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PROCESS INSTRUMENTATION

Clamp-on ultrasonic flow measurement **allows automatic beer filtration control**

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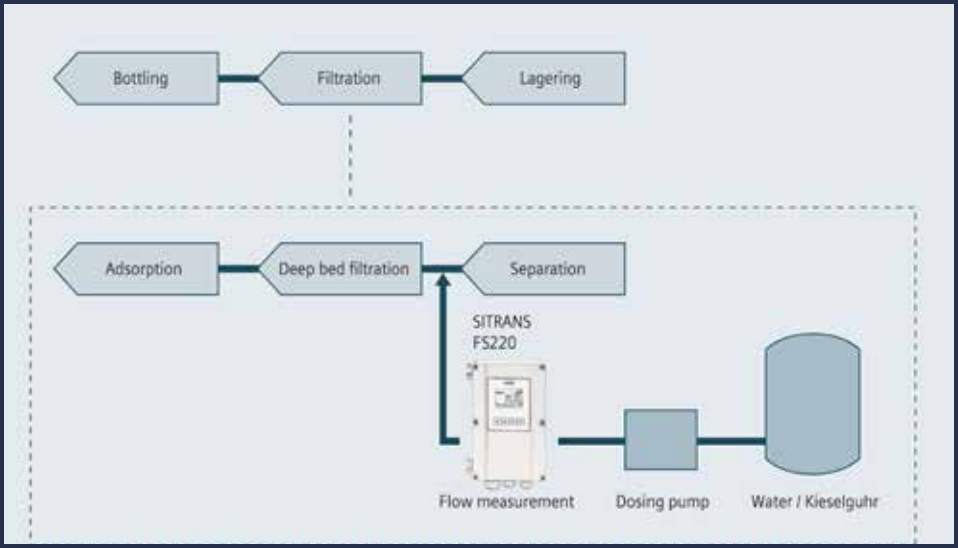
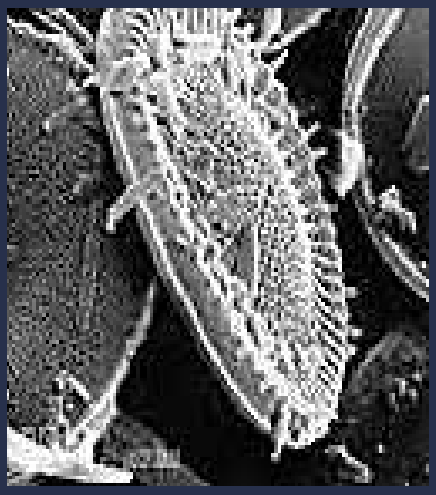
For a German brewery, the introduction of advanced process control technology in the brewing of their high quality beer has resulted in fully automated filtration control, allowing the brewmaster to work on what really matters: combining the technological advancements with old-school knowledge and tradition to bring out the best of water, malt, hops, and yeast; the basic ingredients of beer.

Mannheim, Germany. Eichbaum is one of the largest and most modern regional breweries; a position quite different from its foundation back in 1679 when the Eichbaum Brewery was only one among 25 other breweries in Mannheim. This long history has had, and still has, an impact on the way beer is brewed today. Old-school knowledge and tradition have been passed on to the present brewmaster but at the same time, Eichbaum as the progressive brewery it is, has always been open to the introduction of advanced technologies. As an illustration of this, the modern brewing facilities include a clamp-on ultrasonic flowmeter utilized to control the completely automated filtration process.





Kieselguhr filter material

Background
During the brewing process, the beer passes through a multistage filtration section in which the turbidity forming substances and suspended particles, such as tanning compounds, proteins, yeast cells etc. that make unfiltered beer look unclear, are removed. In addition, it is treated for polished shine and brilliance as well as proper flavor, and stabilized by adding preservatives that ensure durability. Filtering the beer is seen as a crucial part of the brewing process since the beer's crystalclear appearance and characteristic taste are major contributing factors in its market success.

The filtration process
Filtration is a mechanical/physical operation used for the separation of solids from fluids. When a fluid, such as beer, passes through a filtration medium that retains the solids, the amount and type of retained solids depends on the pore size and the thickness of the filtration medium. There are various filter types, sizes and methods but in the brewing industry, two methods are prevalent; surface and deep bed filtration. In surface filtration, the particles are retained mechanically at the surface or in the upper layers of the filter. This method is used when filtrating coffee from the grind in a coffee maker. Although this is a well-established filtration method, surface filters usually clog very fast. This makes it an expensive and insufficient solution for most industrial applications.

Deep bed filtration
In contrast to other filtration systems, deep bed filtration is based mainly on the retention of particles in the inner structures of the filter medium; a chemical process known as adsorption or adhesion. Deep bed filters are usually made of high capacity and very porous substances because the high number of small internal channels provides a very large inner surface. Such materials take much longer to clog, making them the preferred filtration method for industrial applications.

Using Kieselguhr in the filtration process
A very efficient type of deep bed filtration medium is a sediment called Kieselguhr. Kieselguhr is a very porous material that provides high filtration efficiency. Before initializing the filtration process, coarse Kieselguhr is fed to water that is run through a filter vessel. At the Eichbaum Brewery, the filter vessel is made of 638 vertically aligned long narrow slits, or "candles" that provide a total filter surface of approximately 100 m2 (1075 sq/ft). As the coarse Kieselguhr runs through the vessel it clogs the slits of the candles, turning the entire vessel surface into one giant filter. Other breweries may be using horizontal sieves or frames made of mesh or net instead of Kieselguhr as filter medium, but regardless of method, it is a step that is required because the candles themselves have no filtering effect. After the filter has been "laid out" the actual filtration process is ready to begin. With a dosing pump, powdered Kieselguhr is mixed with water to form a substrate that binds all of the unwanted particles and substances in the beer. The mixture is fed to the beer upstream of the inlet of the filter vessel, which then flows through the coarse Kieselguhr bed into the inner part of the candle and from there to the dome of the vessel. When the beer flows through the filter, the fine Kieselguhr is deposited, constantly forming new surfaces that make the filter thicker and thicker. Since the Kieselguhr is accumulating on top of the candles, its weight also increases by the minute. So in order to prevent the filter from breaking apart, the filtration process is stopped at a preset pressure level. The Kieselguhr is removed from the vessel and the candles, and the process starts over again.

Kieselguhr
Kieselguhr, also known as Diatomite, is a very fine and extremely porous sediment, consisting mainly of silica. Kieselguhr is a fossilized remains of diatoms, a type of hard-shelled algae used in many products from toothpaste to car tires. Because of its very high porosity, Kieselguhr also provides excellent filtration capabilities and is used preferably to filter water and other liquids, such as beer and wine. Kieselguhr is highly abrasive, a feature that is exploited in certain products and processes, but which also causes unwanted effects when Kieselguhr comes in contact with sensitive materials.

The problem
To optimize the filtration process it is crucial to monitor and to automatically control the amount of Kieselguhr and water mixture charged to the beer before it enters the filter vessel. This can be done by measuring and controlling the flow rate of the Kieselguhr-water suspension. One major challenge with this approach, however, is that Kieselguhr turns highly abrasive when suspended in water. This causes unwanted effects when it comes in contact with sensitive materials, such as flow measurement devices with sensors/ transducers in contact with the medium. Since the brewery did not have a viable alternative at hand, they chose not to take any measurements at all.

The solution
After an unscheduled visit by a Siemens representative, Eichbaum was made aware of the clamp-on ultrasonic flow technology. Since the transducers of the clamp-on flowmeters are mounted on the outside of the pipe and are installed without cutting the pipe or interrupting the flow, they are a perfect fit for the German brewery. In addition, clamp-on meters can be used to measure any medium, are resistant to pressure drop, and are not affected by high pressure or changing temperatures.

From the list of available clamp-on families, the brewery chose the SITRANS FS220 with transducers mounted on the pipe and the flow computer located on a nearby wall. Since the meter is connected to the brewery's SIMATIC S7 controller, the operator just needs to enter how many grams of Kieselguhr per hectoliter beer are required to run the filtration process and how many kilograms of Kieselguhr have been fed to the filter vessel. Depending on the measured flow rate of the beer, the required amount of Kieselgur is calculated and the flow of the Kieselguhr and water mixture is adjusted accordingly.

For such a process to offer an optimized performance, the flow measurement must be very accurate. The SITRANS FS220 achieves this by means of the patented WideBeam ultrasonic transit-time measurement principle in which an unmatched signal is achieved by adapting the signal transmission to the resonant frequency of the pipe. The signal from the pipe wall can also be used to perform an automatic, continuous zero point compensation, making adjustments at stopped flow conditions superfluous.

User benefits
The main benefits that the Eichbaum Brewery has gained from the installation of the SITRANS FS220 were the ability to manage a high filtration volume and to control the dosage of the Kieselguhr and water substrate. By evaulating and improving most of the steps in the filtration process, the Brewery were able to brew a consistently high quality beer while minimizing the consumption of Kieselguhr. These steps included:

- Elimination of constant dosing that resulted in decreasing performance of the dose pump and the filter at the end of the filtration process and during the filtration of different types of beer caused by increasing counter pressure.
- Extension of the life time of the filter through exact dosing volume adjusted to the actual dedmand.
- Very precise dosing of stabilisation additives and real-time identification of underdosage or faults in the process by means of an alarm has resulted in consitently high beer quaulity.
- Improved working conditions through automatic control of the dosing volume and through the possibility to perform filtration experiments under constant conditions.
- Increased efficiency through minimized Kieselguhr consumption.

A summarizing statement from the Eichbaum Brewery brewmaster confirms the above: The clamp-on technology has, for the first time, made the important process step of deep bed filtration fully transparent and controllable to us. Thus, we gain one option more to optimize the filtration process and to ensure an even higher quality of our beers at a reduced cost through increased efficiency. The direct integration of the SITRANS FS220 flow meter into our SIMATIC S7 control system makes the deep bed filtration an integrated part of the entireautomation system".


Slit filter vessel (deep bed filtration)


Filter cellar with clamp-on flow meter, hose pump (blue) and Kieselguhr tank (open)


Clamp-on flowmeter SITRANS FS220

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