



INDUSTRY APPLICATIONS SERIES

PETROLEUM REFINING



A Guide to Level Instrumentation for Gasoline Refineries

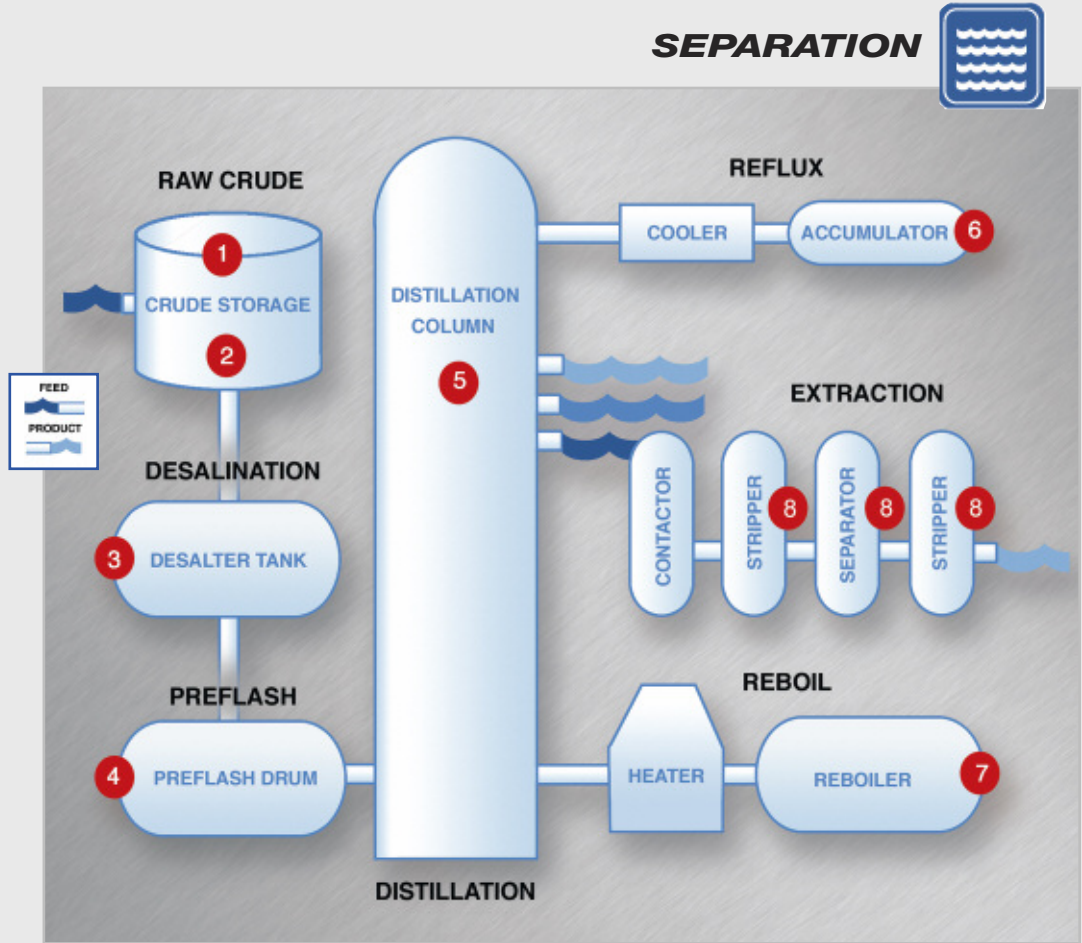


20 Leading Petroleum Refinery Level Control Applications

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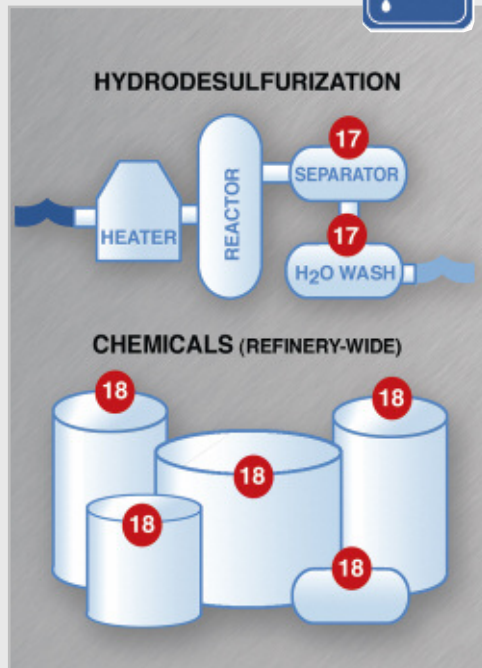
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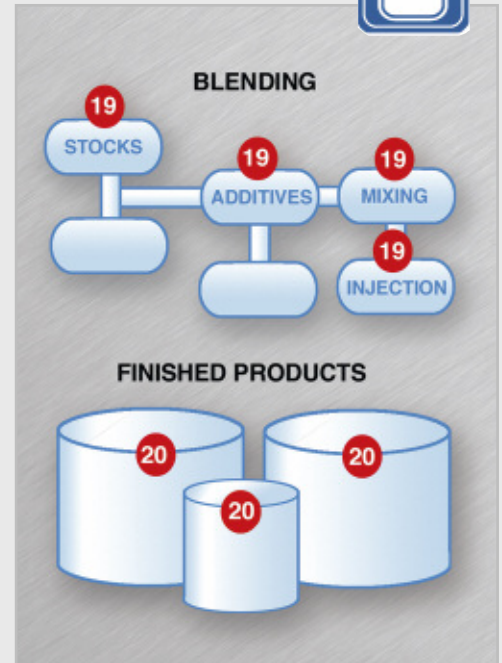
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See page 14 for information on refinery flow controls and level and flow control applications for refinery power generation.

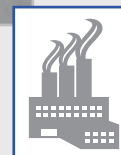
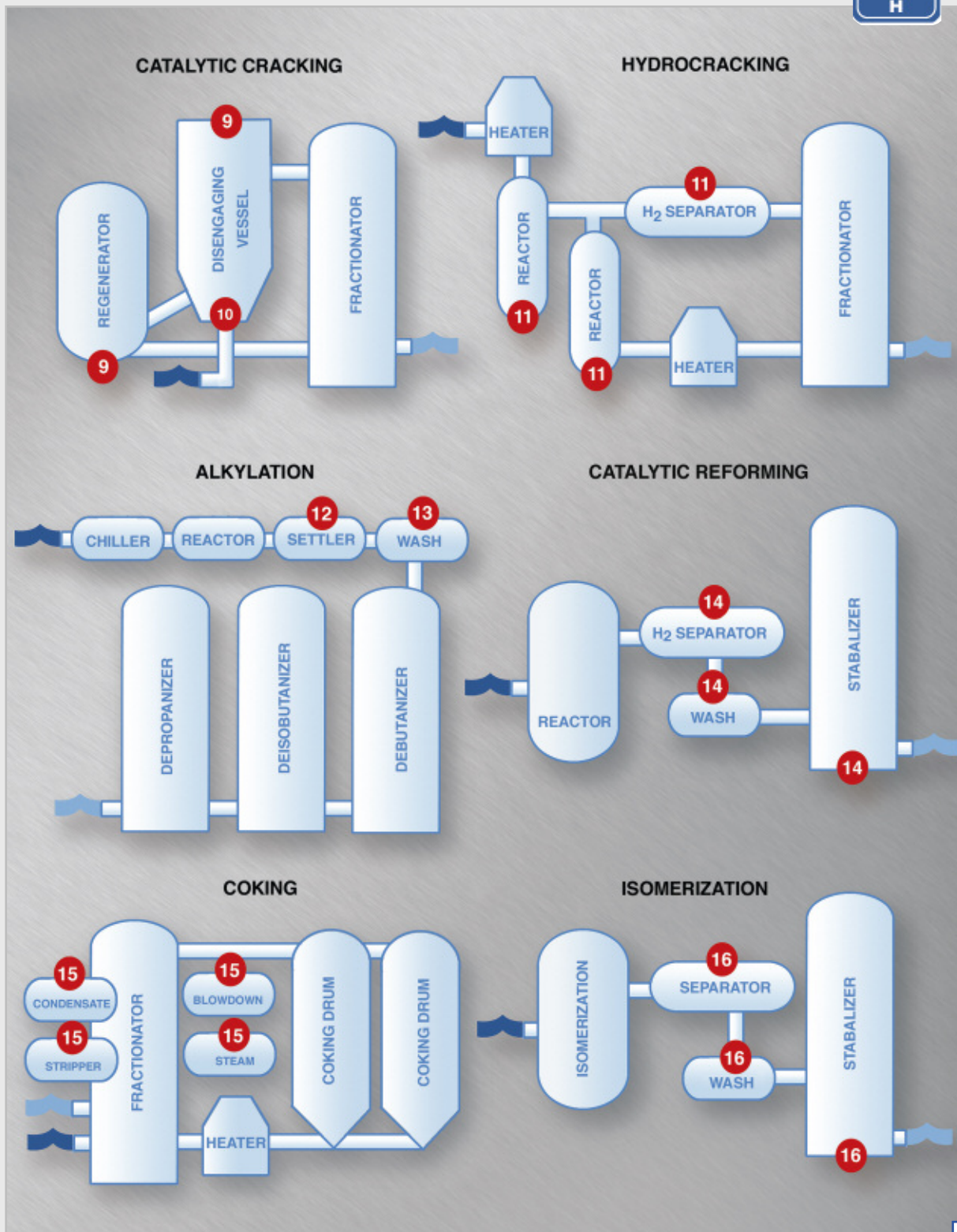
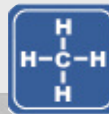
TREATMENT



BLENDING



CONVERSION



1 CRUDE STORAGE



Crude Tanks

Application: Upon arrival at the refinery terminal, crude oil is pumped into above-ground storage tanks with capacities of thousands to millions of gallons. Raw crude is stored in floating- or fixed-roof tanks field-built to API standards. Tank level measurement by noncontact radar has gained share over mechanical float type and servo gauges due to its accuracy, low maintenance, no moving parts and fast set-up.

Challenges: Tank level is maintained by valve actuation. By triggering an emergency cutoff, level controls prevent overflows and shut down pumps when level falls below low level. Safety-certified controls may be necessary due to crude's low flash point.

INSTRUMENTATION



▲ **Point Level:**
Model A15
Displacer-
Actuated Level
Switch



▲ **Continuous Level:**
Pulsar™ Model R86
Pulse Burst Radar
Transmitter



▲ **Continuous Level:**
Eclipse® Model 706
Guided Wave Radar
Transmitter with 7y1
Single Flexible Cable
Probe

2 CRUDE DEWATERING



Crude Tanks

Application: All unrefined crude oil stored in tanks has a percentage of water entrained within it, and while stored in tanks, separation naturally occurs with water collecting at the bottom of the tank beneath the oil. The two fluids are very distinct except for a "black water" or "rag" interface layer which is an emulsion of mixed oil and water. To dewater the tank, water is drawn off of the bottom of the tank and is then sent off to water treatment.

Challenges: Level controls designed for interface detection will sense the beginning of the oil/water interface during dewatering procedures and provide feedback to a control system which will terminate water draw-off when appropriate.

INSTRUMENTATION



▲ **Point Level:**
Model A15
Displacer-
Actuated Level
Switch



▲ **Continuous Level:**
ECLIPSE Model 706
Guided Wave Radar
Transmitter



▲ **Continuous Level:**
E3 Modulevel®
Displacer-Actuated
Transmitter or Kotron®
Model 805 Smart RF
Capacitance
Transmitter

3 CRUDE DESALTING



Desalting Tanks

Application: Inorganic chlorides, suspended solids, and trace metals found in untreated crude must be removed by chemical or electrostatic desalting. This reduces the risk of acid corrosion, plugging, fouling and catalyst poisoning in downstream units. Measurement of the oil/water interface in the desalter is crucial in separating the cleansed crude from contaminants.

Challenges: Coating and build-up on probes may create interface measurement errors. Instruments susceptible to electrostatic grid interference may require special filters. Interface-dedicated level transmitters fitted with quick-disconnect probes provide optimum performance while reducing cleaning and maintenance time.

INSTRUMENTATION



▲ **Point Level:**
Model A15
Displacer-
Actuated Level
Switch



▲ **Continuous Level:**
ECLIPSE Model 706
Guided Wave Radar
Transmitter



▲ **Continuous Level:**
E3 MODULEVEL
Displacer-Actuated
Transmitter

4 PREFLASH DRUM



Preflash Drum

Application: Located in the preheat train of the distillation column, a preflash drum system separates the vapors generated by preheating before entering the heater or main column. This prevents higher heater firing or pressure drops and reduces vapor loading of the column to avoid flooding.

Challenges: Preflash drums create moderate foam that can affect measurement accuracy of liquid levels and decrease distillate production in the atmospheric column. Too low of a pre-flash drum level will cause pump cavitation of the flashed crude. Too high of a level will cause liquid carryover to the distillation column.

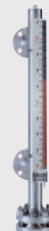
INSTRUMENTATION



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



▲ **Continuous Level:**
E3 MODULEVEL
Displacer-Actuated
Transmitter; or ECLIPSE
Model 706 Guided
Wave Radar Transmitter



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

5 DISTILLATION COLUMN



Application: Following desalination, crude oil enters the distillation column where fractional distillation separates hydrocarbons into separate streams, cuts or fractions. For optimum operation of the distillation column, level controls must contend with occurrences of foaming, bubbling and moderate-to-high temperatures.

Challenges: Sight glasses and displacer systems mounted in external chambers have traditionally provided distillation level measurement. Today, radar retrofitted in these existing chambers is gaining popularity due to radar's less demanding maintenance schedule and ease of retrofit. High product temperatures necessitate temperature-tolerant level sensors.

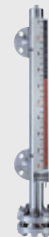
INSTRUMENTATION



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



▲ **Continuous Level:**
E3 MODULEVEL
Displacer-Actuated
Transmitter or
ECLIPSE Model 706
Guided Wave Radar
Transmitter



▲ **Visual Indication:**
ATLAS or AURORA
MLIs can be supplied
with switches or trans-
mitters

6 REFLUX ACCUMULATOR



Application: A heat exchanger removes vapor from the upper parts of the fractionator, cools it to a liquid, and pumps it into an accumulator (reflux drum). Reflux pumps then draw liquid from the bottom of the accumulator and pump part of it back (reflux) where it is reintroduced at a lower point in the column. This refluxing process improves separation in the column by assuring sufficient downward liquid flow meeting the rising vapor.

Challenges: Accurate and reliable level monitoring and control is necessary for the reflux accumulator to serve as a distribution point for reflux and distillate, and prevent excessive reflux from returning back to the tower.

INSTRUMENTATION



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



▲ **Continuous Level:**
E3 MODULEVEL
Displacer-Actuated
Transmitter or
ECLIPSE Model 706
Guided Wave Radar
Transmitter



▲ **Visual Indication:**
ATLAS or AURORA
MLIs can be supplied
with switches or trans-
mitters

7 COLUMN REBOILER



Application: A heat exchanger positioned near the bottom of the distillation column re-heats and vaporizes liquid and reintroduces the vapor several trays higher. This improves separation by introducing more heat into the column. For effective functioning of the reboiling process, level monitoring of the reboiler is required.

Challenges: In some steam reboilers, the level must be controlled so that only a percentage of tubes are covered. This allows a control scheme to regulate the heat transfer in the reboiler by controlling the percentage of the reboiler tubes covered by liquid. This is a critical control loop as heat transfer into the liquid is a strong function of the percentage of tubes covered.

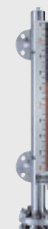
INSTRUMENTATION



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



▲ **Continuous Level:**
E3 MODULEVEL Displacer-Actuated Transmitter or ECLIPSE Model 706 Guided Wave Radar Transmitter



▲ **Visual Indication:**
ATLAS or AURORA MLIs can be supplied with switches or transmitters

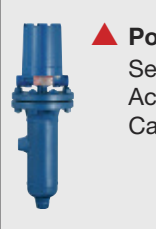
8 SOLVENT EXTRACTION



Application: The heavy fraction remaining following the distillation of crudes is called petroleum resid. A variety of solvent-extraction processes yield deasphalted oil (DAO) from these resid. These oils serve as downstream feedstocks for catalytic crackers and hydro-crackers. Depending upon the system configuration, level monitoring of the separator, pre-flash, stripper and hot oil phases may include surge and flash drums, separators and strippers.

Challenges: Level control is critical because interface level control of the separator feeds the flash drum, whose level feeds the stripper, etc. Application extremes include high temperatures, high pressures, and the presence of steam.

INSTRUMENTATION



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



▲ **Continuous Level:**
E3 MODULEVEL Displacer-Actuated Transmitter or ECLIPSE Model 706 Guided Wave Radar Transmitter



▲ **Visual Indication:**
ATLAS or AURORA MLIs can be supplied with switches or transmitters

9 CATALYTIC CRACKER



Application: The Fluid Catalytic Cracking Unit (FCCU) cracks heavy, low-value feedstocks into high-value, lighter molecular weight hydrocarbons which are blended to finished products. A cracker can produce a wide variety of yield patterns by operating in either Gasoline, Distillate or LPG modes.

Challenges: Catalytic crackers utilize a reactor and a catalyst regenerator with connecting risers where the reactions take place. Level controllers are often positioned on the first stage regenerator and at the top of the reactor. Level measurements involve fluidized solids levels at high temperatures. Conventional measurement techniques can be subject to plugging.

INSTRUMENTATION



- ▲ **Continuous Level:**
E3 MODULELEVEL
Displacer-Actuated
Transmitter

10 CATALYTIC STRIPPER



Application: Variations in cat cracking include Selective Component Cracking (SCC) for polypropylene production, a two-vessel and external-reactor design for processing heavy residue feeds, and a UOP process for converting gas oils and resid feedstocks. All crackers employ a steam stripper to remove hydrocarbons entrained in the spent catalyst.

Challenges: Stripper level control allows sufficient residence time for stripping steam to displace hydrocarbons for recovery. It also maintains sufficient pressure to keep air in the regenerator from reverse flow into the reaction system, thereby causing a hazard. A waste heat recovery steam drum would also require monitoring.

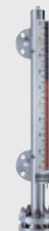
INSTRUMENTATION



- ▲ **Point Level:**
Series 3 Float-Actuated External
Cage Level
Switch or B40
Float-Actuated
Level Switch



- ▲ **Continuous Level:**
E3 MODULELEVEL
Displacer
Transmitter or
ECLIPSE Model 706
Guided Wave Radar
Transmitter



- ▲ **Visual Indication:**
ATLAS or AURORA
MLIs can be supplied
with switches or
transmitters

11 HYDROCRACKING

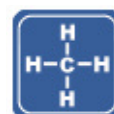


Application: Heavier feedstock difficult to process by cat cracking or reforming can be converted by hydrocracking. By combining catalytic cracking and hydrogenation to crack feedstock in the presence of hydrogen, hydrocracking produces gasoline and distillate blending streams. About a dozen different hydro-cracking process schemes are in current use.

Challenges: Level controls for the catalyst stripper, separator liquid and flash drum liquid must contend with severe process conditions to maintain optimum operation of the hydrocracker. These conditions include elevated temperatures and pressures, the presence of steam and high pressure hydrogen, and aggressive corrosives.

INSTRUMENTATION		▲ Point Level: Series 3 Float-Actuated External Cage Level Switch or B40 Float-Actuated Level Switch		▲ Continuous Level: E3 MODULELEVEL Displacer-Actuated Transmitter or ECLIPSE Model 706 Guided Wave Radar Transmitter		▲ Visual Indication: ATLAS or AURORA MLIs can be supplied with switches or transmitters
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12 ACID SETTLING TANKS



Application: Alkylation is a combining process that creates *alkylate*, a premium, high-octane blending stock. A large acid settler tank within the unit allows for separation of the acid/hydrocarbon emulsion created in the reactor. Sight glasses have traditionally measured settler level, but these are susceptible to plugging and require diligent flushing at regular intervals.

Challenges: Interface level control of the settler is required. Product/acid cross-contamination causes overall efficiency problems and can result in hazardous conditions. Inaccurate settler level indication is a frequent cause of physical acid carryover in the reactor effluent. Release of acid can cause extreme hazards to both process and personnel.

INSTRUMENTATION		▲ Point Level: Model A15 Displacer-Actuated Level Switch		▲ Continuous Level: E3 MODULELEVEL Displacer-Actuated Transmitter or ECLIPSE Model 706 Guided Wave Radar Transmitter		▲ Visual Indication: ATLAS or AURORA MLIs can be supplied with switches or transmitters
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13 ALKYLATION TANKS



Application: Storage and wash vessels in the alkylation unit include those for fresh and depleted acid and water, an acid analyzer settling pot, and a number of wash tanks. Caustic washes neutralize free acid carried over from the reaction zone and neutralize alkyl sulfates in the net effluent. Water washes decompose remaining esters and remove caustic and salt that might have carried over from the caustic wash.

Challenges: Interface level control in caustic and water washes prevents corrosion and fouling of the deisobutanizer and other downstream units. Levels rising above high set points can cause carryover of caustic or water, while too low levels can cause hydrocarbon carryunder.

INSTRUMENTATION		▲ Point Level: Echotel® Models 910, 961 or 962 Ultrasonic Level Switches or Model A15 Displacer-Actuated Switch		▲ Continuous Level: E3 MODULEVEL Displacer-Actuated Transmitter or ECLIPSE Model 706 Guided Wave Radar Transmitter or PULSAR R86 Radar Transmitter		▲ Visual Indication: ATLAS or AURORA MLIs can be supplied with switches or transmitters




14 CATALYTIC REFORMER



Photo of Catalytic Reformer courtesy of CB&I

Application: Catalytic reforming upgrades low-octane naphthas into high-octane gasoline blending components called *reformates*. Using heat and pressure with platinum catalysts to rearrange hydrocarbon molecules, this process converts low-octane gasoline fractions into petrochemical feedstocks and higher octane stocks suitable for finished gasoline blending.

Challenges: A hydrogen-rich gas stream is removed from the separator for recycling. Liquid product monitored for level at the bottom of the separator is sent to a stabilizer. Where stabilizer fouling has occurred due to the formation of ammonium chloride and iron salts, a monitored water wash system should also be included.




INSTRUMENTATION		▲ Point Level: Series 3 Float-Actuated External Cage Level Switch		▲ Continuous Level: E3 MODULEVEL Displacer-Actuated Transmitter or ECLIPSE Model 706 Guided Wave Radar Transmitter or PULSAR Model R86 Radar Transmitter		▲ Visual Indication: ATLAS or AURORA MLIs can be supplied with switches or transmitters

15 COKING OPERATIONS



Application: Coking is the final means of converting the heaviest products of atmospheric and vacuum distillation. Feed is heated and cracked into light gases, gasoline blendstocks, distillates, and gas oil. Level applications for delayed and continuous (contact or fluid) coking include the fractionator, light gas oil stripper, steam, condensate, blowdown and settling drums, and vent gas knockout drums.

Challenges: Process conditions that level instrumentation must contend with include high temperatures, high pressures, foaming, and steam. An interface level gauge in drums that are susceptible to foaming will help avoid foam-over and increase coke drum output.




INSTRUMENTATION		<p>▲ Point Level: Series 3 Float-Actuated External Cage Level Switch or B40 Float-Actuated Level Switch</p>		<p>▲ Continuous Level: E3 MODULEVEL Displacer-Actuated Transmitter or ECLIPSE Model 706 Guided Wave Radar Transmitter</p>		<p>▲ Visual Indication: ATLAS or AURORA MLIs can be supplied with switches or transmitters</p>
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16 ISOMERIZATION



Application: Isomerization in a variety of process configurations alters the arrangement of atoms to convert normal butane into isobutane, and normal pentane and hexane into high-octane gasoline components. Isomerization is similar to catalytic reforming in that the hydrocarbon molecules are rearranged, though isomerization only converts normal paraffins to isoparaffins.

Challenges: Near the end of the process, reactor effluent is cooled and separated into the liquid-product *isomerate* and a recycle hydrogen-gas stream. Isomerate is caustic-washed and water-washed, acid stripped, and stabilized before going to storage. Stabilizer bottoms and wash tanks require level monitoring.

INSTRUMENTATION		<p>▲ Point Level: Model A15 Displacer-Actuated Level Switch</p>		<p>▲ Continuous Level: E3 MODULEVEL Displacer-Actuated Transmitter or ECLIPSE Model 706 Guided Wave Radar Transmitter</p>		<p>▲ Visual Indication: ATLAS or AURORA MLIs can be supplied with switches or transmitters</p>
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17 HYDRODESULFURIZATION



Application: Catalytic Hydrotreating treats hydrocarbon liquids in the presence of hydrogen. This process removes 90% of the sulfur, nitrogen, oxygen, and metals from feedstocks. Hydrotreating can also provide hydrodearomatization (HDAR), heavy diesel hydrocracking (HDHDC), dewaxing, and performance enhancements of pyrolysis gasoline and diesel.

Challenges: Hydrotreatment will necessitate level indication of liquid/gas separators and water wash tanks. Level devices suited for high temperatures and pressures are essential in removing contaminants that can have detrimental effects on equipment, catalysts, and the quality of the finished product.




INSTRUMENTATION		▲ Point Level: Series 3 Float-Actuated External Cage Level Switch or B40 Float-Actuated Level Switch		▲ Continuous Level: E3 MODULELEVEL Displacer-Actuated Transmitter or ECLIPSE Model 706 Guided Wave Radar Transmitter		▲ Visual Indication: ATLAS or AURORA MLIs can be supplied with switches or transmitters
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18 CHEMICAL STORAGE & FEED



Application: From acids to water treatment additives, a wide array of chemicals are stored at a refinery in vessels that range in size from plastic totes to large steel tanks. Chemicals such as sulfuric and hydrochloric acid, sodium hydroxide, liquid catalysts, blending additives and water treatment chemicals are essential to a refinery's day-to-day operation.

Challenges: Liquid solution storage and day tanks require stringent level monitoring to ensure ongoing chemical processing. The nature of the chemical, the geometry of the holding vessel, and the presence of mixers or other hardware will determine the most suitable level technology for the storage or feed application.

INSTRUMENTATION		▲ Point Level: ECHOTEL Models 910, 961 or 962 Ultrasonic Switches or TUFFY II Float-Actuated Switch		▲ Continuous Level: PULSAR Model R86 Radar Transmitter or ECLIPSE Model 706 Guided Wave Radar Transmitter with Insulated Single Rod Probe		▲ Visual Indication: ATLAS or AURORA MLIs can be supplied with switches or transmitters
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19 BLENDING OPERATIONS



Blending Stocks

Application: Mixing finished gasoline requires level monitoring of blending stocks, in-line blending, additive storage, dilution systems and injection systems. Blend stocks are straight-run gasoline, alkylate, reformate, benzene, toluene and xylene. Additives include octane boosters, metal deactivators, anti-oxidant and knock agents, gum and rust inhibitors, and detergents.

Challenges: Level is normally measured only for inventory control and, in some cases, custody transfer. The precision of level indication that is required varies. If level is used only for internal inventory control, a less accurate measurement can be used. If level is used for custody transfer, highly accurate measurements are required.

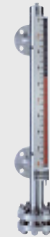
INSTRUMENTATION



▲ **Point Level:**
ECHOTEL Models
910, 961 or 962
Ultrasonic Level
Switches



▲ **Continuous Level:**
ECLIPSE Model 706
Guided Wave Radar
Transmitter or PULSAR
Model R86 Radar
Transmitter



▲ **Visual Indication:**
ATLAS or AURORA MLIs
can be supplied with
switches or transmitters

20 FINISHED PRODUCT STORAGE



Finished Storage

Application: Finished refinery products stored in tanks with capacities that often exceed 100,000 gallons are motor gasoline, jet fuel, diesel fuel, fuel oils, and LPG. Marketed products also include feedstocks for textiles, tires, pharmaceuticals and plastics.

Challenges: Tank monitoring uses buoyancy, pressure, servo-driven, and radar. Tanks may be provided with automatic overflow control and alarm systems. Automated tank gauging networks with proprietary protocols are a vital part of tank farm architecture. Today, thousands of tanks can be linked in a network offering enhanced data acquisition, field calibration and remote diagnostics.

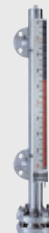
INSTRUMENTATION



▲ **Point Level:**
Model A15
Displacer-
Actuated Level
Switch



▲ **Continuous Level:**
PULSAR Model R86
Radar Transmitter or
ECLIPSE Model 706
Guided Wave Radar
Transmitter



▲ **Visual Indication:**
ATLAS or AURORA MLIs
can be supplied with
switches or transmitters

REFINERY FLOW APPLICATIONS



Application: The vast piping systems within today's refineries transport hydrocarbon gas/vapor streams, light liquid gas/liquid streams, heavier liquid streams, water, and steam throughout the refinery. Certified, reliable and accurate flow measurement is essential for a refinery's safe and efficient operation.

Challenges: Flow alarms and continuous flow controls monitor product streams, signal no-flow conditions caused by plugging or valve closure, and provide a defense against pump cavitation. Pumps operating in a reduced or no-flow condition can overheat and rupture the pump's seal and cause a dangerous deviation in process pressure and temperature.

INSTRUMENTATION



▲ **Flow Alarm:**
Thermatel® Model TD2
Thermal Dispersion
Flow Switch



▲ **Pump Protection:**
THERMATEL Model TD2
Thermal Dispersion
Flow Switch



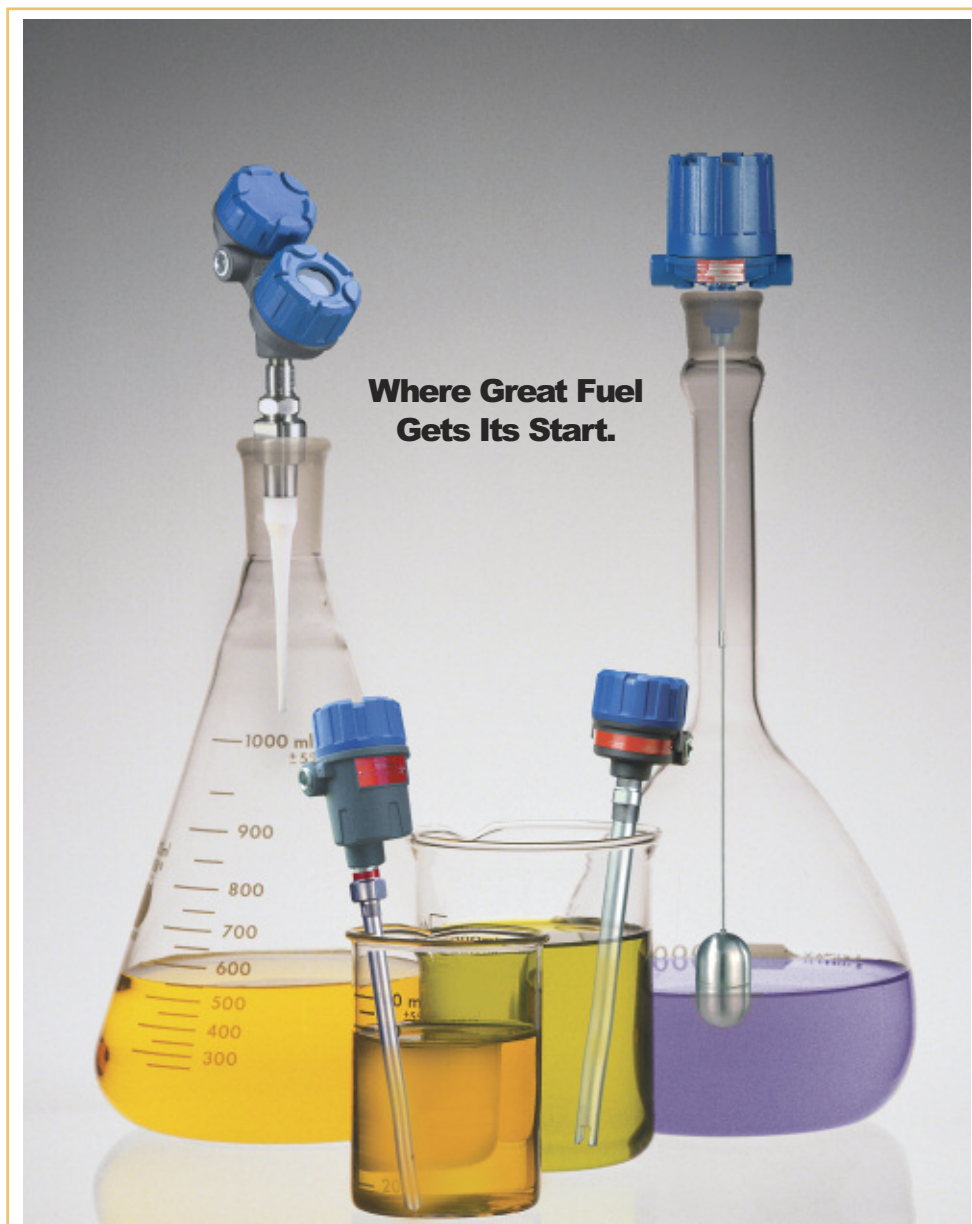
▲ **Continuous Air or Gas Flow:**
THERMATEL Model TA2
Thermal Dispersion Mass
Flow Transmitters

POWER GENERATION

Power Generation: Many petroleum refineries incorporate power generating plants into their refinery operations. These include power stations with coal-fired boilers and gas-fired co-generation plants.

Because a thorough discussion of power generation applications is beyond the scope of this brochure, we invite you to log onto Visit www.magnetrol.com and download the pdf of the MAGNETROL Power Generation brochure. This 16-page brochure describes 20 essential level control applications in power generation—most of which are applicable to today's refinery operations.





Refinery professionals know that great gasoline can only originate within a great process scheme. And that especially means process controls that deliver reliable service in the most demanding applications. Acquiring level and flow controls of this high calibre is why so many instrument professionals turn to MAGNETROL.

Our buoyancy products were introduced to refinery service in 1932. Later we were among the first to apply thermal dispersion, ultrasound, capacitance and other electronic technologies to refinery challenges. More recently we pioneered ECLIPSE Guided Wave Radar and PULSAR Pulse Burst Radar to bring customers the leading-edge in level transmitters—the kind that balance sophisticated sensing technology with simplified ease-of-installation and operation.

MAGNETROL also offers a wealth of application engineering know-how and a worldwide service network that's second to none. And that's the difference between just buying an instrument and partnering with a world-class level and flow specialist.

Contact your MAGNETROL sales representative today to learn how our products can not only help you create great gasoline, but will actually increase the profitability of your refinery's operation. ■





PETROLEUM REFINING

AN INDUSTRY GUIDE TO LEVEL MEASUREMENT AND CONTROL FROM MAGNETROL

Other industry and special application brochures from MAGNETROL include:

- **Chemical**
- **Crude Oil Processing**
- **Flue Gas Desulfurization**
- **Food & Beverage**
- **Interface Level Measurement**
- **Life Science**
- **Mass Flow Measurement**
- **Modular Skid Systems**
- **Natural Gas Processing**
- **Nuclear Power**
- **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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