KATflow Ultrasonic Clamp-On Flowmeters for the Brewing Industry

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Katronic Technologies provide the Brewing Industry with portable and fixed installed contactless flow measurement solutions, which help small and large size companies saving resources and costs.

Introduction

The UK brewing industry uses an estimated 34 million m^3 of water per year – enough water to supply everyone living in the city of Edinburgh for the same period of time. However, the cost of supplying water to a brewery is only the beginning. Most breweries discharge over 70% of supplied water as trade effluent and, in many cases, trade effluent costs are higher than water supply costs. In most breweries, the total cost of water supply and trade effluent disposal is about the same as the site's energy bill. If you add pumping, water treatment and effluent treatment costs, the bill is even higher.

Unit costs for water supply and trade effluent discharge are expected to continue to rise as water companies invest in new plants needed to comply with EC and UK legislation.

Although brewery waste is relatively simple and highly biodegradable, complicating factors are the waste water volumes, varying pH levels, and concentrations of enclosed substances. In order to get a good characterization of the waste water, flow rates and concentrations must be monitored simultaneously during all time.

The suspended solids in the effluent contain organic substances such as grain, trub, yeast, and label pulp as well as inorganic materials such as filter aids and silica gel. Dissolved solids are mainly from beer, wort, and cleaning and sanitization solutions (CIP detergents).

Typical types of discharge contents of large breweries are:

- Lauter tun rinse and drain
- Trub and wort losses
- Rinse and CIP chemicals
- Press liquor
- Surplus yeast handling waste
- Spent filter materials
- Fermenting and finishing waste

The waste water from breweries may be discharged several ways. Either directly into a river or ocean, or into a municipal sewer system. Alternatively, waste water can also be discharged into a river or municipal system after being partially treated or fully cleaned in the brewery's own water treatment plant.

Discharges into public waters are often subject to limitations in organic load, suspended solids, pH, temperature and chlorine. The high costs that are often required for waste water treatment offer brewers an additional incentive to eliminate unnecessary wastes and to optimize the reuse of effluents.

Even though it is very rarely discharged into rivers without being treated before, brewery waste water contributes to the pollution of the environment.

Beer is the world's oldest and most widely consumed alcoholic beverage and the third most popular drink overall after water and tea. Facts which keep breweries busy all over the world.

Beer mainly consists of water – a valuable natural resource. It is therefore essentail to limit its waste as much as possible. However, most breweries still discharge over 70% of supplied water as trade effluent. The amount of discharged water can be limited by introducing a water management programme which includes a constant monitoring of flow volumes. This not only helps the environment but also enables breweries to save costs.

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Solution

The above mentioned water and effluent costs can be controlled. A water management programme, for example, can produce significant savings. The consequent monitoring of flow processes helps reducing water and effluent costs during the brewing process, packaging / bottling, ancillary processes and in general areas.

Reducing the amount of water used not only reduces supply costs, but also the volume of trade effluent produced. However, reducing the strength of your brewery's trade effluent is equally important.

Taking action to minimise the discharge of wastes with a high level of organic content e.g. residual wort and ullage, will dramatically reduce your trade effluent charges. Optimising the CIP cleaning procedures, identifying leaks and stopping overflows are other areas where significant savings can be achieved.

Installing flowmeters and carrying out a survey of water use will help you to decide your priorities for action.

How the KATflow Ultrasonic Clamp-On Flowmeters Can Help

The KATflow ultrasonic clamp-on flowmeters help breweries to save costs at almost every production step, which involves liquids flowing through fully filled pipes.

Due to their ultrasonic measurement technique, they are cost effective in installation and operation. Additionally, as Katronic not only offers fixed installed but also portable meters, they can be used for many different purposes and applications regardless of the type of fluid, pipe material or diameter.

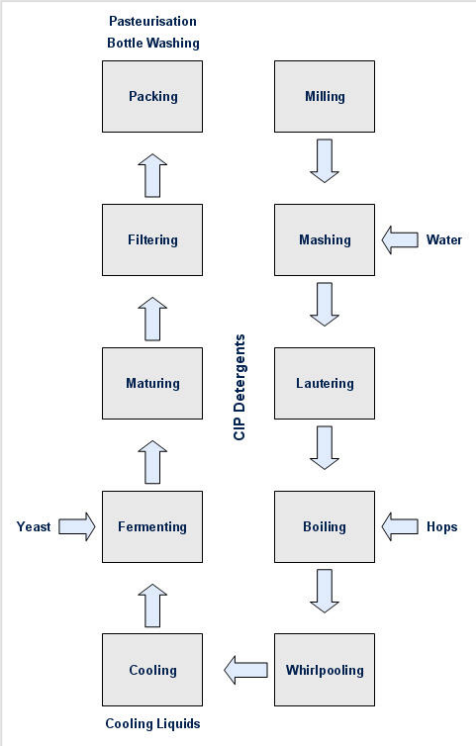
Measurement Principle of Ultrasonic Clamp-On Flowmeters

The Katronic ultrasonic clamp-on flowmeters can be used to monitor almost any flow process in a brewery. This flexibility is achieved by the ultrasonic measurement technique. It enables the flow of liquids to be measured non-intrusively and non-invasively from the outside of pipes.

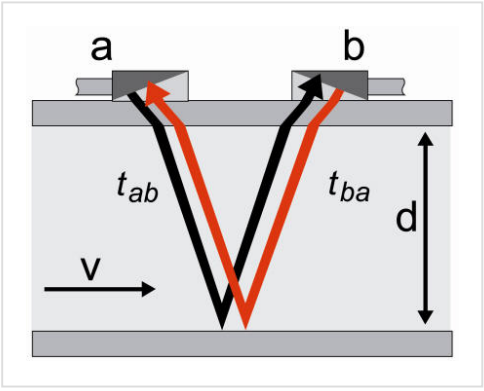
Ultrasonic flow measurement in general is based on the principle that sound waves are influenced by every flowing medium. The ultrasonic flow measurement technique of Katronic's KATflow series in particular applies the elementary transit time difference effect. Two sensors are mounted on the pipe wall whilst simultaneously sending and receiving ultrasonic pulses which travel with and against the flow of the liquid.

At zero flow, both sensors receive the transmitted ultrasonic waves without any delay in transit time. When the fluid is in motion, however, the ultrasonic pulse does not reach the two sensors at the same time. This measured "transit time difference" is directly proportional to the flow velocity and in combination with the given pipe and medium parameters other measurement units can be determined. Ultrasonic transit-time differential measurement can be employed to measure the flow of any acoustically conductive liquid regardless of its electrical conductivity.

This measurement technique has no effect on the flowing medium and provides reliable and precise results for a wide range of liquids over a broad range of flow velocities.



Simplified illustration of a the beer brewing process. Brewing includes flows of various liquids which contribute directly or indirectly to the production of beer. As the ultrasonic sensors are never in contact with the fluids, the Katronic flowmeters can measure all of them.



Transit time measurement technology as applied by Katronic flowmeters:

The ultrasonic pulse from sensor a to sensor b is travelling faster with the current than the pulse from sensor b to sensor a, which has to travel against it. The resulting transit time difference is directly proportional to the flow velocity (v). Provided with the pipe diameter (d) the flowmeter determines the flow volume.

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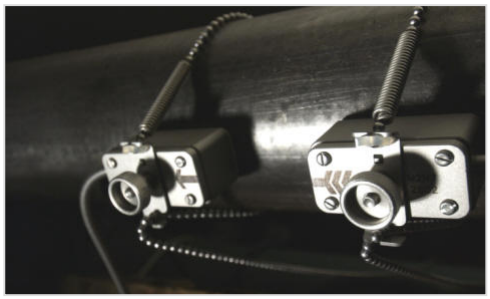
General Advantages of Katronic Ultrasonic Clamp-On Flowmeters

1. **No Shut Down:**
   By mounting the flowmeter on the outside of the pipe, there is no requirement to shut the flowing system down. This means no lost production.
2. **No Engineering:**
   As the sensors are mounted externally to the pipeline, there is no need to conduct costly pipe modification, no need for specially trained manpower and no risk of any kind of leakage.
3. **No Hidden Costs:**
   The only expense with a clamp-on unit is the purchase cost. Engineering work, down-time and trained staff are all expensive additions to more conventional metering solutions. Furthermore, on non-ultrasonic meters the hidden material costs of bolts, seals, washers etc. can more than double the price of an instrument.
4. **Maintenance Free:**
   Katronic ultrasonic clamp-on flowmeters do not contain moving parts, which could wear out. Moreover, the sensor casings are manufactured of stainless steel and are not in contact with the flowing medium, which helps avoid corrosion. As a result, maintenance is not necessary.
5. **High Accuracy:**
   For volume flow measurements, the KATflow flowmeters achieve an uncertainty of down to only 1.0% of the measured value depending on the conditions of the specific flow application. A decreased uncertainty of approx. 0.5% can be achieved by carrying out an on-site process calibration. In case of flow velocity measurements, the KATflow flowmeters achieve an uncertainty within 0.5% of the measured value.
6. **User-Friendliness:**
   As the ultrasonic flow sensors are simply clamped onto the pipe surface, KATflow flowmeters can be installed without the need to open pipes. The sensors are fixed to the pipe using special metal chains, straps or mounting rails. Every instrument of the KATflow series is equipped with a set-up wizard and the *Audible Sensor Positioning Assistant*™, which guide the user step-by-step through the installation process. As a result, it only takes a few minutes to install and set up the flowmeter.

KATflow Range of Flowmeters: KATflow 200, 230 and 150

The KATflow range of ultrasonic clamp-on flowmeters comprises three instruments: The KATflow 200, 230 and 150. The KATflow 200 is a light, hand-held meter with one flow channel. Like all other models, it offers a datalogger to store the measurement data. The KATflow 230 is a portable flowmeter with two flow channels and a variety of process outputs for applications, which require comprehensive measurement options and high mobility alike. Furthermore, it is not only capable of measuring the flow of liquids but also their temperature.

The KATflow 150 is an adjustable meter for permanent installation to be used on simple and advanced applications alike. It can be equipped with one or two flow channels and is capable of measuring flow as well as temperature. Its comprehensive process in- and output options also enable the instrument to monitor and regulate flow processes.



Ultrasonic flow sensors strapped onto the pipe surface using chains and clips.

The clamp-on mounting technique allows flow to be measured on pipes of various diameters and materials without the need to carry out costly engineering work or to shut down the flowing system.

Ultrasonic flow sensors with stainless steel head casing and cable conduit for extreme robustness. There are two sensor types available to cover a diameter range from 10 mm to 3,000 mm.

Katronic Technologies have been ISO - 9001 certified by SGS since 2003 ensuring highest quality standards for their customers.

Katronic KATflow flowmeters: Developed and manufactured in the European Union.

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Meeting Process Conditions and Hygienic Standards of Breweries

As it is the case with all production processes within the food and beverage industry, maintaining a sterile process environment is crucial for breweries. It is therefore important that installing a new flow meter does not compromise the cleanliness of the fluid. All invasive metering technologies including electromagnetic flowmeters require the pipes to be opened up to the environment during installation compromising the cleanliness of the lines. Additionally, as sensors of electromagnetic flowmeters protrude into the pipe, intrusions are created which allow bacterial growth to occur. Furthermore, they disrupt the flow in smaller lines. In contrast to that, the ultrasonic flow sensors of the Katronic flowmeters are clamped onto the pipe surface and consequently are in no contact with the fluid. As a result sterile process conditions can be maintained at all times.

There is another advantage resulting from of the fact that the sensors are not in contact with the fluid: Katronic's portable flowmeters can be used at different points and process steps to measure the flow of all liquids which can be found in a brewery regardless of the type of fluid. This includes water, waste water, discharges, wort, beer, CIP detergents as well as cooling and heating liquids. Additionally, the sensors can be employed on every common pipe material including stainless steel, copper and various types of plastic – materials which are mainly used in breweries. The ultrasonic flow sensors cover pipe diameters from 10 mm to 3,000 mm (3.0 m) enabling the flowmeters to measure on virtually every pipe within the plant.

Applications in the brewing industry present further challenges for flow measurement devices. For example flowmeters must also be able to cope with rapid changes of flow velocities and varying process temperatures.

With a response time of only one second, the KATflow flowmeters can measure rapidly changing flow velocities as they occur during CIP (clean-in-place) flushing processes. The ultrasonic flowmeters can be used during these processes to identify the interfaces between rinse water and the end product.

The process temperatures of the brewing pre- and end-products as well as of supporting mediums (e.g. coolants) can vary considerably. The temperatures during mashing, for instance, range from 49 °C to 75 °C. During the boiling stage the liquid in the b rew kettle is heated to around 100 °C. Lower temperatures are needed after the whirlpooling when the wort must be brought down to fermentation temperatures of about 20 °C to 26 °C before yeast can be added. In modern breweries this is achieved through a plate heat exchanger. Water cooled plates can drop 95 °C wort to 20 °C while warming the cool ant from 10 °C to 80 °C. The last few plates of the heat excha ngers often use a medium, which can be cooled to below freezing point (e.g. glycol), which allows a finer control over the wort-out temperature, and also enables cooling the wort to around 10 °C.

As they are designed to operate at temperatures ranging from -30 °C to 130 °C or more, the KATflow ultrasonic flow sens ors can be used on any application related to the brewing process. In addition to simple flow measurements, the Katronic flowmeter models KATflow 230 and 150 can also contribute to reduced energy bills by determinating temperature related energy consumption on heating and cooling lines. Alternatively, the temperature measurement function can also be used to monitor the cooling rate during wort cooling and consequently become an integral part of the production process.

Brew kettles made of copper. At this stage hops are added to the wort before being boiled. Once the liquid has achieved the correct aroma, it is transferred to the heat exchanger to be cooled down.

Fermentation tanks made of stainless steel. After the addition of yeast the fermentation process creates the beer's alcohol and carbon dioxide.

The Katronic flowmeters can also be used at the bottling stage to determine the volume of detergents used for bottle washing and of hot water used for pasteurisation.

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Meeting Process Conditions and Hygienic Standards of Breweries

Liquids contributing to the end product are almost constantly kept under pressure within the pipelines. At the same time it is important to monitor the amounts of liquid ingredients added to the process or the volume of the product transferred to next process steps.

Breweries are therefore interested in keeping pressure on a consistent level at all times. At the same time, they want to obtain reliable and accurate flow readings. Whereas all inline flowmeters cause pressure drops within pipes, ultrasonic clamp-on meters guarantee the pressure level to remain equal whilst providing highly accurate measurement data of the flow velocity and volume.

Making CIP Cleaning Processes More Efficient

Furthermore, ultrasonic clamp-on flowmeters can be used to optimise CIP (clean-in-place) flush processes, which are regularly carried out at breweries to keep pipes free of micro bacterial contamination. The CIP system is used to clean the process piping several times a day with each process including water flushes of several minutes duration. The CIP process itself uses a caustic solution to wash through and ensure product integrity.

The wash cycle includes a pre-flushing stage, followed by a caustic solution, an intermediate flushing, an acid solution, and then a final flush prior to restarting of production. As elevated temperature and hazardous chemical detergents are employed to enhance cleaning effectiveness, flow sensors have to withstand rapid changes in temperature and must not be in contact with the medium.

As the ultrasonic sensors are installed by simply clamping them onto the pipe wall, they are in no contact with cleansing chemicals at any time. This makes them suitable for measuring CIP flushes. The clamp-on flowmeters enable the brewer to optimise the cleaning process by determinating the exact volume of detergents necessary to achieve satisfactory results. This leads to less detergents, water and energy being used. In addition to that, by saving water and energy through minimised flush periods, breweries can improve their eco-friendliness. Finally, streamlining the CIP cleaning process also reduces costs for the stoppage of production.

Contributing to Process Automation in the Brewing Industry

Large brewing companies nowadays have almost fully automated their production processes. It is therefore important for them that every new measurement equipment can easily be integrated into their existing automated process control systems.

The ultrasonic flowmeters of the KATflow series deliver very accurate and reliable measurement data. They are therefore trusted devices, which can be employed to monitor and control production processes. Featuring various process in- and outputs as well as serial communication interfaces, the flowmeters can be fully embedded into process automation systems.

KATflow 200 hand-held flowmeter. Ideal for simple spot measurement applications such as leak and blockage detection, pump and inline flowmeter performance verification, CIP flush monitoring and discharge volume determination.

KATflow 230 portable flowmeter. Ideal for advanced spot measurements such as monitoring the fluid's temperature change.

Offered process inputs:

- Current 0/4…20 mA active or passsive (only KATflow 150)
- PT 100 temperature (only KATflow 230 and 150)

Offered process outputs (only KATflow 230 and 150):

- Current 0/4...20 mA active
- Digital open collector
- Digital relay

Offered serial communication:

- RS232/USB (all models)
- RS485, Modbus (only KATflow 150)

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Advantages Regarding Process Conditions and Hygenic Standards

1. **Hygiene:**
   Installing a clamp-on flowmeters does not create intrusions which allow bacterial growth inside the pipe. This means that there is no risk of contaminating the product.
2. **Variability:**
   As the sensors are never in contact with the flowing medium, the portable flowmeters can be used on many different applications regardless of the type of fluid. In addition to that, the instruments work on all common pipe materials and diameters from 10 mm to 3,000 mm.
3. **Low Response Time:**
   With a response time of only one second, the KATflow flowmeters can measure rapidly changing flow velocities.
4. **High Temperature Tolerance:**
   The KATflow ultrasonic flowmeter sensors are designed to with-stand temperatures ranging from -30 ℃ to 130 ℃ and more. As a result, they can be used on any application involved in or related to the brewing process.
5. **Measuring Temperature Changes and Energy Consumption:**
   Whether you want to determine the cooling rates during the wort cooling process, or if you want to measure temperature related energy consumption to fine tune heating or cooling systems for higher system efficiencies: The KATflow 230 and 150 flowmeters enable the brewer to monitor the temperature changes of almost any flowing liquid.
6. **No Pressure Drop:**
   Externally mounted sensors mean that the Katronic flowmeters have no effect on the flowing liquid and will not cause a pressure drop across the measurement location.
7. **Ideal for Monitoring CIP Processes:**
   Due to their contactless ultrasonic flow measurement technique, low response time, and the high temperature tolerance of the flow sensors, Katronic flowmeters are ideal to monitor CIP flushes.

KATflow 150 adjustable flowmeter for fixed installation. Ideal for permanent installation on existing or new lines.

Molson Coors with their famous beer brands Carling™ and Grolsch™ have decided to use a portable ultrasonic clamp-on flow-meter from Katronic Technologies to monitor brewing and cleaning processes as well as thermal energy consumtion.

Conclusion

Whether they are portable instruments or designed for permanent installation, the Katronic KATflow ultrasonic clamp-on flowmeters are cost effective devices for breweries to save resources, energy, and as a result costs. Additionally, the flowmeters help increase the brewery's eco-friendliness and contribute to a more efficient production process – considering the high level of competition in the market, this benefit can not be regarded highly enough. For these reasons and due to Katronic's excellent and flexible customer service, leading companies of the brewing industry have decided to use KATflow flowmeters.

Opinions

When asked for his reasons for choosing Katronic, the Molson Coors Technical Support Manager responsible for the purchase of the instrument said:

"I was drawn to the Katronic flowmeter because of the high specification of the unit, the ease of use and the excellent build-quality of both the sensors and the electronic transmitter".

Furthermore, since taking possession of the meter and putting it into use he described himself as

"impressed with the comparative accuracy of the meter against trusted existing flowmeters".

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