



SOLUTIONS FOR REFINERIES

Level, Multiphase Level and Density Measurements

APPLICATIONS IN REFINERIES

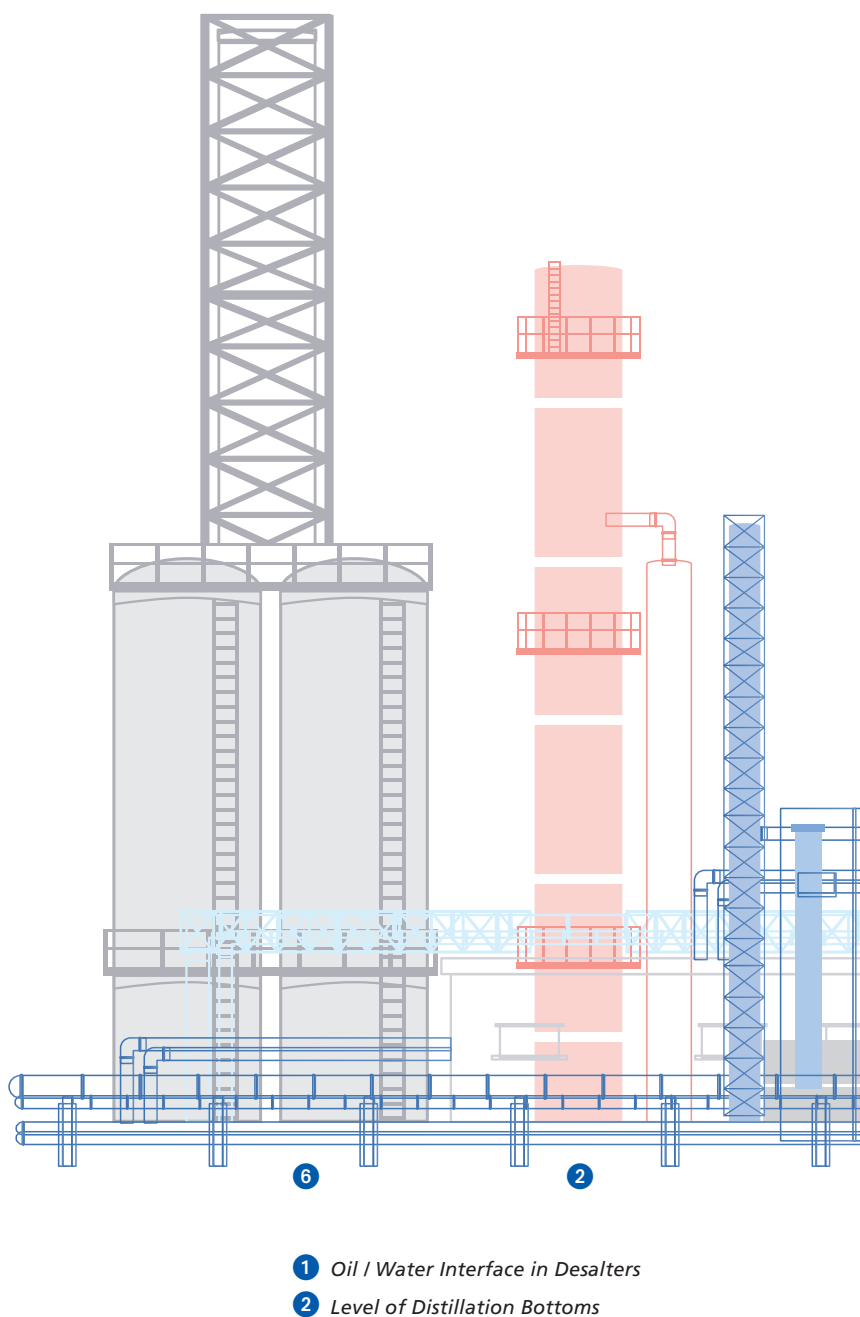
Berthold Technologies radiometric instruments for non-contacting level and density measurement are widely used in the global oil refining industry. Among our customers are well-known companies like Exxon Mobil, Sinopec, Shell, BP, Conoco Phillips, Lukoil, Total – just to name a few.

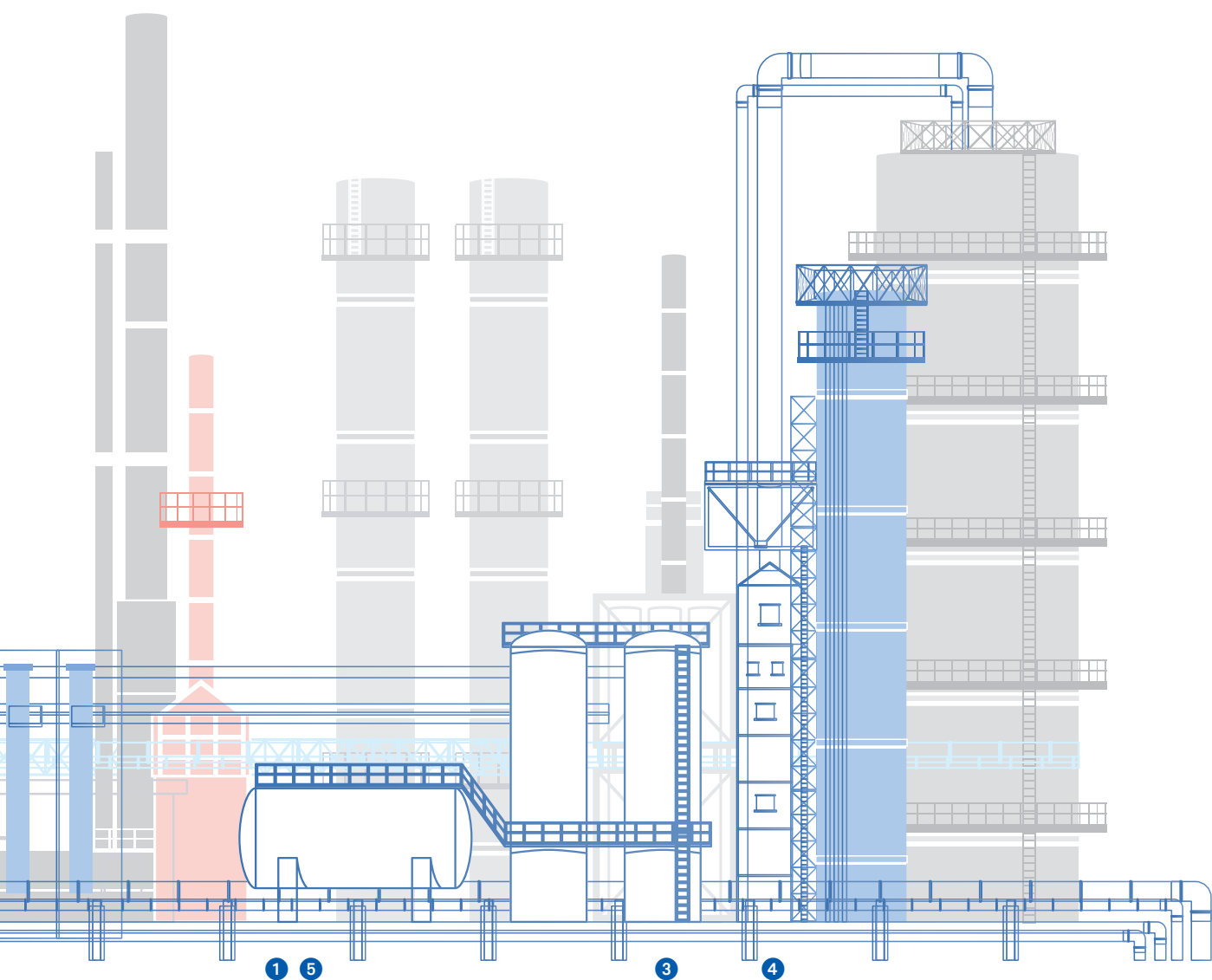
With our measuring systems based on Gamma transmission we help our customers to reliably control their processes and thus ensuring a safe operation and maximizing efficiency and profit.

Berthold Technologies is renowned for cutting-edge technology and high-class products. We provide a wide range of standard solutions to the industry and in addition we develop in close cooperation with customers and licensors tailored systems for new processes and measuring tasks.

Non-contact perfect!

- Outside mounting of components
- Not exposed to the harsh process conditions
- Free of wear and maintenance
- Smooth handling and operation
- Lowest cost of ownership
- Easy to install on existing pipes or tanks without modifications
- Perfect for all high temperature, high pressure applications





③ Level in Catalytic Reforming (CCR)

④ Level and Density in Catalytic Cracking

⑤ Level in Alkylation Units

⑥ Level in Delayed Coking Units

MONITORING THE OIL / WATER INTERFACE IN DESALTERS



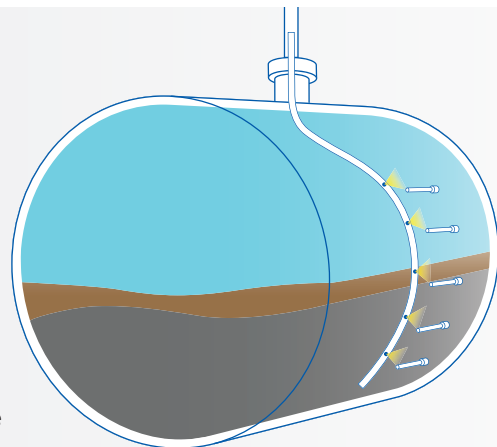
Fresh water is mixed with the crude oil to wash out dissolved salts and minerals. In the desalter vessel the brine is separated from the oil by gravity separation. This separation process is usually characterized by an intermediate zone of oil / water emulsion. To make sure that the retracted brine is free of oil and to ensure that the water doesn't impact the electrostatic grid or even enter the oil outlet, the different levels have to be controlled carefully. The Berthold Multiphase Level Measurement is used to reliably monitor the separation process online. It can either provide the product density at specific heights or it can continuously measure the level of the different layers. Suited for all API oil grades – even for heavy and extra heavy crudes – the measurement is very repeatable and stable over time and above all, maintenance-free.

Application Profile

Measurement task	Oil / Water Interface	
Location	Desalter	
Berthold Solution	Multiphase Level Measurement	
Customer Benefit	<ul style="list-style-type: none"> ■ Maximum throughput and availability ■ Ideal control of drained water quality ■ Ideal control of oil outlet flow ■ Reduced operational costs of the desalter ■ Effective addition of emulsion breaking chemicals ■ Increased safety for subsequent distillation processes 	

Characteristics

- Multiple detectors and sources distributed along the measurement range
- Very precise density information at corresponding detector height, density accuracy $\leq 0.002 \text{ g/cm}^3$ (aligned arrangement)
- Or: continuous level measurement of interface layers (staggered arrangement), level accuracy $\leq 20 \text{ mm}$
- Option to determine the sand level
- Highly repeatable, very stable measurement
- Maintenance-free
- Not affected by scaling and mineral build-ups
- Works for light crude as well as for heavy and extra heavy crude







MEASURING THE LEVEL OF DISTILLATION BOTTOMS

In the vacuum distillation process as well as in the atmospheric distillation, the oil is split-up into different fractions. A residue remains in the bottom of the columns consisting of liquids and foam. The level of this residual bottom is important to measure. The higher the level, the longer the residence time and the more volatile components can be extracted. However, if the level becomes too high the residue could enter the upper fractions and affect product quality. With the radiometric level systems from Berthold the residue can be reliably measured in a non-contacting manner, regardless of temperature and pressure changes.

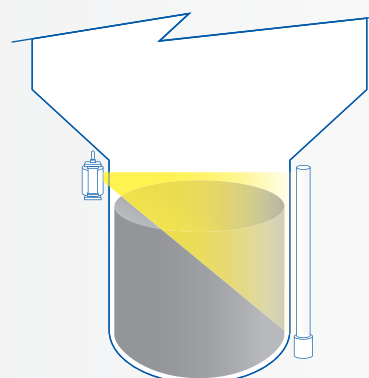


Application Profile

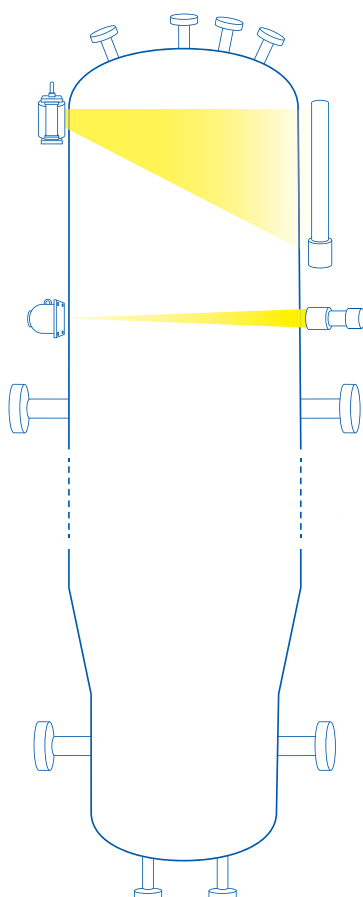
Measurement task	Level of residual bottoms
Location	Vacuum Distillation Column, Atmospheric Distillation Column
Berthold Solution	Radiometric level measurement
Customer Benefit	<ul style="list-style-type: none"> ■ Stable level conditions ■ Avoid foam or liquid entering the upper fractions ■ Increased efficiency of distillation process

Characteristics

- Continuous level measurement, typically 2...4 m measuring range
- Installed on the cylindrical bottom of the column
- Due to the importance of the measurement a redundant setup is often used
- Typical arrangement uses Cs-137 point sources and scintillation rod detectors
- On small diameter columns Co-60 rod sources achieve best measurement results
- Highly reliable measurement, not affected by temperature, pressure changes or foaming
- Easy to install on existing columns, without process downtime



MEASURING LEVELS IN CONTINUOUS CATALYTIC REFORMING PROCESSES (CCR)



Catalyst Regenerator

By means of chemical catalysts the hydrocarbon molecules are re-arranged in the CCR unit. The catalyst loses its properties over time and thus regeneration of the catalyst is necessary. Radiometric level systems from Berthold are used on the regenerator ensuring a smooth and continuous re-activation process. Due to high process temperatures, the non-contacting technology is the only one which provides reliable level control – the basis for an efficient catalyst regeneration.

Application Profile

Measurement task	Level of catalyst (continuous level and low level alarm)
Location	Catalyst Regenerator
Berthold Solution	Radiometric level measurement (continuous) in combination with level switch
Customer Benefit	<ul style="list-style-type: none"> ■ Optimized control of regeneration process ■ Ideal utilization of regenerator capacity ■ Reliable control of catalyst feed ■ Safe prevention from running empty

Characteristics

- Non-contacting, non-intrusive technology
- Standard: point source, rod detector arrangement
- Easy to install on existing tanks, without modification or process downtime
- Highly repeatable and stable over years of operation
- Requiring no maintenance and no re-calibration due to patented stabilization technology
- Immune to interfering radiation, XIP or RID facilitates operation during weld inspections
- SIL2 /SIL3 certified option

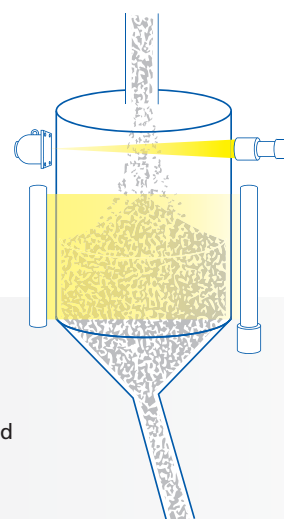
Hoppers

Continuous level measurements and high level / low level alarms are applied on different hopper types (upper hopper, lock hopper, disengaging hopper) feeding catalyst into the reactor and regenerator. A reliable, fast responding control of the catalyst level inside the hopper is very important to ensure a high quality process. Each hopper is equipped with continuous level gauges using rod source technology from Berthold. Rod sources offer highest precision and reliability because the radiation is ideally distributed over the measurement range. Therefore the system will also detect the formation of cones, which means that the true amount of catalyst inside the hopper is determined and filling can be optimized. In addition radiometric level switches are installed to provide high level or low level alarms for safety reasons. All measurements can be supplied with SIL2 certificates.



Application Profile

Measurement task	Level of catalyst (continuous level and high level / low level alarm)
Location	Lock Hopper, Upper Hopper, Disengaging Hopper
Berthold Solution	Radiometric level measurement (continuous) in combination with high level switch or low level switch
Customer Benefit	<ul style="list-style-type: none"> ■ Reliable information on catalyst level ■ Optimal filling and discharging process ■ Improved control of catalyst supply for reforming process



Characteristics

- Non-contacting, non-intrusive level gauge
- Very fast responding measurement ensures reaction within fractions of a second
- Best results achieved with Co-60 rod source arrangement
- Sensitive to cone formation (pile-up cones and downward-pointing cones)
- Very easy to calibrate (also during on-going process)
- Immune against interfering radiation, XIP or RID facilitate operation during weld inspections
- SIL2 / SIL3 certified option

MEASURING LEVEL AND DENSITY IN CATALYTIC CRACKING

The catalytic cracking process is the most important conversion process in a refinery. It is used to crack heavy fractions to achieve lighter and more valuable products. There are many different processes and technologies established in the market but radiometric measurements from Berthold are applied in all of them.



Hydrocracker

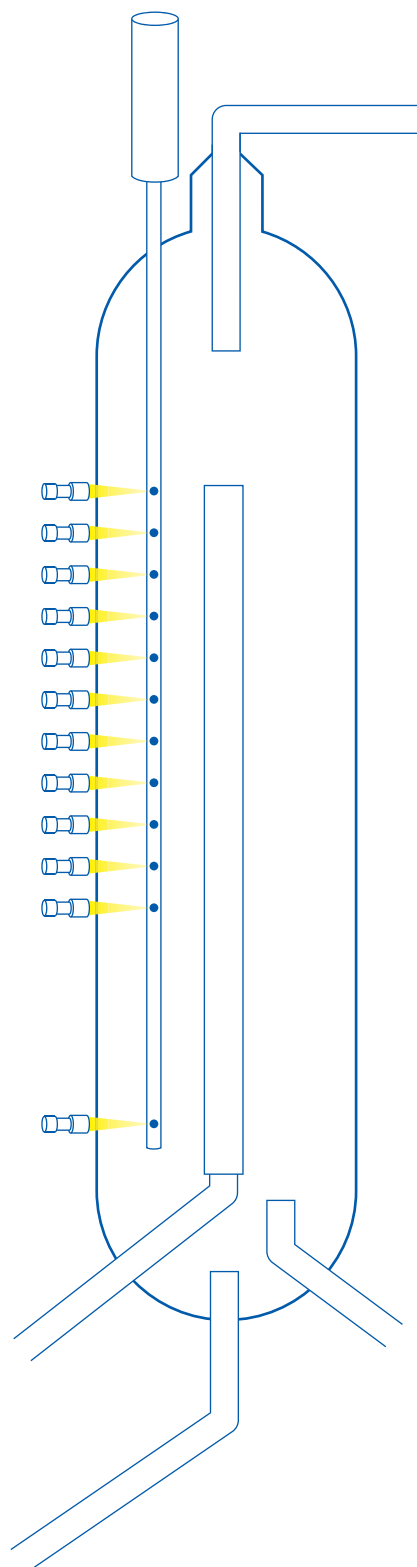
To achieve optimum control of the cracking taking place inside the Hydrocracking reactor the level of hydrocarbons, catalyst and gas is monitored by means of multiple density measurements along the reactor height. The radiometric density gauges from Berthold are very fast responding and are capable of measuring measure smallest density changes down to a resolution of $\leq 0.002 \text{ g/cm}^3$.

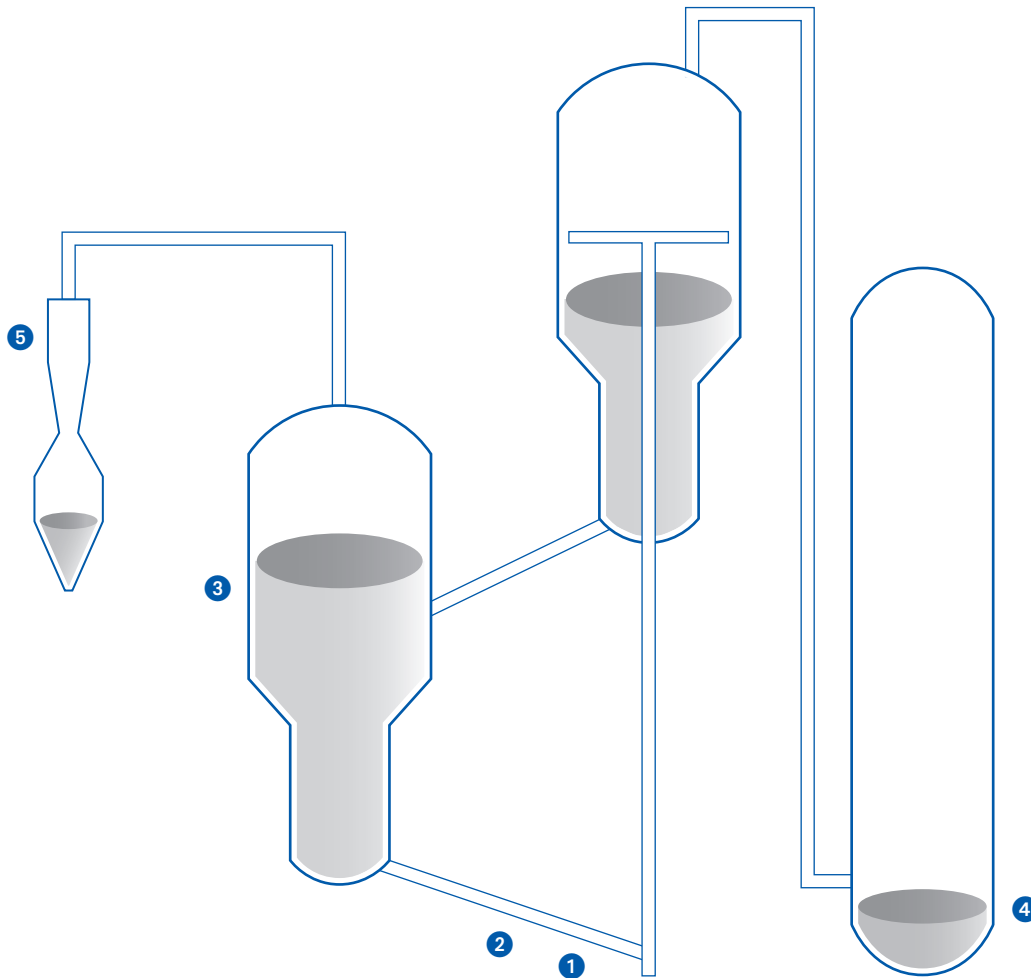
Application Profile

Measurement task	Multiple density measurements on different elevations
Location	Hydrocracker
Berthold Solution	Multiphase level measurement, radiometric density systems with multiple sources in dip pipe
Customer Benefit	<ul style="list-style-type: none"> ■ Maximum process transparency ■ Reliable control over the cracking process ■ Increased throughput and availability ■ Efficient utilization of catalyst

Characteristics

- Multiple point sources inserted in dip pipe
- Density detectors mounted outside the reactor
- Typically a reduction of the vessel wall is required for improved measurement effect
- Highly accurate density reading, resolution of $\leq 0.002 \text{ g/cm}^3$
- Very fast responding measurement
- SIL2 / SIL3 certified detectors





- ① Density measurement of catalyst in the regenerated standpipe
- ② Level measurement of catalyst in the regenerated standpipe
- ③ Level measurement in the regenerator
- ④ Level measurement in the distillation column
- ⑤ Level measurement in the cyclone separator

Fluid Catalytic Cracking (FCC)

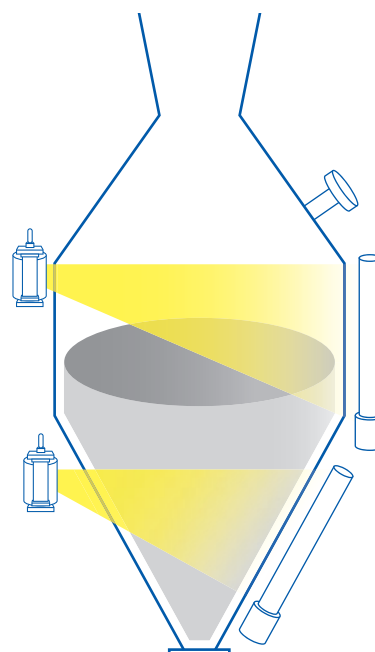
In the fluid catalytic cracking process the catalyst circulates between reactor and regenerator. Radiometric level measurements from Berthold are applied on several sections, e.g. on the cyclone separator, on the regenerator and on the regenerated standpipe. Also density of the regenerated catalyst is continuously monitored by a radiometric densitometer mounted on the regenerated standpipe.

Cyclone separator

Catalyst fines have to be removed from the regenerator flue gas to fulfill regulatory requirements and to protect downstream equipment. Thus cyclonic separators are used filtering out the remaining catalyst fines. The solid particles settle down at the bottom of the separator, their level is controlled by radiometric level systems from Berthold. The non-contacting technology is ideally suited for this kind of application since dust and temperature have no impact on the measurement performance.

Application Profile

Measurement task	Level of catalyst fines
Location	Cyclone separator
Berthold Solution	Radiometric level measurement
Customer Benefit	<ul style="list-style-type: none"> ■ Improved catalyst removal ■ Reliable process control ■ Ideal utilization of vessel capacity

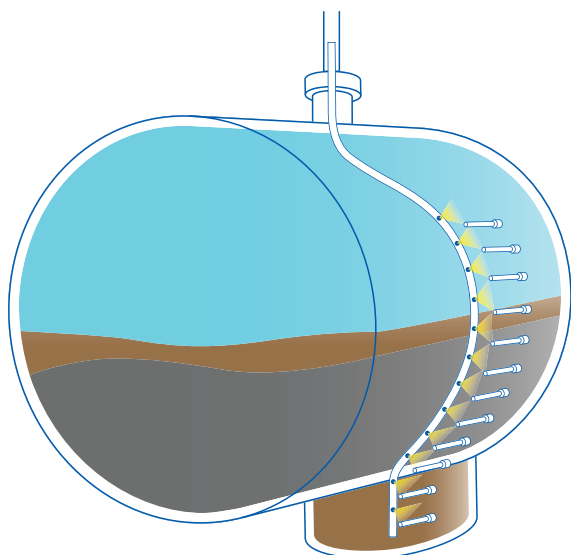


Characteristics

- Continuous level measurement, typically 2...4 m measuring range
- Installed at the bottom conical part
- Typical arrangement uses Cs-137 point sources and scintillation rod detectors
- Non-contacting, non-intrusive technology
- High repeatability and long-term stability due to automatic stabilization technology based on cosmic radiation
- No re-calibrations, no maintenance required
- Immune against interfering radiation, XIP or RID feature ensure operation during weld inspections
- SIL2 / SIL3 certified option



MEASURING LEVEL IN ALKYLATION UNITS



Acid Settler

Light hydrocarbons produced in the FCC and Coking units are treated with acid to receive a high octane product with premium properties. In the acid settler the hydrocarbons are separated from the acid. Due to the density difference the acid settles down at the bottom while the hydrocarbons form the top layer. Between the two products an intermediate phase is present. To control the layer thickness of the intermediate phase and to ensure that the drained products are not contaminated a Multiphase Level System from Berthold is used to determine the interface positions of the different product layers. The non-contacting, non-intrusive technology is ideal for the harsh acidic process.

Application Profile

Measurement task	Hydrocarbon / Acid Interface
Location	Acid Settler
Berthold Solution	Multiphase level measurement
Customer Benefit	<ul style="list-style-type: none"> ■ Online monitoring of separation process ■ Reliably prevents acid carry-over ■ Increased process safety ■ Virtually no need for maintenance or care-related work, keeping work time in the acidic area to a minimum

Characteristics

- Multiple detectors and sources distributed along the measurement range
- Fixed installation, no moving parts and therefore very robust system
- Very precise density information at corresponding detector height, density accuracy $\leq 0.002 \text{ g/cm}^3$ (aligned arrangement)
- Or: continuous level measurement of interface layers (staggered arrangement), level accuracy $\leq 20 \text{ mm}$
- Highly repeatable, very stable measurement
- Maintenance-free
- Immune against interfering radiation, XIP or RID feature ensure operation during weld inspections
- Optional: Control unit for display and operation

Acid Storage Drum

The acid used in the alkylation process is stored in the acid storage drums. Measuring the acid level in this drum is important. Especially in an emergency case where all acid has to be pumped back into this drum, the level measurement must be very reliable and fast responding. In addition to the level gauge, Berthold also provides a radiometric level switch for high level alarm.

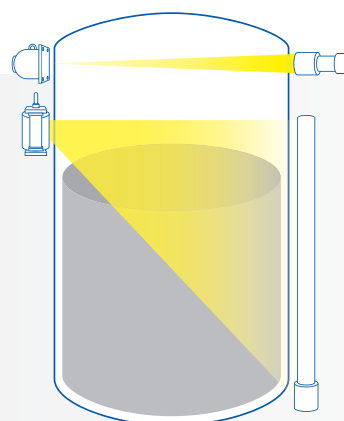


Application Profile

Measurement task	Level of acid
Location	Acid Storage Drum
Berthold Solution	Radiometric level measurement and level switch
Customer Benefit	<ul style="list-style-type: none"> ■ Real-time information on acid level ■ Reliable control of acid process cycle ■ Increased safety in emergency shut down cases

Characteristics

- Non-contacting, non-intrusive level gauge
- Easy to install on existing tanks, without modification or process downtime
- Repeatable and long-term stable measurement due to patented stabilization technology
- No re-calibrations required, maintenance-free
- Immune against interfering radiation, XIP or RID feature ensure operation during weld inspections
- SIL2 / SIL3 certified option



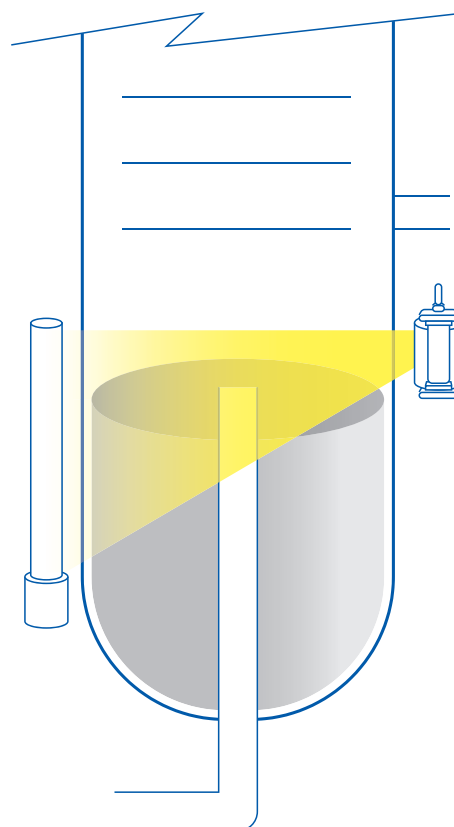
MEASURING LEVEL IN DELAYED COKING UNITS

Fractionator

The fractionator is another crucial part of the delayed coking unit. The Berthold radiometric level gauges are used to monitor the bottom liquid level – an important parameter for the efficient control of the complete coking cycle. The measurement is not affected by surface turbulences, sprinkler rain, different product densities or scaling / coking and the use of SIL2 certified detectors satisfies the need for a safe and reliable operation.

Application Profile

Measurement task	Level of bottom liquids
Location	Fractionator
Berthold Solution	Radiometric level measurement
Customer Benefit	<ul style="list-style-type: none"> ■ Efficient control of coker feed ■ Increased process safety and reliability ■ Safety prevents from liquid carry-over into the vapor inlets ■ Ensures minimum liquid head for the coker charge pump

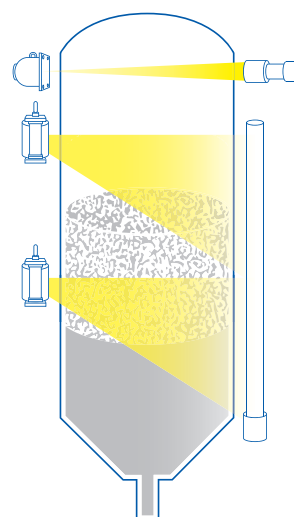


Characteristics

- Non-contacting, non-intrusive level measurement
- Not affected by surface turbulences, sprinkler rain, different product densities or scaling / coking
- Due to the importance of the measurement a redundant setup is often used
- SIL2 / SIL3 certified option
- Reduced source activity due to highly sensitive scintillation technology
- High repeatability and long-term stability due to automatic stabilization technology based on cosmic radiation
- No re-calibrations required
- Immune against interfering radiation, XIP or RID feature ensure operation during weld inspections

Coke Drum

Residues are upgraded in the delayed coking unit. The heated residues are fed to the coke drum where the last volatile components are gathered. Solid coke remains in the drum which slowly fills up. The radiometric level technology from Berthold is ideal for monitoring the coke level due to its non-contacting, non-intrusive nature. Since strong temperature variations through the whole operational cycle of a coke drum are a known issue to the operators, the patented automatic stabilization technology from Berthold based on cosmic radiation has proven to be the most important feature to guarantee a stable and reliable level measurement without the need for re-calibration or auto-zero adjust. Separate level alarms ensure additional process safety.



Application Profile

Measurement task	Level of coke (continuous level and high level alarm)
Location	Coke Drum
Berthold Solution	Radiometric level measurement e.g. using TowerSENS detectors
Customer Benefit	<ul style="list-style-type: none"> ■ Reliable level control ■ Improved utilization of drum capacity ■ Efficient use of anti-foam agent ■ Increased throughput ■ Safe operation



Characteristics

- Non-contacting, non-intrusive level measurement
- Use of 8 m long TowerSENS detectors (covering up to 32 m in cascaded mode)
- Highest sensitivity due to solid scintillators leading to significantly lower source activities
- High repeatability and long-term stability
- No re-calibrations required
- Immune against interfering radiation, XIP or RID feature ensure operation during weld inspections
- SIL2 / SIL3 certified option

COMMITTED TO TECHNOLOGICAL LEADERSHIP

Outstanding long-term stability

A reliable measurement is vital for the operation of a process and is therefore, our highest priority. Berthold's detectors operate absolutely stable irrespective of changes in ambient temperature. Even drastic temperature shifts, e.g. from winter to summer don't irritate the measurement drift. Due to various patented technologies for detector stabilization and the use of cosmic radiation as an external reference source, the detectors output does not change more than 0.001% per °C temperature change. Apart from employing these cutting-edge technologies in our detectors Berthold is also the only supplier that compensates degradation caused by natural aging. The result: Many years of operation without the need for re-calibration or maintenance and a measurement that you can absolutely rely on!

Protected against X-Ray Interference (XIP, RID)

Non-destructive testing e.g. for weld inspections can become really distressing if nothing is done to protect the radiometric measurement against interfering radiation. Every Berthold detector employs the X-ray Interference Protection (XIP), whereby the system is able to detect interference. As a result the measurement value is locked before a false level signal can be communicated. Of course, the Berthold detectors do not get harmed by the excessive radiation and automatically return to normal operation when the disturbance is over.

By employing Berthold's unique Co-60 rod sources in combination with our patented Radiation Interference Discrimination (RID) feature, it is even possible to continue the measurement despite non-destructive testing is being carried out. This secures a safe process and makes you independent from actions that might even occur in neighboring plants.

Minimal source activity

Berthold detectors are highly sensitive to gamma radiation. With a scintillation crystal of 150x150mm the SuperSENS is the most sensitive detector on the market. Due to their excellent efficiency the detectors can be operated with very low source activities, which is important for our customer's HSE programme and also a major cost saving factor. In fact Berthold detectors can be retrofitted on existing measurements where the source has become too weak to work with the current detector.

SIL2 / SIL 3 Certified

The SENSseries LB 480 detectors are certified for use in SIL2 applications. Even SIL3 is achieved with homogenous redundancy. The certificate covers all measurement applications, from high level or low level alarms to continuous level measurement and density measurement. Thus safe operation of critical processes is guaranteed.

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Expertise in Radiometric Technology

Berthold Technologies has specialized in radiometric process measurements for more than 65 years. Berthold's expertise in radiometric technology is our core competence – our products are always a step ahead. Working with our customers in the oil refining industry means developing tailored solutions for each individual application, perfectly adapted to tank geometries and optimized in terms of performance and radiation safety. Our in-house source production facility is only one example of our flexibility in order to meet our customers requirements, providing quickest support if needed.

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Health, Safety and Environment is of major importance in the oil & gas industry therefore making it important to us. Our global network of sales and service experts is well trained and able to support you through all stages of your project – around the corner and around the world!

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