Liquitrend QMW43

Secure detection, quantifying and qualifying of buildup and fouling

White Paper

Endress+Hauser
People for Process Automation

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Register

Secure detection, quantifying and qualifying of buildup and fouling in filled tanks and pipes using Liquitrend QMW43

When media is heated, cooled or transported, we often encounter unwanted buildup or fouling in pipes or tanks. During these processes, layers are formed which normally are very thin. However even thin buildup can lead to problems in cleaning or heat transfer. How can we detect this buildup reliably and also quantify and qualify the extent of the pollution without having to open the tank or pipes?

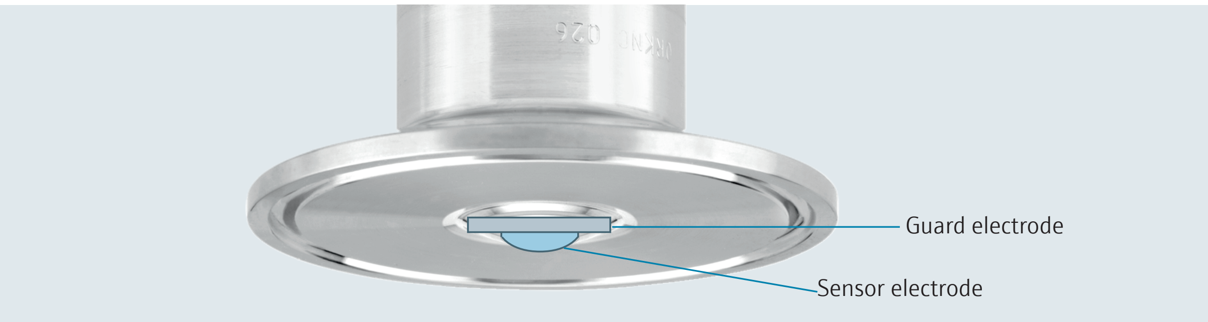
Here, using Liquitrend QMW43 we can present a solution to the problem.

1 Operation of Liquitrend QMW43

The Liquitrend QMW43 is a measuring device which contains two circular fitted electrodes. The electrodes are separated by a layer of isolating food grade PEEK. The inner sensor electrode is used to define the buildup height in conductive and non- conductive media. The outer guard electrode is only used to determine the conductivity of the media and as a determining factor for the buildup height calculation in conductive media. The Liquitrend uses both a capacitive and a conductive measuring cycle for the determination of the buildup height on the sensor. In this way the software in the electronics of the Liquitrend QMW43 can always use the correct measuring algorithm depending on the media which then results in the most exact measurement. Due to the use of both measuring modes- capacitive and conductive- the Liquitrend QMW43 is also able to react fast and conclusively on the different situations with media on the sensor surface respectively in the filled pipe.

Conductive media:
In a conductive media like water, milk, beer or similar products, the conductivity of media is measured via the current measurement of the guard electrode, thus the resistance of the media against the current flow from guard electrode to ground. The buildup on the sensor is determined by the comparison of the current at the sensor electrode and the current at the guard electrode against ground. This relationship is proportional to the buildup height on the sensor. The kind of media and buildup height on the sensor have a direct influence on the measuring signal.

Non-conductive media:
When measuring in non- conductive media like fat or concentrated sugars or similar media, the measurement mode is capacitive only. Within this measurement mode, the signal amplitude of the sensor electrode is used to establish the buildup height on the sensor surface accurately. If high precision in signal is needed, the knowledge of the dielectric constant (DC) is a precondiction. The sensor electrode signal amplitude is equivalent to the buildup height on the sensor surface. As basis for determination, a standard DC of DC=13 is taken which is pre-set in the device electronics. This factor can also be altered manually or via the measurement of the actual DC of media via the Liquitrend QMW43. Like this, we can measure the buildup height on the sensor reliably and proportional even at low DC media.



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2 Interpretation of measuring signal with Liquitrend QMW43 measuring in emptied tanks or pipes

In emptied tanks or pipes, the sensor signals represent the actual buildup height of media residues on the sensor in millimeters (mm). The residual conductivity of this buildup is measured in micro siemens per centimeter (μS/cm). When the pipe is been filled again, the full expected current can be measured at the electrodes. The device measures the conductivity of the media in the pipe or tank at the given temperature. At the same time, the Liquitrend QMW43 will output a buildup height value between 9 and 10mm. In a proven clean and filled pipe or tank, these measurement values would be the initial value ("zero point") for a signal interpretation in a filled pipe or tank.

3 Signal interpretation of Liquitrend QMW43 output in filled pipes or tanks

When buildup or fouling is formed on the sensor surface, it changes the current or the capacitive signals which can be measured and their relation to each other. The measured value "buildup" changes while the buildup is forming on the sensor surface. At the same time, the measured conductivity also adapts. This change in conductivity can be relatively small, depending on the type and quantity of the coating or fouling. Thus, by means of the signal behavior at the measured value „buildup" a coating or fouling can be reliably detected.

The more fouling or coating accumulates, the greater the change in the signal value „buildup" compared to the initial value ("zero point") in the measured medium. For example, a change from 9.6mm to 9.7mm indicates a very small buildup in cold wort, while the change from 9.6mm to 9.9mm in hot wort describes a much heavier buildup.

The type of fouling or coating also changes both measurement signals if the Liquitrend QMW43 is located in a pipe or tank filled with conductive medium:

a) If the buildup is conductive and has a high DC value (e.g.: detergent, wort), the signal „buildup" lifts and the conductivity of the liquid also changes to a slightly higher value than initially measured.

b) If the buildup is not conductive but has a high DC value (e.g. honey), the measured value of the „buildup" signal rises with a coating of this nature. At the same time the measured conductivity drops.

c) If the coating or buildup is non-conductive and at the same time has a low DC value (e.g.: grease), this leads to a decrease in the measured signal „buildup" with this type of fouling. At the same time the measured conductivity also decreases.

This device behavior can be used with Clean in place (CIP) to **detect buildup or fouling, assess the strength of the fouling that has occurred and optimize cleaning cycles**. In addition, the device behavior can be used to carry out a problem analysis.

4 Procedure in the application to detect fouling or deposits before and after cleaning

The detection of fouling or deposits before and after cleaning can be easily accomplished by means of the measuring signals of the Liquitrend QMW43 and programmed into the control system.

For this purpose, a starting point or "zero point" for the evaluation of the device signals must be selected. A good starting point is, for example, the water phase after cleaning before the actual production starts. Here the pipe or tank is clean and filled with water.

The signals of the Liquitrend QMW43 take on a value specific to this situation. For example: conductivity: 300µS/cm and „buildup": 9.5mm

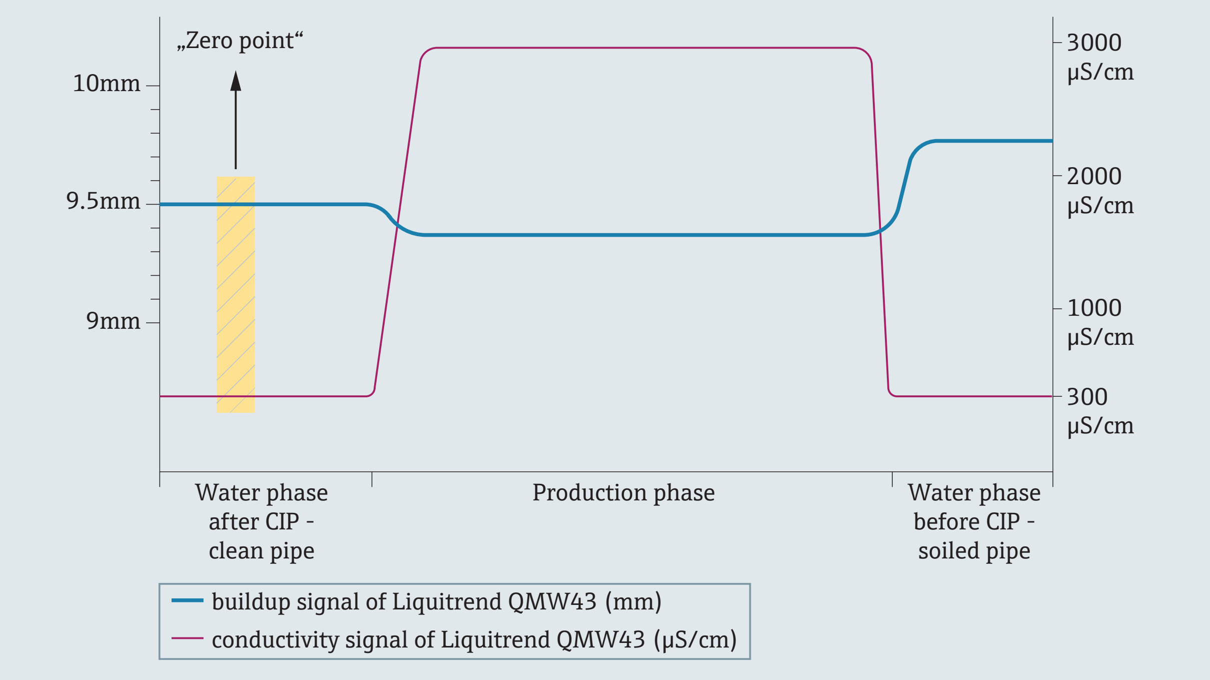
When the production phase is initiated and the product is transported through the pipe or tank, small deposits or fouling can begin to form on the pipe or tank wall.

During the following preliminary cleaning with water these can be detected by the changed signal values of the Liquitrend QMW43. The deposits could, for example, appear as follows: conductivity: 310µS/cm and „buildup": 9.7mm in comparison to the original measurement values at the "zero point".

This signal change makes it clear that a buildup has formed during the production phase. The aim of the CIP phase is to remove this deposit and clean the pipeline or tank without leaving any residue.

If the CIP cleaning was successful, the Liquitrend QMW43 shows the output signal of the starting point again in the water phase. In this example: conductivity: 300µS/cm and „buildup": 9.5mm. This can then be used in the control system as documentation and evidence for cleaning validation.

If the CIP cleaning was not successful in removing the deposits, the signal value of the Liquitrend QMW43 will not be at the previously determined output signal "zero point", but will still have a different value. For example: conductivity: 300µS/cm and „buildup": 9.6mm. This result can be used for the cleaning documentation and the reasoning for a specific extension of the cleaning or production cycle in the control system.



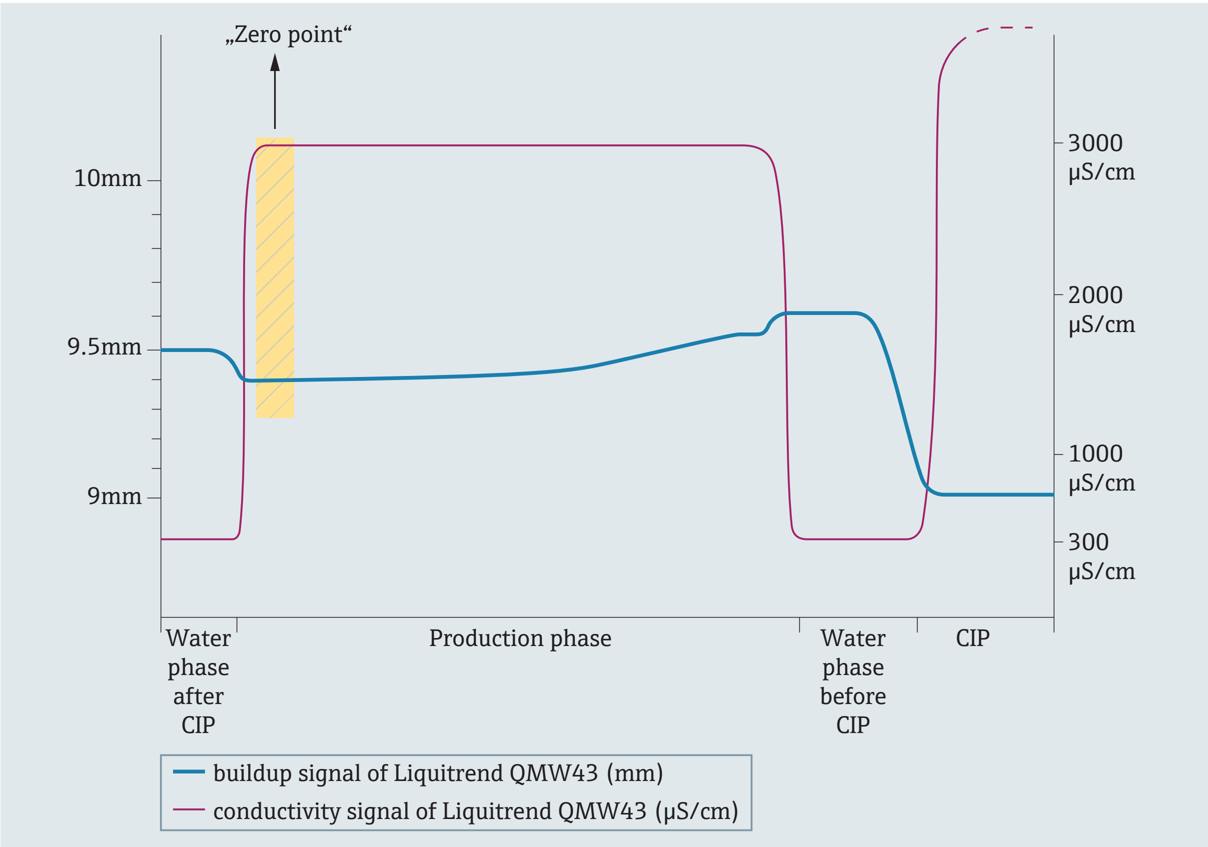
Example 1: „zero point"/starting point definition in water phase

5 Procedure in the application for determining the relative buildup thickness in full pipes and tanks

In full pipes or tanks, the dynamics of the measurement signal „buildup“ in the value range between 9 and 10mm is important. In this case, the sensor indicates that it must be a filled pipeline or a filled tank. The electrical changes at the sensor face due to deposits or fouling are expressed by the change in the signal between 9 and 10mm.

The user would like to estimate the thickness of a coating at this stage. Then he wants to optimize his process based on this information.

For this purpose, the starting point in the media must be determined. After cleaning and subsequent rinsing with water, the starting point is now determined in the product phase, where a clean pipe filled with product is present.



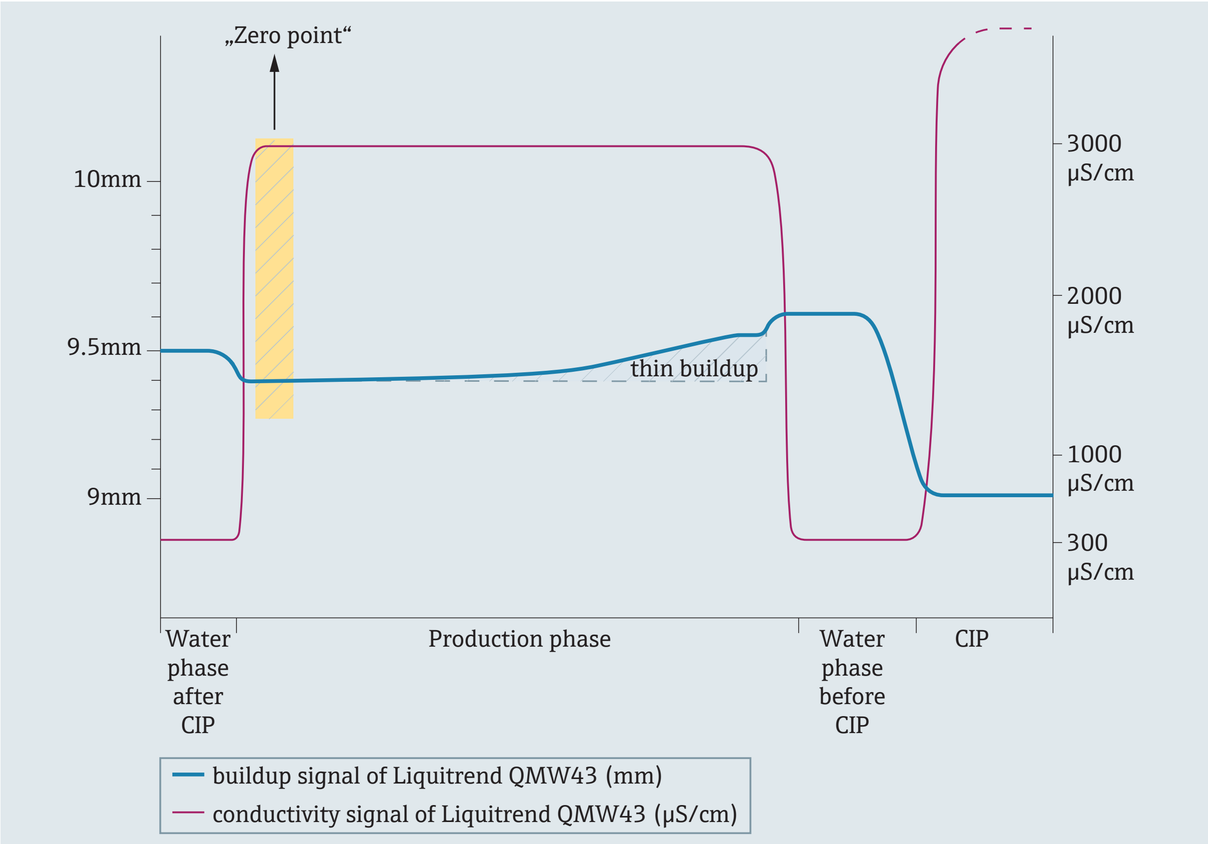
Example 2: „zero point“ /starting point definition in product phase

In this example, the signals are represented as follows for a conductive medium: conductivity: 3000µS/cm and „buildup“: 9.4mm

When production starts again the fouling from buildup could continue to grow due to the effect of e.g. heating in the process. This fouling is expressed in the sensor signals as follows, for example: Conductivity: 3000µS/cm and „buildup“: 9.5mm.

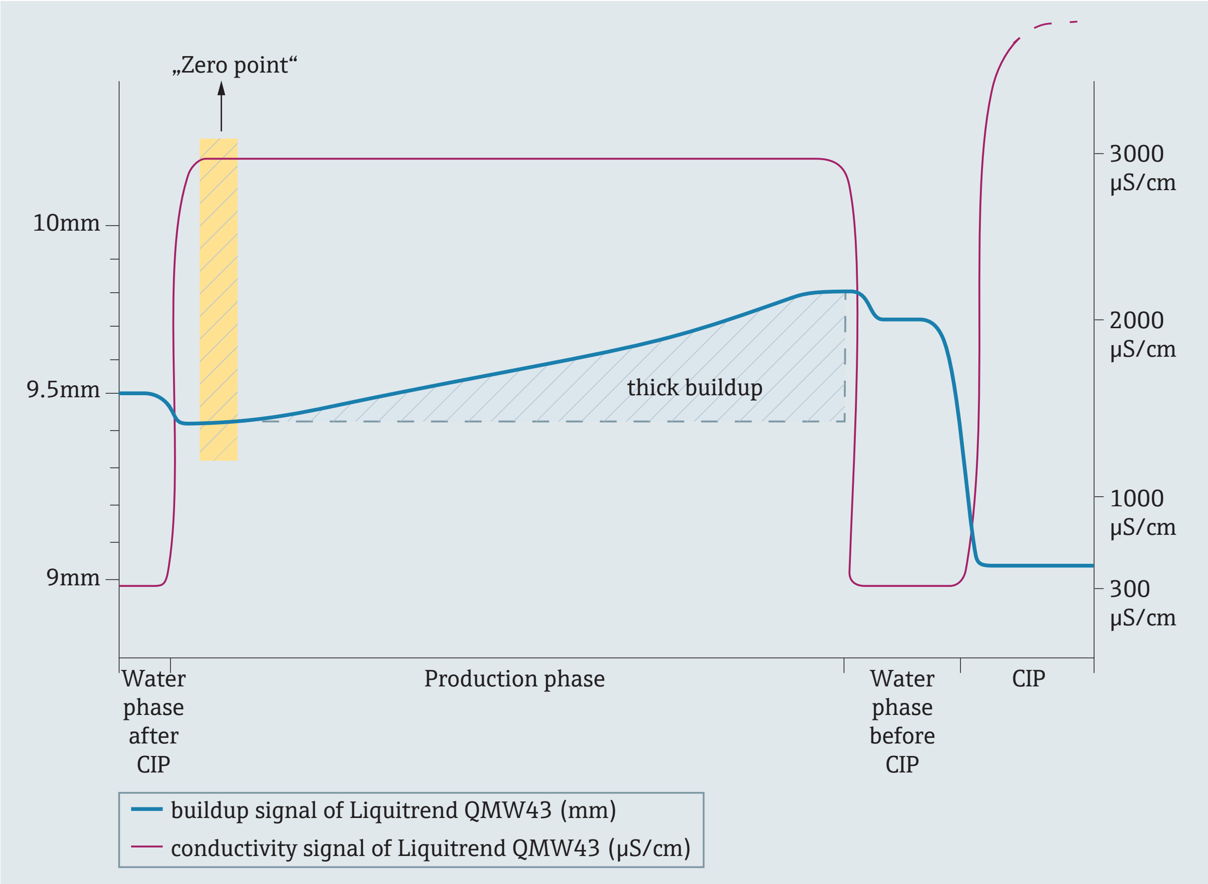
As the process continues and the thickness of the fouling increases, the sensor reading „buildup“ will continue to rise in proportion to the increase in the thickness of the fouling. The difference between the initial value and the measured value „buildup“, in this case 9.5mm - 9.4mm = 0.1mm, should not be seen as an absolute indication of the actual buildup height. Rather, it is a proportional measurement that shows whether there is more or less buildup.

For an evaluation of the actual buildup thickness, the pipe or tank must be emptied and the measurement signal recorded in the empty, dirty tank or pipe with the coating present on the sensor. Thereby it becomes clear to which actual coating thickness the previously determined differential value of 0.1mm corresponds:



Example 3: product phase and thin buildup formation

If it is to be determined whether a thick fouling or buildup forms during the production phase, the plant operator must consider the initial value in relation to the developing measured values during the production phase. If the slope of this development is very steep, this indicates a strong coating. If the gradient is incremental, however, it is a slow-growing, thinner buildup.



Example 4: product phase with thick buildup formation

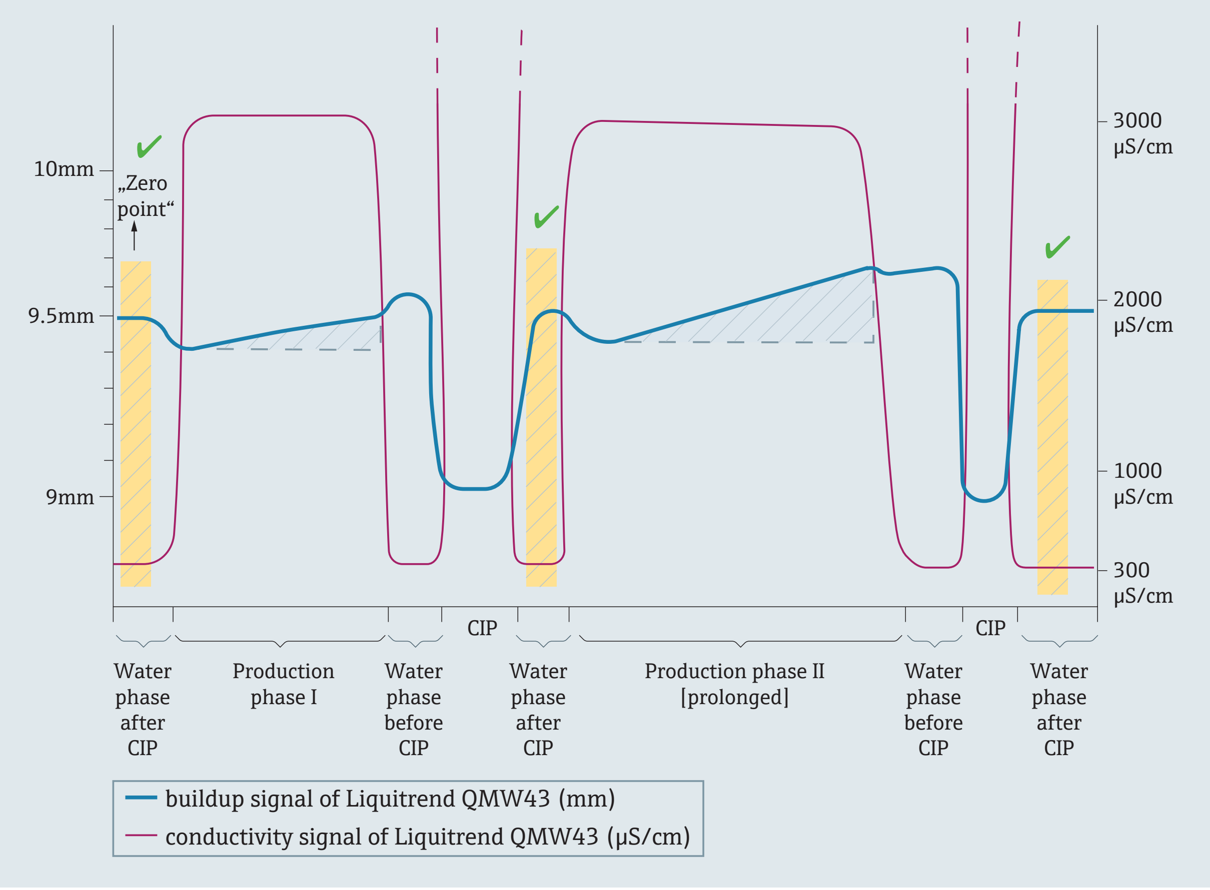
6 Procedure in the application to optimize cleaning cycles according to the necessity in the process

The descriptions preceding this chapter can be used for optimizing cleaning cycles.

If the cleaning cycles are to be optimized adapted to the necessities in the process, a status quo must first be recorded. For this purpose, the starting point measurement values in the water and product phase are determined as described above. Based on these values, the increase in the thickness of the buildup which is forming and the cleaning success after the production phase is then evaluated.

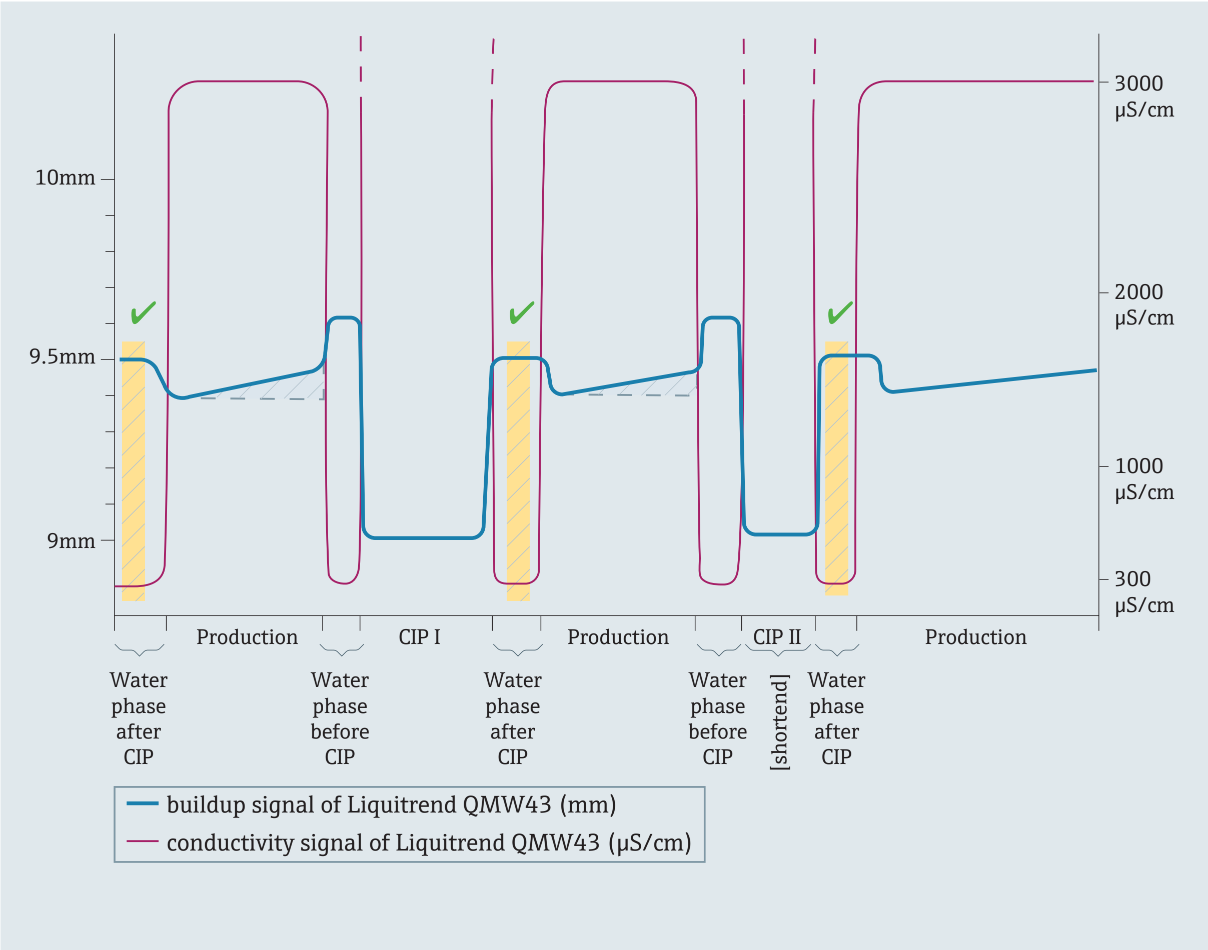
If the initial state is known and it can be determined that there are no problems due to insufficient cleaning, the production cycle can be extended in time. For example, until the measurement signal of the Liquitrend QMW43 indicates a higher buildup value than that of the status quo recording.

At this point a CIP cleaning can be carried out again to determine whether the clean initial state of the water-filled pipeline or the water-filled tank can be achieved. If this is the case, the extension of the production time can be maintained and the effective cleaning time can be optimized.



Example 5: prolongation of production time

In the same way, the plant operator can reduce the cleaning time to what is necessary to achieve the target. For this purpose the measurement information of the Liquitrend QMW43 in the water phase before and after the CIP cleaning is used. The plant operator shortens the actual cleaning time and checks after the cleaning whether the "zero point" initial state can be reached again. If this is the case, the shortened cleaning time is sufficient to reach the target of a clean installation and the previously used safety times can be reduced.



Example 6: shortening of cleaning times

7 Summary

If the measuring signals of the Liquitrend QMW43 - conductivity and „buildup“ - are evaluated, valuable knowledge about the entire process sequence and the behaviour of the media in the process can be gained.

By means of signal interpretation, the time required for cleaning can be reduced or the time available for production can be extended. Both approaches increase the productivity of the process and in turn the availability of the plant.

In addition, by interpreting the measurement signals of the Liquitrend QMW43, a deeper problem analysis can be carried out if necessary.

The measurement signals of the Liquitrend QMW43 also serve the plant operator to document the plant status. They ensure continuous processes and continuous documentation and create transparency.

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