MEASUREMENT SOLUTIONS FOR THE REFINING INDUSTRY

Optimize your production throughput with increased safety and reliability
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 solutions based on gamma absorption 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-intrusive, 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
- No process connection therefore no risk of hazardous material leaks

1 Measuring the interfaces of oil / emulsions / water in desalters
2 Measuring the level of distillation columns
3 Measuring the level in delayed coking units
4 Measuring the level in solvent deasphalting units
5 Measuring the level in alkylation units
6 Measuring the level and density in resid hydrocracking
7 Measuring the level and density in fluidized catalytic cracking units (FCC)
8 Measuring the level in continuous catalytic reforming processes (CCR)
MEASURING THE INTERFACES OF OIL / EMULSIONS / WATER

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. Berthold’s multiphase level measurement system EmulsionSENS is used to reliably monitor the separation process online. Due to two different arrangements either the product density at specific heights (aligned arrangement) is provided or the level of different layers can be measured continuously (staggered arrangement). It is 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 / emulsions / water interfaces
- **Location**: Desalter
- **Berthold solution**: EmulsionSENS – The multiphase level measurement system

Customer Benefit
- Maximum throughput and availability
- Ideal control of drained water quality
- Ideal control of oil outlet flow
- Reduced operational costs of the desalter
- Efficient addition of emulsion breaking chemicals
- Increased safety for subsequent distillation processes

Characteristics
- Number of sources/detectors dependent upon measuring range and arrangement
- Highly repeatable and very stable measurements
- Detectors are mounted outside of the vessel for ease of maintenance and ensuring no cooling is required
- Increased reliability, operates on all API crudes
- Very precise density at each corresponding height, density accuracy <0.002g/cm^3 (aligned)
- Or continuous level measurement of the interface layers, level accuracy +/- 25 mm (staggered)
- Optional mud level measurement
MEASURING THE LEVEL 
IN DISTILLATION COLUMNS

In the atmospheric distillation process as well as in vacuum distillation, the oil is split-up into different fractions. The oil that is not fractionated ends up in the bottom of the column, where the liquid level is important to measure, to prevent the level from being either too high or too low. If the level is too high, this could lead to tray damage and cause quality issues with products. If the level is too low, this could potential damage pump seals or the pumps themselves. By using 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
- 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 and process density changes, pressure changes or foaming
- Easy to install on existing columns, without process downtime

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CONTINUOUS CATALYTIC REFORMING PROCESSES (CCR)

The chemical process which is used to convert napthas distilled from crude oil into high-octane liquid products, so-called reformates, is known as catalytic reforming. Here the hydrocarbon molecules are re-arranged by means of chemical catalysts. The most modern and increasingly used type of catalytic reformers is continuous catalytic reforming (CCR).

CATALYST REGENERATOR MEASURING THE LEVEL AND LOW LEVEL ALARM

The catalyst used for reforming loses its properties over time and thus regeneration of the catalyst is necessary. CCRs are characterized by a continuous regeneration of parts of the catalyst in special regenerators, whereby the regenerated catalyst is subsequently returned to the reactor. 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

- 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 recalibration due to patented stabilization technology
- Immune to interfering radiation, XIP or RID facilitates operation during weld inspections
- SIL2 / SIL3 certified option
HOPPERS
MEASURING THE LEVEL AND HIGH / LOW LEVEL ALARM

Reliable and 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. 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.

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 or low level switch

Customer Benefit

- 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
- The SpeedStar feature ensures extremely fast response times in the millisecond range
- 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

FLUID CATALYTIC CRACKING (FCC)

Fluid catalytic cracking (FCC) is one of the most important conversion processes used in petroleum refineries. In a FCC unit, the catalyst circulates between reactor and regenerator to ensure efficient conversion. Radiometric level measurements from Berthold are applied on several sections, e.g. on the cyclone separator, on the regenerator, electrostatic precipitation hoppers and on the regenerated standpipe. The ability of the radiometric devices to measure solid catalyst under the high temperatures needed in a FCC unit, makes it the ideal measurement solution to maintain safe and reliable operation.

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 fractionator tower bottom
5. Level measurement in the cyclone separator

FURTHER APPLICATIONS:

Vessels that use radiometric devices in the FCC besides cyclone separators are electrostatic precipitation hoppers and fractionator tower bottom levels. The radiometric level measurement on the fractionator tower bottom, unlike differential pressure, is unaffected by the changing percentage of catalyst fines. This increases the reliability of the level potentially preventing tray damage if level gets too high, or pump damage if level gets too low. Level and density measurements of the fluidized bed in the standpipe is also an often required measurement task.
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 to filter out the remaining catalyst fines. The solid particles settle down at the bottom of the separator, where 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**
- 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 recalibrations, no maintenance required
- Immune against interfering radiation, XIP or RID feature ensure operation during weld inspections
- SIL2 / SIL3 certified option
RESID HYDROCRACKING

The resid hydrocracking process is becoming more and more important to refiners since it allows a higher conversion rate than other heavy oil conversion processes. 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 REACTOR
MEASURING THE LEVEL & DENSITY ON DIFFERENT ELEVATIONS

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 smallest density changes down to a resolution of ≤0.002 g/cm³.

Application Profile
- **Measurement task**: Multiple density measurements on different elevations
- **Location**: Resid hydrocracker
- **Berthold solution**: EmulsionSENS – The multiphase level measurement system

Customer Benefit
- 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 ≤0.002 g/cm³
- Very fast responding measurement
- SIL2 / SIL3 certified detectors

FURTHER APPLICATIONS:
Various thick walled vapor/liquid separators, catalyst handing vessel, various towers and in-line densities at high temperature and high pressure are also typical applications. Radiometric level and density measurements are used in the separation section of the hydrocracker to ensure that proper vapor/liquid separation occurs as the pressure and temperature is lowered through the various separators. Radiometric measurements are also used in the catalyst section of the hydrocracker to ensure the proper amount of catalyst is added or withdrawn from the reaction system to maintain effective cracking.

EmulsionSENS
Multiple point sources inserted in dip pipe and density detectors mounted outside the reactor
ALKYLATION UNITS

ACID SETTLER
MEASURING THE HYDROCARBON / ACID INTERFACE

Light hydrocarbons are converted into high quality alkylate in the presence of an acid catalyst, either HF or H₂SO₄. In the acid settler the hydrocarbons are separated from the acid due to the density difference and thus the acid settles down at the bottom. Between the two products an intermediate phase is present. To control the layer thickness of this phase and to ensure that the drained products are not contaminated, the multiphase level measurement system EmulsionSENS from Berthold is used. Due to two different arrangements either the product density at specific heights (aligned arrangement) is provided or the level of different layers can be measured continuously (staggered arrangement). The non-contacting, non-intrusive technology is ideal for the harsh acidic process.

Acid Storage Drum
MEASURING THE LEVEL OF ACID

The acid used in the alkylation process is stored in the acid storage drums. Measuring the acid level is important to fulfill the highest safety standards, especially in an emergency case where all acid has to be pumped back into this drum. Therefore it is of extreme importance, that the level measurement is reliable and fast responding. In addition to the level gauge, Berthold also provides a radiometric level switch for high level alarm.

Further Applications:
Minimize vessel leak points by using radiometric level measurement in various column bottoms such as depropanizer, acid rerun column and acid storage/emergency dump drum.

Application Profile
- **Measurement task**
  - Hydrocarbon / acid interface
- **Location**
  - Acid settler
- **Berthold solution**
  - EmulsionSENS – The multiphase level measurement system

Customer Benefit
- 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 at each corresponding height, density accuracy <0.002 g/cm³ (aligned)
- Or continuous level measurement of the interface layers, level accuracy +/- 25 mm (staggered)
- Highly repeatable, very stable measurement
- Maintenance-free
- Immune against interfering radiation, XIP or RID feature ensure operation during weld inspections
- Optional: control unit for visualization and operation

Application Profile
- **Measurement task**
  - Level of acid
- **Location**
  - Acid storage drum
- **Berthold solution**
  - Radiometric level measurement and level switch

Customer Benefit
- 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 recalibrations required, maintenance-free
- Immune against interfering radiation, XIP or RID feature ensure operation during weld inspections

By using EmulsionSENS, operators can safely control the acid level while ensuring that acid is not carried over or hydrocarbons are not removed from the bottom of the settler.
MEASURING THE LEVEL & LEVEL SWITCH IN DELAYED COKING UNITS

Residues are cracked or converted in the delayed coking unit. The heated residues are fed to the coke drum where they are cracked into light more valuable hydrocarbon chains and the extra carbon is rejected. 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-intrusive nature. Since large temperature variations through the whole operational cycle of a coke drum are a known issue to the operators, our patented automatic stabilization technology based on cosmic radiation has proven to be the most important feature to guarantee a stable and reliable level measurement without the need for recalibration. Separate level alarms ensure additional process safety. The same applies for the fractionator. Our 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 unaffected by surface turbulences, product falling down from the trays, different product densities or scaling/coking.

Application Profile

- **Measurement task**
  - Level of coke and bottom liquids (continuous level and high level alarm)
- **Location**
  - Coke drum and fractionator
- **Berthold solution**
  - Radiometric level measurement e.g. using TowerSENS detectors

Customer Benefit

- Reliable level control
- Improved utilization of drum capacity
- Efficient use of anti-foam agent
- Increased throughput and 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 recalibrations required
- Immune against interfering radiation, XIP or RID feature ensure operation during weld inspections
In the extractor, there is an interface between the solvent and the extracted asphaltenes. This interface is typically not a clean interface, meaning that there is a zone where the two products of different densities separate. This zone is a gradient change in the density. The level is typically measured by means of a float or differential pressure. Other technologies measure the physical characteristics of the fluids. If the physical characteristics change slightly, this leads to errors in the level measurement.

The vessels using radiometric devices in this process have a large advantage over other level technologies which tend to malfunction, or where measurement errors occur due to the coating that can occur with heavy asphaltenes. The radiometric measurement from Berthold is non-intrusive, and therefore this coating and fouling does not affect our level measurement.

**Characteristics**
- Highly reliable measurement not affected by coating or fouling by the product
- Can be used on high temperature and high pressure vessel
- Easy to install on existing columns, without process downtime

MEASURING THE LEVEL IN SOLVENT DEASPHALTING UNITS

Solvent deasphalting (SDA) is a solvent extraction method used to extract up to two thirds of the vacuum reduced crude to be used as good quality feed for a fluid catalytic cracking unit to convert it to gasoline and diesel fuel blending stock. This technology uses light hydrocarbons (propanes to pentanes) as the solvents and uses subcritical extraction methods but supercritical techniques to recover the solvents thus increasing cost efficiencies. This technology can be used in conjunction with delayed cokers and resid hydrocrackers such as CLG’s LC-Fining and AXEN’s H-Oil processes. Typical uses of radiometric devices within a SDA unit includes: extractor, pitch stripper, DAO stripper, resin stripper and DAO separator.
COMMITTED TO TECHNOLOGICAL LEADERSHIP

Outstanding long-term stability
A reliable measurement is vital for the safe operation of a process and is therefore, our highest priority. Berthold’s detectors operate consistently irrespective of changes in ambient temperature. Even drastic temperature shifts, e.g. from winter to summer don’t influence the measurement error. Due to various patented technologies for detector stabilization and the use of cosmic radiation as an external reference source, the detectors output has an accuracy of under 0.001% per °C temperature change. Apart from employing these cutting-edge technologies in our detectors, Berthold’s measurement systems compensate degradation caused by natural aging. The result: many years of operation without the need for recalibration 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. By no means are Berthold detectors harmed by the excessive radiation and automatically return to normal operation after 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 150 x 150 mm 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 program 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 SENSeries 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 and density measurement. Thus safe operation of critical processes is guaranteed.
THE EXPERTS
IN MEASUREMENT TECHNOLOGY

Berthold Technologies stands for excellent know-how, high quality and reliability. The customer is always the focus of our solution. We know our business!
Using our varied product portfolio, our enormous specialized knowledge and extensive experience, we develop suitable solutions together with our customers for new, individual measurement tasks in a wide variety of industries and applications. Berthold Technologies is specialised in radiometric process measurements for 70 years. This is our core competence with state-of-the-art and cutting edge products and solutions covering a vast range of industries and applications.

We are here for you – worldwide!
The engineers and service technicians from Berthold Technologies are wherever you need them. Our global network assures you fast and above all competent and skilled assistance in case of need. No matter where you are, our highly qualified experts and specialists are ready and waiting and will be with you in no time at all with the ideal solution for even the most difficult measurement task.