

**ENGINEERING STANDARD**

**FOR**

**PROCESS DESIGN OF CRUDE OIL ELECTROSTATIC**

**DESALTERS**

**ORIGINAL EDITION**

**JULY 1995**

This standard specification is reviewed and updated by the relevant technical committee on June 2000. The approved modifications are included in the present issue of IPS.

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## 0. INTRODUCTION

The crude oil delivered to refineries for processing always contains salts in addition to other impurities. These salts occur mainly in dissolved form in the water and sometimes also in crystalline form in the crude oil. Due to the corrosive effects of the salts on metals damage can be caused in pipelines and downstream refineries. It is therefore essential in refineries to reduce the salt and water content of the crude oil. The crude oil is primarily desalted before being delivered to refineries.

As is well known, when oil is distilled the chloride salts dissociate and as a result hydrochloric acid (HCl) is formed, causing severe corrosion effects in refinery downstream Units.

Further forms of damage which can occur with inadequate desalting are deposits and blockages in heat exchangers, furnace tubes and distillation tower bottoms. This may reduce the throughput, change the degree of fractionation and finally impair the quality of some end products.

A further function of the desalter is to remove left-over impurities such as finely divided sand particles, clays, iron oxide, drilling muds, iron sulphide, arsenic, etc., from the crude oil.

Since, as already mentioned, the salt normally occurs dissolved in water and salt crystals are found only in a few types of crude oil, the desalter has to deal both with the aqueous solution and also with any soluble salt crystals. For this purpose water is normally added to the crude oil stream, which is preheated to the required temperature.

The two are then mixed to form an emulsion in order to dissolve the salt in the added water. The degree of mixing can be controlled by means of a mixing valve. A water-clarifying chemical (demulsifier) will be added to the crude oil charge ahead of the mixing valve, the demulsifier helps reducing the amount of the oil entrained (trapped) in the water, thus reducing the amount of oil carried out of the desalter with the effluent water. After mixing, the added wash water is as completely as possible removed in the desalting drum. This can be accomplished by electrical and/or chemical means.

In the electrical desalter, the water-oil emulsion is subjected to the action of a high voltage field. This breaks down the oil film which surrounds the individual water droplets, thus making possible the combination of a number of droplets.

Because of the higher relative density (specific gravity) of the droplets thus increased in size, they drop to the bottom of the drum and are withdrawn for disposal.

Relative densities (specific gravities), surface tension, chemical impurities of contaminants in the crude oil and water, determine the size, stability and distribution of the emulsion particles. Surface-affecting media such as asphalt, resins, waxes, solid bodies, clays or organic acids, which occur in the crude oil, can act as emulsion stabilizers. The desalter must therefore be able to dissociate even the most complex emulsions.

**1. SCOPE**

This Standard specification covers minimum process design requirements and design considerations for electrostatic desalters.

**Note:**

**This standard specification is reviewed and updated by the relevant technical committee on June, 2000. The approved modifications by T.C. were sent to IPS users as amendment No. 1 by circular No. 105 on June, 2000. These modifications are included in the present issue of IPS.**

**2. REFERENCES**

Throughout this Standard the following dated and undated standards/codes are referred to. These referenced documents shall, to the extent specified herein, form a part of this standard. For dated references, the edition cited applies. The applicability of changes in dated references that occur after the cited date shall be mutually agreed upon by the Company and the Vendor. For undated references, the latest edition of the referenced documents (including any supplements and amendments) applies.

**ASTM (AMERICAN SOCIETY FOR TESTING OF MATERIALS)**

ASTM D4007 "Test methods for water & sediment for crude oils"

**3. DEFINITIONS AND TERMINOLOGY**

**3.1 Water Content (of the Crude)**

Water content of the crude is that water which is emulsified, entrained or free in the crude oil, excluding the water that is in solution at the operating temperature of the desalting system .

**4. SYMBOLS AND ABBREVIATIONS**

<b>API</b>	=	American Petroleum Institute
<b>bbbl/sd</b>	=	Barrel per Stream Day
<b>BS &amp; W</b>	=	Basic Sediment and Water; Bottom Settling and Water
<b>CCR</b>	=	Central Control Room
<b>Eq</b>	=	Equation
<b>FCV</b>	=	Flow Control Valve
<b>FI</b>	=	Flow Indicator
<b>FIC</b>	=	Flow Indicator and Controller
<b>kg/1000</b>	=	Kilograms per Thousand Barrels (kg/159 m3)
<b>bbbl</b>		
<b>LIC</b>	=	Level Interface Controller
<b>LICV</b>	=	Level Interface Control Valve
<b>LS</b>	=	Level Switch
<b>PI</b>	=	Pressure Indicator

<b>P &amp; ID</b>	=	Piping and Instrumentation Diagram
<b>ppm</b>	=	Parts per Million
<b>PSV</b>	=	Pressure Safety Valve
<b>RVP</b>	=	Reid Vapor Pressure
<b>TDS</b>	=	Total Dissolved Solids
<b>TI</b>	=	Temperature Indicator
<b>vol%</b>	=	Volume Percent.

**5. UNITS**

This Standard is based on International system of units (SI), except where otherwise specified.

**6. DESIGN CRITERIA**

**6.1 Process Requirements**

**6.1.1 Crude properties**

The following properties have to be specified for desalter design:

selected crude oil;

gravity, API;

BS & W, vol%;

salt content, kg/1000 bbl (kg/159 m<sup>3</sup>);

viscosity at two temperatures, cSt;

sulfur content, mass %;

pour point, °C;

RVP at 38°C, kPa (abs.) or bar (abs.);

delivery pressure (at inlet of the mixing valve), kPa (ga) or bar (ga).

**6.1.2 Process water properties**

Water to refinery desalter can be supplied from sour water stripper. Vendor shall confirm suitability of wash water and recommend any change if necessary. Vendor shall specify the required water rate. Other wash water sources may also be specified. The following characteristics shall be specified for all specified types of water.

<b>H<sub>2</sub>S</b>	<b>(mg/kg)</b>
<b>NH<sub>3</sub></b>	<b>(mg/kg)</b>
<b>CN</b>	<b>(mg/kg)</b>
<b>Phenols</b>	<b>(mg/kg)</b>
<b>Thiocyanides</b>	<b>(mg/kg)</b>
<b>Free oil</b>	<b>(mg/kg)</b>
<b>Ca<sup>++</sup></b>	<b>(mg/kg as CaCO<sub>3</sub>)</b>
<b>Mg<sup>++</sup></b>	<b>(mg/kg as CaCO<sub>3</sub>)</b>
<b>Na<sup>+</sup></b>	<b>(mg/kg as CaCO<sub>3</sub>)</b>

<b>K +</b>	<b>(mg/kg as CaCO3)</b>
<b>HCO<sub>3</sub><sup>-</sup></b>	<b>(mg/kg as CaCO3)</b>
<b>SO<sub>4</sub><sup>-</sup></b>	<b>(mg/kg as CaCO3)</b>
<b>Cl<sup>-</sup></b>	<b>(mg/kg as CaCO3)</b>
<b>NO<sub>3</sub><sup>-</sup></b>	<b>(mg/kg as CaCO3)</b>
<b>Free O<sub>2</sub></b>	<b>(mg/kg)</b>
<b>SiO<sub>2</sub></b>	<b>(mg/kg)</b>
<b>TDS</b>	<b>(mg/kg)</b>
<b>Iron</b>	<b>(mg/kg)</b>
<b>pH</b>	

The expected water temperature at the injection point has to be specified by the Company.

A typical wash water injection rates may be between 3-7 (vol % of crude).

Injection point should be ahead of the mixing valve and /or ahead of heat exchanger train (not fired heater).

**6.1.3 Operating and mechanical design conditions**

The following conditions shall be specified by the Company:

**6.1.3.1** Operating pressure of the desalter (minimum pressure must be sufficient to maintain desalter content in liquid state).

**6.1.3.2** Operating temperature at the inlet of the desalter (range may be specified).

**6.1.3.3** Allowable pressure drop for the desalter (including the mixing valve).

**6.1.3.4** Design flow rate of crude oil (bbl/sd).

**6.1.3.5** Maximum anticipated system pressure and temperature.

**6.2 Performance Requirements**

The desalter shall produce a treated crude, under steady state conditions, which conforms to the following requirements:

**6.2.1** Specified design throughput (bbl/sd).

**6.2.2** The desalted crude salt content will be specified by the Company where depending on this requirement, one or more desalter stages may be furnished.

**6.2.3** In case when more than one stage is specified, facilities for series and parallel flow should be provided.

**6.2.4** Desalter shall be able to perform its duty with specified water types.

**6.3 Instrumentation and Control System**

Independent of safety devices like safety valves, the instrumentation and control system shall protect all items of the system against maloperation by operators, equipment failure, etc., but also enable the operators to undertake suitable actions during operation. A typical Piping and Instrumentation Diagram (P & ID) for a refinery is also shown in Appendix B.

Vendor shall submit the proposed instrument and control schematic drawings, adequate to fulfill the requirements of his process and mechanical guarantees for Company's approval. All instrumentation shall be suitable for continuous working in the conditions of their location.

Provision shall be made for local tripping of critical equipment. The desalter Supplier shall be

responsible for the satisfactory design and operating capability of the instruments, controls and safety equipment associated with the desalter and he shall submit details to the Company for approval.

The type of valves/control valves shall be selected according to the service. Special valves shall be used where cavitation, noise, flashing or erosion may occur. All shut-down systems shall be capable of full function testing from primary sensor up to final actuation device while the plant is on line. Test key-operated override switches shall be provided for this function. These shall override the minimum number of function components. Alarms shall be provided to show automatically when the trip circuit is being overridden for test. All override test facilities shall be mechanically protected and shall be accessible only to the personnel authorized to carry out testing.

The items listed below are regarded as the minimum required instrumentation/control components of the electrostatic desalting system.

#### **6.3.1 Mixing valve**

The desalter shall be furnished with a suitably sized valve in the crude oil entrance line. A local differential pressure indicator, connected to the upstream and downstream sides of the mixing valve, shall be provided for reading of the adjusted pressure drop. Pressure drop across the mixing valve shall also be monitored in CCR. This valve shall be manually operated for dispersion of process water into the crude oil. This mixing shall be accomplished with a minimum pressure drop for creating a water-in-oil emulsion.

#### **6.3.2 Level interface controller (LIC)**

Level interface controller shall receive measurement information from the level interface transmitter. The transmitter shall be connected to the displacer at the water/oil interface. The controller uses this measurement information to control the action of the level interface control valve and is provided with high and low level interface alarms. This control valve shall maintain the vessel's water-oil interface at the desired level.

#### **6.3.3 Level interface control valve (LICV)**

This control valve shall be installed in the vessels effluent water line to control the flow rate of water leaving the vessel. Signals transmitted by the level interface controller determine how much air is supplied to the control valve actuator.

#### **6.3.4 Pressure indicator (PI)**

A pressure indicator (local) shall be furnished to show the operating pressure of the vessel.

#### **6.3.5 Temperature indicator (TI)**

A Temperature indicator (local) shall be furnished to show the operating temperature of vessel.

#### **6.3.6 Level switch (LS)**

A level switch shall be provided for the purpose of switching off the power in case the vessel is not completely full of liquid (cut-off and alarm). In no case the power must be applied on the desalter if vessel is not totally filled with liquid.

#### **6.3.7 Pressure safety valve (PSV)**

Pressure safety valve(s) shall protect desalter in case of eventual overpressure in the system.

### **6.3.8 Process water flow indicator (FI)**

This instrument shows the flow rate of the process water (local and in CCR).

### **6.3.9 Process water flow controller (FC)**

This controller receives the measurement information from the process water flow transmitter. The controller uses this measurement information to control the action of the process water flow control valve.

### **6.3.10 Process water flow control valve (FCV)**

This control valve shall be installed in the process water line. Signals transmitted by the process water flow controller determine how much air is supplied to the control valve actuator.

## **6.4 Local Control Panel**

A local control panel shall be provided as a point for engaging or disengaging the electrical supply that energizes the desalter transformers.

## **6.5 Chemical Injection System**

The injection facility of controlled addition for demulsifier chemical shall be provided (pump, tank, measuring column, etc.). Vendor shall advise the required injection rate of the demulsifier chemical. The pressure at the injection point of the demulsifying chemical shall be specified.

**6.5.1** The demulsifiers are added to crude oil to be desalted to counter the effects of emulsifiers within the crude. To be effective the demulsifier must be distributed uniformly throughout the crude oil.

For a successful chemical treatment it is important to choose the proper demulsifier type via relevant tests and to add it in sufficient quantity at the right point of the system.

### **6.5.2 Caustic injection**

Some crude oils contain traces of inorganic acid from acidizing operations in the field, along with H<sub>2</sub>S and naphthenic acids. If tests for pH reveal that the effluent water from the desalter is corrosive, a small amount of caustic should be added to the desalter makeup water. Caustic must be added cautiously, because crudes containing high values of organic acidity (naphthenic acid) can react with the caustic to produce naphthenic soaps that are emulsion stabilizers. These soaps may prevent adequate water and oil separation.

### **6.5.3 Wash water pH adjustment**

It is sometimes necessary to adjust the pH of the brine to obtain pH values of 7.0 or less in the water. If the pH of the brine exceeds 7.0, emulsions can be formed because of the sodium naphthenate and sodium sulfide present. For most crude oils it is desirable to keep the pH below 8.0.

Better dehydration is obtained in the pH range of 6.0 to 8.0 with the best dehydration obtained at a pH near 6.0.

## **6.6 Mud Washing System**

An on-stream mud washing system shall be provided in the water phase of the desalter system to prevent the accumulation of undissolved solids at the bottom of the vessel.

The mud washing system shall incorporate solids removal piping that extend through the length of the settling zone near the bottom of the vessel.

An external pump shall recycle water from the effluent water discharge line and move it into the solids removal piping.

Water from the nozzles stirs up solids at the bottom of the vessel, so the solids can be carried out with the effluent water.

### **6.7 Vent Line**

The vent line shall be opened to a visible sewer so an operator can determine when the vessel is liquid full. If the desalter is to be shut down, the vent line must be opened to relieve the vacuum inside the vessel as the vessel is pumped out.

### **6.8 Steam-out Connection**

A permanent steam-out connection shall be provided.

### **6.9 Sample Connections**

Adequate sample connections should be provided. The Company may elect to install additional sampling lines and to route all lines to a central collection box. Sample coolers may be required at the collection point. If sample coolers are to be installed, one cooler should serve the desalted crude sampling line and another should serve the remaining sampling lines. The use of two coolers helps to prevent contamination of the desalted crude sample.

## **7. PROCESS GUARANTEE**

Vendor shall guarantee the followings:

- 1) Desalter capacity under the specified operating conditions.
- 2) Equipment and accessories are of sufficient size to fulfill satisfactorily the specified operating conditions.
- 3) Desalter shall be able to perform its duty with either of the specified types of wash water.
- 4) Specified desalted crude salt content.

## **8. TESTING**

Within 30 days after the plant has been placed into operation, Company may subject it to such tests as are necessary to demonstrate a 36-hours performance test to demonstrate that the plant will meet the process guarantees. These tests may be witnessed during this period by Company and Vendor's representative.

If during these tests the equipment fails to meet the specifications, the Vendor shall take the necessary steps at his expense, to make the equipment meet guaranteed performance.

Vendor shall propose the test methods by which operating results shall be measured. These methods are subject to Company's approval.

## **9. DOCUMENTATION**

- 1) At quotation stage Suppliers shall provide the following in the numbers requested at the time of quotation:
  - a) Comprehensive descriptive literature.
  - b) List of recommended commissioning spares with prices.
  - c) Details of any special tools required.
- 2) At ordering stage Suppliers shall provide the following in quantities and at times as detailed in the order:
  - a) List of recommended spares for two years continuous operation.

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- b) Illustrated comprehensive spare parts manual with part numbers suitable for warehouse stocking.
  - c) Illustrated installation and operating instructions, e.g.,
    - Desalter general drawing
    - Desalter vessel fabrication drawing
    - Desalter vessel internals drawing
    - Desalter vessel external attachments drawings
    - Desalter vessel internal electrode parts drawings
    - Schematic control diagram
    - Instruments data sheets
    - Control panel wiring diagram
    - Data sheet of chemical feed system
    - Other relevant data sheets/diagrams/drawings manuals
  - d) Maintenance manuals.

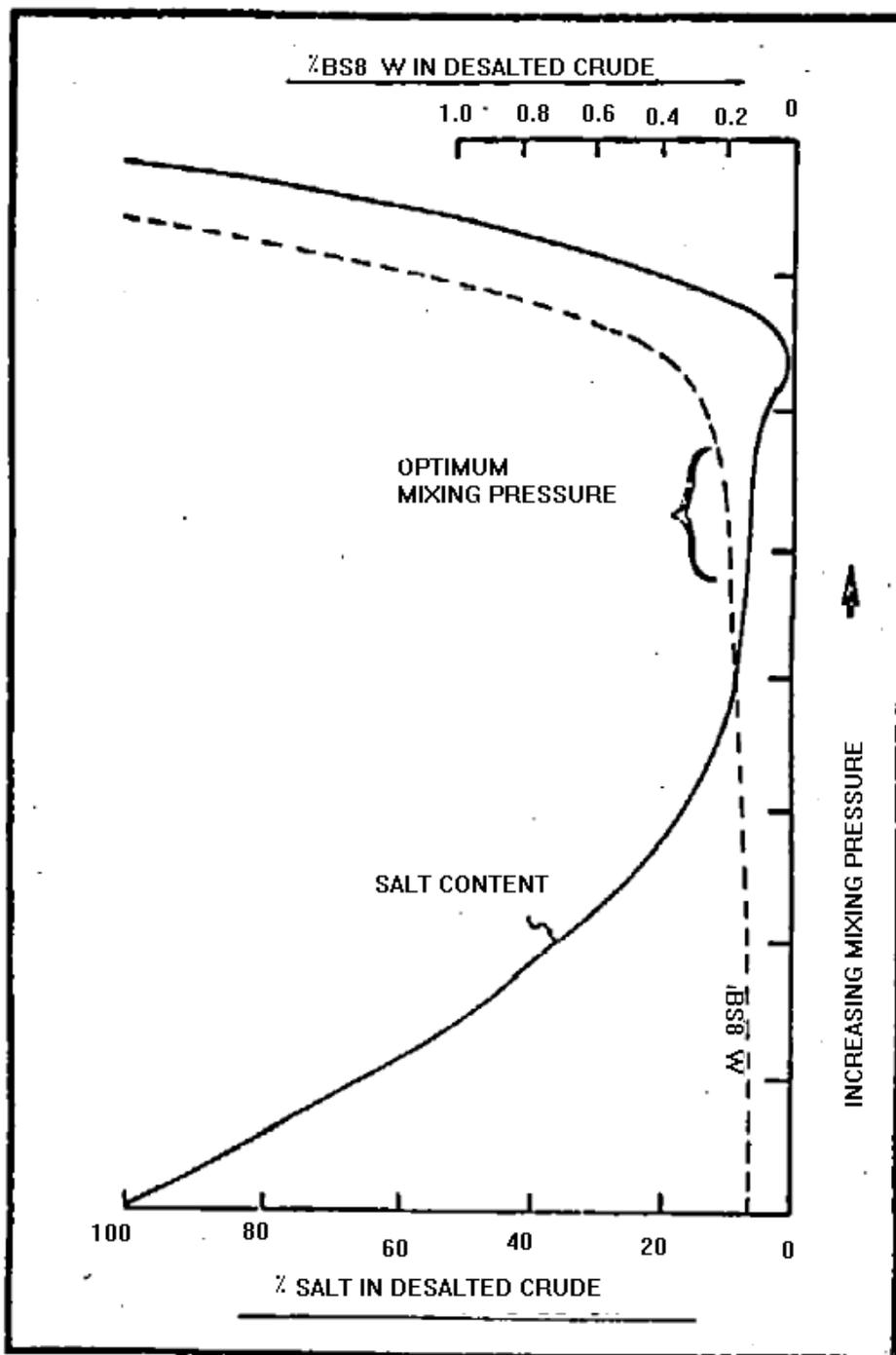
## 10. PACKING AND SHIPPING

Equipment shall be carefully protected and packed to provide adequate protection during transit to destination and shall be in accordance with any special provision contained in the specification or order. Special attention shall be given to protection against corrosion during transit. All bright and machined parts must be painted with a rust preventative. Ancillary items forming an integral part of the equipment should be packed preferably in a separate container if the equipment is normally cased or crated. Alternatively the ancillary items should be fixed securely to the equipment and adequate precaution taken to ensure that the items do not come loose in transit or be otherwise damaged. Instruments having delicate movements and assembled into panels for inspection and test shall be replaced in makers special shock absorbing packages for transit, all connections being marked for remounting in IRAN. Such instruments shall be packed in same case as associated panel, but protected by a bulkhead or equivalent packing arrangement.

APPENDICES

APPENDIX A

TYPICAL CURVES FOR DESALTED CRUDE SALT CONTENT AND BS & W VERSUS MIXING VALVE PRESSURE DROP





APPENDIX B (continued)

