



CRUDE OIL PROCESSING



A Guide to Level Instrumentation for Onshore/Offshore Oil Processing



INDUSTRY APPLICATIONS SERIES

Level & Flow Applications for CRUDE OIL PROCESSING

Level and flow controls in these applications are crucial for both process control and safety shutdown systems.

Level Applications:

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Flow Applications:

Flow controls for pumps, compressors, and liquids are found throughout crude oil field operations.

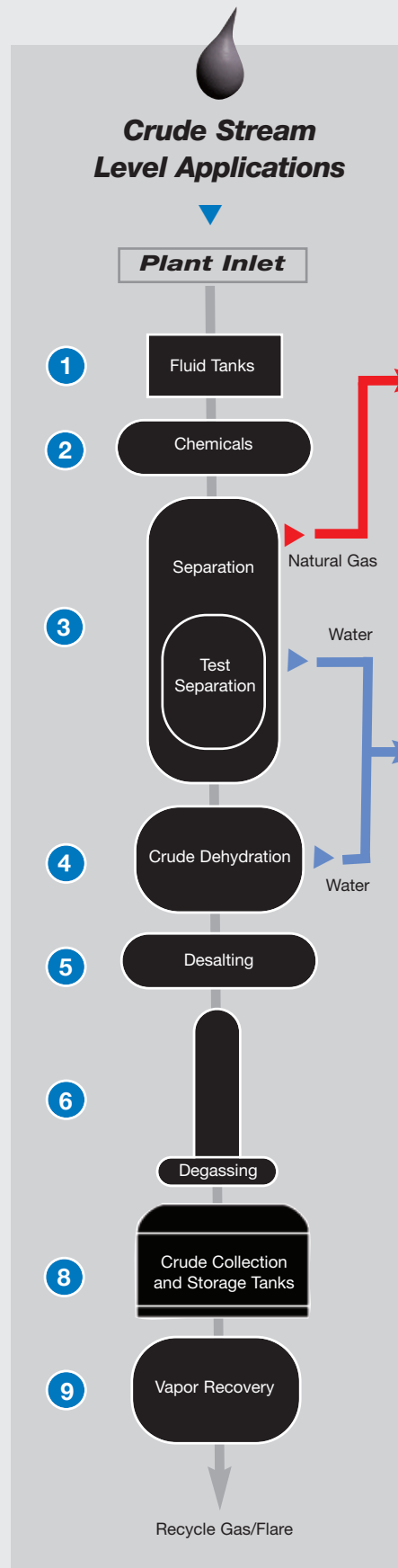
▲ Flow Alarm:

Thermatel® Model TD2 Thermal Dispersion Flow Switch

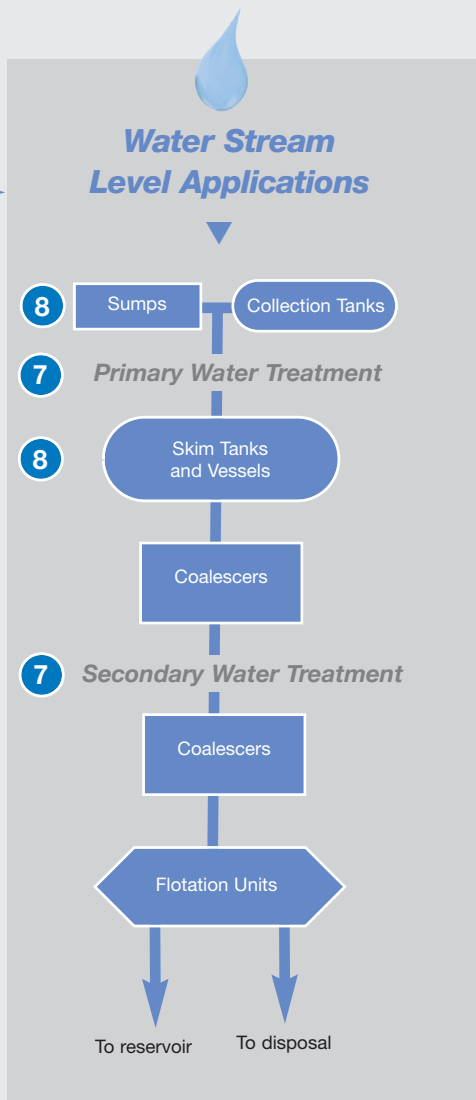
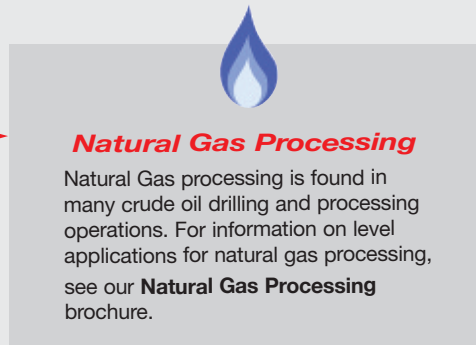


▲ Continuous Gas Flow:

Thermatel® Model TA2 Thermal Dispersion Mass Flow Meter



NOTE: The actual nature and number of steps in crude oil processing most often depends upon the source and makeup of the wellhead production stream. In some cases, several of the steps shown in the schematic below may be integrated into one unit or operation, performed in a different order or at alternative locations, or not required at all.



1 PRODUCTION FLUID STORAGE



Storage Tanks

Application: A variety of chemicals are typically stored in the field or processing facility to expedite processing time by preconditioning an inlet fluid. These fluids may first enter into a hold tank to allow upstream solids and liquids time to separate prior to production, which allows the facility to better handle upset conditions without stopping production. Stored additive chemicals include dispersants, flocculants, surfactants, glycols, diluents and rust inhibitors.

Challenges: Fluids are typically stored in a series of outdoor steel tanks. The tank fluid volume should be continuously monitored since level variations may lead to upsets. Tanks contain agitated media with suspended solids that can coat floats, displacers and probes.

INSTRUMENTATION



▲ **Point Level:**
 Thermatel® Model TD1/TD2 Thermal Dispersion Switch or Model A15 Series Displacer-Actuated Level Switch



▲ **Continuous Level and Interface Level:**
 Eclipse® Model 706 Guided Wave Radar Transmitter with Enlarged Coaxial Probe or Pulsar® Model R86 or Model R82 Radar Transmitters

2 CHEMICAL INJECTION



Chemical Injection Skid

Application: Chemical agents employed in crude processing include drilling fluid additives, methanol injection for freeze protection, glycol injection for hydrate inhibition, produced water treatment chemicals, foam and corrosion inhibitors, de-emulsifiers, desalting chemicals, and drag reduction agents. Chemicals are frequently administered by way of chemical injection skids.

Challenges: Level monitoring controls chemical inventory and determines when the tanks require filling. The careful selection and application of level controls to chemical injection systems can effectively protect against tanks running out of chemicals or overfilling.

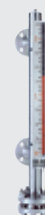
INSTRUMENTATION



▲ **Point Level:**
 Echotel® Model 961 Ultrasonic Switch; Thermatel Model TD1/TD2 Thermal Dispersion Switch or Tuffly® II Float-Actuated Switch



▲ **Continuous Level:**
 Eclipse Model 706 Guided Wave Radar Transmitter or Jupiter® Magnetostrictive Transmitter



▲ **Visual Indication:**
 Atlas™ or Aurora® Magnetic Level Indicators can be supplied with switches or transmitters

3 WELLSTREAM SEPARATORS



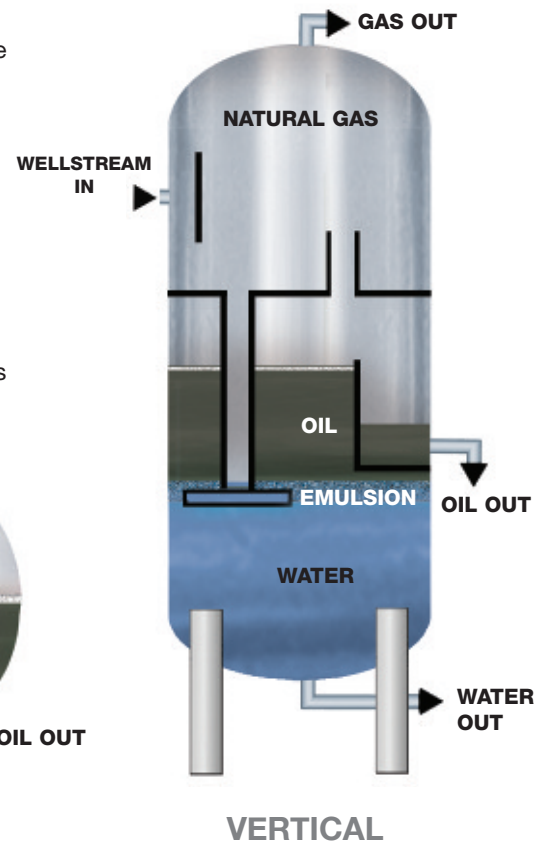
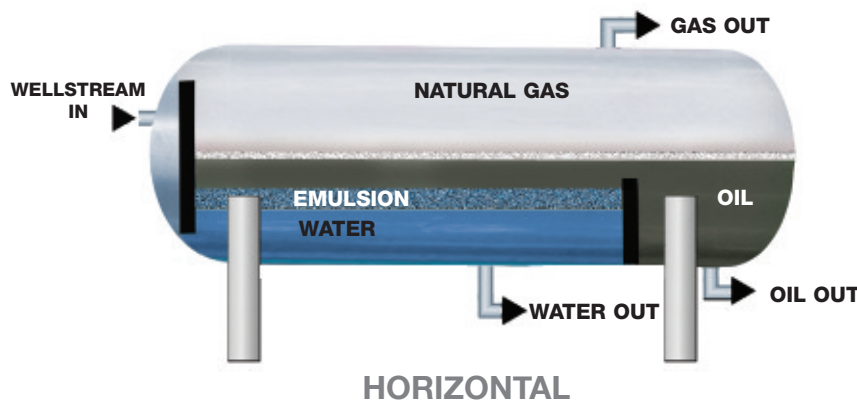
Application: Separators are large drums designed to separate wellstreams into their individual components. They are commonly designed to separate two-phase (gas/liquid) or three-phase (gas/crude/water) wellstreams. Separators are also classified according to horizontal or vertical configuration (see below), operating pressure, turbulent or laminar flow, and test or production separation.

Challenges: Interface level measurement will actuate a valve to adjust vessel level. An emulsion layer along the oil/water interface can contaminate the oil with water or the water with oil. Foaming along the gas/liquid interface, if entrained, can cause liquid carryover or gas blowby.

TWO PRINCIPAL TYPES OF SEPARATORS

Vertical (right): Vertical separators can accommodate large surges of liquids. They are well suited for high sediment loads; conical bottoms are sometimes attached for large volumes of sediment. Vertical separators are preferred when wellstreams have large liquid-to-gas ratios. These separators occupy less floor space than horizontal types and are often found on offshore platforms where floor space is at a premium.

Horizontal (below): These separators are well suited for three-phase separation because of their large interfacial area between the two liquid phases. Horizontal types are preferred when wellstreams have high gas-to-oil ratios, when wellstream flow is more or less constant, and when liquid surges are insignificant. These separators also have a much greater gas/liquid interface area, which aids in the release of solution gas and in the reduction of foaming.



INSTRUMENTATION



▲ **Point Level:**
Series 3 Float-Actuated External Cage Switch; Thermatel Model TD1/TD2 Thermal Dispersion Switch or Model A15 Series Displacer-Actuated Switch



▲ **Continuous Level and Interface Level:**
Eclipse Model 706 Guided Wave Radar Transmitter; Jupiter Magnetostrictive Transmitter or E3 Modulelevel® Displacer Transmitter



▲ **Visual Indication:**
Atlas or Aurora Magnetic Level Indicators can be supplied with switches or transmitters






▲ **Flow Indication: ALARM:**
Thermatel Model TD1/TD2 Flow Switch; **CONTINUOUS:**
Thermatel Model TA2 Mass Flow Meter

4 CRUDE DEHYDRATION



Application: Not all water is removed from crude oil during the first stage of gravity separation. Separated crude may contain up to 15% water which exists in an emulsified form that is difficult for a separator to remove. The oil and water emulsion must be broken down so that the water can be removed before the crude is shipped. De-emulsification processes are accomplished using chemical agents such as glycol and heat.

Challenges: Level control is found on two-phase and three-phase water knockout drums, heater treaters and chemelectric dehydrators. Interface measurement is critical in dehydration as it keeps the water-emulsified oil from flowing over the separator weir.




INSTRUMENTATION		▲ Point Level: Series 3 Float-Actuated External Cage Level Switch		▲ Continuous Level and Interface Level: Eclipse Model 706 Guided Wave Radar Transmitter or E3 Modulevel Displacer Transmitter		▲ Visual Indication: Atlas or Aurora Magnetic Level Indicators can be supplied with switches or transmitters
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5 CRUDE DESALTING



Application: Salt in the crude stream presents serious corrosion and scaling problems, and must be removed. Salt is dissolved within the remnant brine of the crude oil. Desalting removes both salt and the residual free water. Field desalting is necessary due to pipeline requirements.

Challenges: Level instrumentation is integral to single and two-stage desalting systems, multiple orifice plate mixers, and the settler tank of a chemical desalter. Interface level control keeps free water from hitting the desalter electrodes and prevents expensive damage. The interface level should be kept constant, otherwise electrical field changes will disturb electrical coalescence.

INSTRUMENTATION		▲ Point Level: Series 3 Float-Actuated External Cage Switch; Thematel Model TD1/TD2 Thermal Dispersion Switch		▲ Continuous Level: Eclipse Model 706 Guided Wave Radar Transmitter with Enlarged Coaxial probe or E3 Modulevel Displacer Transmitter		▲ Visual Indication: Atlas or Aurora Magnetic Level Indicators can be supplied with switches or transmitters
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6 CRUDE DEGASSING



Reboiler

Application: By removing dissolved gases and hydrogen sulfide, crude stabilization and sweetening processes diminish safety and corrosion problems. Gases are removed by a stabilizer. Sweetening employs stabilization or vaporization processes along with a gas or steam-based stripping agent.

Challenges: Removing dissolved gases by stabilization requires level control in the reboiler unit. Sweetening by stage vaporization and trayed stabilization require level control in a series of staged separators. Sweetening by reboiled trayed stabilization requires additional level control in a reboiler.

INSTRUMENTATION



▲ **Point Level:**
Series 3 Float-Actuated External Cage Switch or Tuffy II Float-Actuated Switch



▲ **Continuous Level:**
Eclipse Model 705 Guided Wave Radar Transmitter or E3 Modulelevel Displacer Transmitter



▲ **Visual Indication:**
Atlas or Aurora Magnetic Level Indicators can be supplied with switches or transmitters

7 WATER PROCESSING



Water Wash Tank

Application: Produced water, wash-down water or collected rainwater require treatment whether they're reused for reservoir flooding or simply disposed of. Water collected from process operations contains hydrocarbon concentrations too high for safe discharge. Suspended hydrocarbon droplets in water also hinders well-injection.

Challenges: Treatment equipment is similar to three-phase separators except that water is the main product. Level control is found on skim tanks, precipitators, coalescers, flotation units, and collection tanks and sumps. Interface level measurement is essential for proper draining of clean water and removal of the residual oil.

INSTRUMENTATION



▲ **Point Level:**
Echotel Model 961 Ultrasonic Switch or Series 3 Float-Actuated External Cage Switch



▲ **Continuous Level:**
Eclipse Model 706 Guided Wave Radar Transmitter; Kotron® Model 805 Smart RF Transmitter or E3 Modulelevel Displacer Transmitter



▲ **Visual Indication:**
Atlas Magnetic Level Indicator can be supplied with switches or transmitters

8 PROCESS & STORAGE TANKS



Storage Tanks

Application: Crude oil and water are stored in oil fields. Unlike midstream tank farms at terminals and refineries, field storage consists of smaller vessels associated with oil and water processing. Diesel generator fuel, potable water, and fire water are also stored.

Challenges: Tank level monitoring can be provided with overflow control and alarm systems or shutdown pumps when level falls below the specified low level. Interface controls will sense the beginning of an oil/water interface during tank dewatering and control the water draw-off.

API 2350: New recommended practices regarding tank overflow protection for above-ground storage tanks that receive Class I (flammable) liquids outline that careful selection and application of level controls can effectively protect against tank overfills.

INSTRUMENTATION

▲ Point Level:
Model A15 Series Level Switch with optional Proof-er® Ground Check or Tuffy II Float-Actuated Switch



▲ Continuous Level:
Eclipse Model 706 Guided Wave Radar Transmitter with Flexible Probe; Pulsar Model R86 Radar Transmitter or E3 Modulevel Displacer Transmitter



9 VAPOR RECOVERY UNIT FLASH DRUM




Field VRU

Application: If allowed to escape into the atmosphere, hydrocarbon vapors diminish income through loss of hydrocarbon volume and create fire hazards and pollution problems. A Vapor Recovery Unit (VRU) collects vapors from storage and loading facilities, reliquefies the vapors and returns the liquid hydrocarbons back to storage. Methods to recover vapors include absorption, condensation, adsorption and simple cooling.


Challenges: A VRU is a simple, economical process unit that provides EPA compliance and improves operating economies by capturing up to 95% of fugitive emissions. Critical to the VRU is the flash drum where vapors are reliquefied. Liquid level control of the flash drum is essential.

INSTRUMENTATION


▲ Point Level:
Series 3 Float-Actuated External Cage Switch; Tuffy II Float-Actuated Switch or Echotel 961 Ultrasonic Switch




▲ Continuous Level:
Eclipse Model 706 Guided Wave Radar Transmitter or E3 Modulevel Displacer Transmitter



▲ Visual Indication:
Atlas or Aurora Magnetic Level Indicators can be supplied with switches or transmitters



▲ Flow Indication:
CONTINUOUS:
Thermatel Model TA2 Thermal Dispersion Mass Flow Meter





CRUDE OIL PROCESSING

AN INDUSTRY GUIDE TO LEVEL MEASUREMENT AND CONTROL FROM **MAGNETROL**

Other industry and special application brochures from Magnetrol include:

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- **Nuclear Power**
- **Petroleum Refining**
- **Power Generation**
- **Pulp & Paper Mills**
- **Renewable Energy**
- **Steam Generation**
- **Tank Bridle Level Measurement**
- **Tank Overfill Prevention**
- **Understanding Safety Integrity Level (SIL)**
- **Water & Wastewater**

PLEASE NOTE: The instruments recommended in these brochures are based on field experience with similar applications and are included as a general guide to level and flow control selection. Because all applications differ, however, customers should determine suitability for their own purposes.



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