil residence times of 15 – 20 min. are possible with proper control of the oil-water interface level.

A desalter simulation trial run was performed to study the effectiveness of the grids for coalescing the emulsion (Fig. 2). The raw crude oil (33° API) was treated with 13 ppm emulsion breaker. The desalter inlet temperature (250°F), wash water feed, and mixing rate (3400 r.p.m.) were maintained constant throughout the experiment. Samples of the raw and desalted crude oil and effluent brine were collected after processing at each voltage condition for 1 hr. The raw crude chlorides and BS&W were 130 – 160 ppm and 1.0 – 2.0 vol. %, respectively. As expected, salt removal was directly correlated to the ability of a desalter to dehydrate the crude oil and dehydration efficiency increased with increasing applied grid voltage.

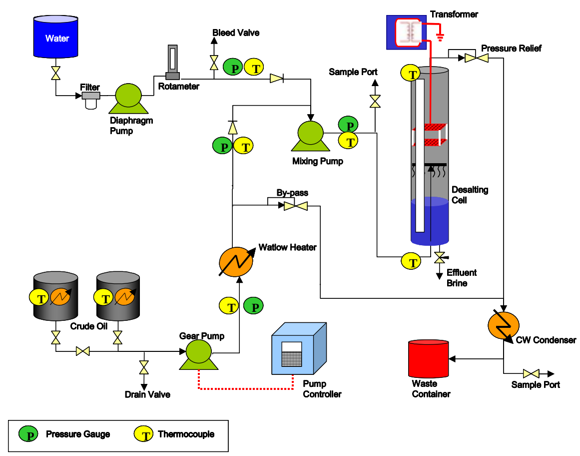

Fig. 1. Flow diagram for the Dynamic Visual Desalter

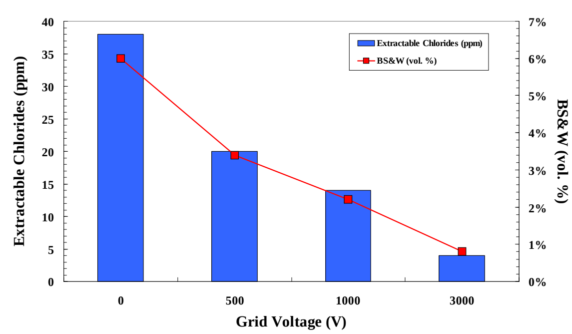

Fig. 2. Extractable chlorides and BS&W of desalted crude oil as a function of grid voltage.

The Dynamic Visual Desalter will be used in the development of new desalting chemistries. Possible applications and/or simulation scenarios include: iron, calcium, inorganic solids, and other contaminant removal; rag collapse and control; oil undercarry control; and dehydration aids.