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# PROCESS DESIGN OF CRUDE OIL ELECTROSTATIC DESALTERS

# (PROJECT STANDARDS AND SPECIFICATIONS)

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## SCOPE

This Project Standards and Specifications covers minimum process design requirements and design considerations for electrostatic desalters.

## 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"

## DEFINITIONS AND TERMINOLOGY

**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.

## SYMBOLS AND ABBREVIATIONS

| SYMBOL/ABBREVIATION | DESCRIPTION |
|---|---|
| API | American Petroleum Institute |
| bbl/sd | Barrel per Stream Day |
| BS & W | Basic Sediment and Water; Bottom Settling and Water |
| CCR | Central Control Room |
| Eq | Equation |
| FCV | Flow Control Valve |
| FI | Flow Indicator |
| FIC | Flow Indicator and Controller |
| kg/1000 bbl | Kilograms per Thousand Barrels (kg/159 m3) |
| LIC | Level Interface Controller |
| LICV | Level Interface Control Valve |
| LS | Level Switch |

| | |
|---|---|
| PI | Pressure Indicator |
| P & ID | Piping and Instrumentation Diagram |
| ppm | Parts per Million |
| PSV | Pressure Safety Valve |
| RVP | Reid Vapor Pressure |
| TDS | Total Dissolved Solids |
| TI | Temperature Indicator |
| vol% | Volume Percent. |

## UNITS

This Standard is based on International System of Units (SI) except where otherwise specified.

## DESIGN CRITERIA

### Process Requirements

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 m3);
   - 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).

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.

| | |
|---|---|
| $H_2S$ | (mg/kg) |
| $NH_3$ | (mg/kg) |
| CN | (mg/kg) |
| Phenols | (mg/kg) |
| Thiocyanides | (mg/kg) |
| Free oil | (mg/kg) |
| $Ca^{++}$ | (mg/kg as CaCO3) |
| $Mg^{++}$ | (mg/kg as CaCO3) |
| $Na^{+}$ | (mg/kg as CaCO3) |
| $K^{+}$ | (mg/kg as CaCO3) |
| $HCO_3^{-}$ | (mg/kg as CaCO3) |
| $SO_4^{--}$ | (mg/kg as CaCO3) |
| $Cl^{-}$ | (mg/kg as CaCO3) |
| $NO_3^{-}$ | (mg/kg as CaCO3) |
| Free $O_2$ | (mg/kg) |
| $SiO_2$ | (mg/kg) |
| TDS | (mg/kg) |
| Iron | (mg/kg) |
| pH | |

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).

3. Operating and mechanical design conditions

   The following conditions shall be specified by the Company:

   a. Operating pressure of the desalter (minimum pressure must be sufficient to maintain desalter content in liquid state).
   b. Operating temperature at the inlet of the desalter (range may be specified).
   c. Allowable pressure drop for the desalter (including the mixing valve).
   d. Design flow rate of crude oil (bbl/sd).
   e. Maximum anticipated system pressure and temperature.

**Performance Requirements**

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

a. Specified design throughput (bbl/sd).
b. The desalted crude salt content will be specified by the Company where depending on this requirement, one or more desalter stages may be furnished.
c. In case when more than one stage is specified, facilities for series and parallel flow should be provided.
d. Desalter shall be able to perform its duty with specified water types.

**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.

Vendor shall submit the proposed instrument and control schematic drawings, adequate to fullfill 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 overriden 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.

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.

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.

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.