Conductivity measurement equipment for steam boilers and condensate systems

- From absolute measurement to BUS-capable
- 4-electrode measurement compensated for temperature, fouling and polarity with TÜV approval as per VdTÜV bulletin “Water Monitoring 100”
The concentration of the boiler water.

With the two-capable four-electrode conductivity

controller LRR 11 of the first generation of

sensors for steam boilers and condensate systems, the equipment

was already offering the fourth generation of

equipment for safety equipment.

Continuous blowdown controller LRR 11 of the first

generation without temperature compensation

was used. With the introduction of automatic continuous

blowdown control at boiler plants and the

advancement of boiler house automation,

the codes demanded ever lower

concentrations of boiler systems as well as the development

of control algorithms in the precision of the monitoring

equipment. In following the progress in boiler construction,

the codes stipulated even lower conductivities in the boiler water together with

improved quality of the measurement systems.

History of the development:

With the introduction of automatic continuous

temperature compensation, there too, the familiar
two-electrode measurement procedure was used. With the introduction of automatic tempera-
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ture compensation, there too, the familiar
two-electrode measurement procedure was used. With the introduction of automatic tempera-
temperature on the conductivity measure-

ment result, by means of a compensating measurement using a sample cooler (e. g. PK 45).

The advance was rapidly accepted by the market and implemented in numerous boiler

plants. It is still viable in use today. The devices

were extended with a 4-20 mA current output, which was used for a pressure indication or for

remote control of cleaning devices.

With the advancement of boiler house automa-
tion, the more stringent demands on the boiler water quality with the limit of 6,000 µS/cm as

per EN standard) and the need for optimized

measurement systems, the limits of the tech-
nique have been proved and it is now frequently used

what happens in the case of:

- pressure fluctuations and the associated temperature variations
- temperature variations in condensate lines
- plants in which the service pressure is

reduced (down to 1 bar, etc.)

Such question always address the influence of the temperature on the conductivity measure-

ment.
Conductivity measurement equipment for steam boilers and condensate systems

In pursuing the objective of always offering the right measurement system to suit both the needs of our customers and the advanced requirements of the technical codes, we considered, during the development of the SPECTOR family, the simultaneous advance of the VdTÜV bulletin "Water Monitoring" (WÜ 100) and incorporated it into the products. This resulted in systems which have a Pt1000 temperature sensor integrated into the electrodes and hence can usually sense the temperature to integrate it into the result of the conductivity measurement. In this way it became possible to ensure that the displayed and evaluated conductivity values were always referred to 25 °C, irrespective of temperature fluctuations. In the previous electrode configurations, the wall of the boiler, vessel or pipe served as the reference electrode. Because of the integrated protection tube, the new electrodes had a defined reference electrode, which led to a further improvement in the measurement accuracy. This enhancement prompted an application for a type examination of the conductivity measurement systems of the SPECTOR family. The basis of the examination was provided by the draft of the now-published VdTÜV bulletin WÜ 100 *), issue date 07/2006. The approval number was already granted in 2001. From the viewpoint of many external experts, this was one of the foundations for 72h operation according to TRD 604.

With the latest product of the SPECTOR family, GESTRA AG again blazed a new trail in boiler technology.

Through the continuous surveillance of our products by the quality assurance section and our laboratories, it was found that there were repeated complaints about the quality of the measurement results yielded by the systems described above. Investigations showed that, as had already been the case in the past, the quality of the water treatment or the handling of the plant and the resulting water quality are the decisive factors affecting the quality of measurement. Deposits exhibiting various kinds of damage and impairment were submitted as part of the complaints.

If the diagram shown alongside is considered in view of the principle of conductive measurement, it rapidly becomes clear that the deposits will increase the resistance, i.e. the conductivity will appear to decrease. These results and our desire to achieve reliable and accurate measurement convinced us that we had to optimize the measurement system for the conductivity range from 500 µS/cm, as is required in industrial steam boilers, for example.
In the past, there were complaints about the quality of the measurement systems described above. Measurements taken at the site of the laboratory, the quality of the water, the resulting water quality are the decisive factors for the success of these measurements. If the diagram shown alongside is considered in this respect, it becomes clear that the deposits will increase the resistance, i.e. the conductivity will decrease.

The results and our desire to achieve reliable and accurate measurement as well as to optimize the measurement system for applications in industrial steam boilers, for example, led to the development of the new four-electrode measurement method.

For this system, the conductivity sensing electrode consists of two current and two voltage electrodes. The current electrodes are used to apply a measurement current $I$ with a fixed frequency, in this case 1 kHz, to the medium; a potential difference $U$ then arises between these electrodes.

This potential difference is sensed by the voltage electrodes and evaluated as the measurement voltage $U$. The relationship between current and voltage is proportional to the conductance. Any line resistances, polarization effects or fouling of the electrodes are compensated.

The electrical conductivity is then calculated from the measurement values $U$ and $I$ and depending on the set temperature coefficient $T_k$, is referred linearly to the reference temperature of 25 °C. After conversion into a current signal that is proportional to the conductivity, the signal is available as a current of 4-20 mA (LRGT 1x-2) or as the corresponding signal on the bus (LRG 1x-41).

The lines to the measuring electrode and resistance thermometer are checked for interruptions and short circuits; moreover, the electronic circuit board is protected against excessive temperatures in the terminal box.

The four-electrode measurement system was type-approved in 2007, also on the basis of the VdTÜV bulletin WÜ 100 (issue date 07/2006), in the combinations SPECTORcompact (LRGT 1x-2/ KS 90) and SPECTORbus (LRG 1x-41/ LRR 1-40).

In conjunction with the system enhancements in the control unit, such as:

- the possibility of selecting the temperature compensation mode as $T_k$-Manu, $T_k$-Norm or $T_k$-Auto for optimized adaptation to the water treatment,
- 24h purging pulse for the blowdown line / valve,
- integrated program-controlled intermittent blowdown with pulse repetition,
- an adjustable repetition rate for the intermittent blowdown pulses,
- temperature-compensated display of the actual value, and
- the capability of changing between three-position control (flow / speed / pressure / flow) and three-position stepping control etc.

In this way, much higher level of sophistication is achieved.

Thanks to the three-position stepping control, there is the possibility of controlling the actual TDS value of the boiler water as close as possible to the limiting value specified by the fitness for purpose or the boiler manufacturer. The result of this operation mode is an increase in the concentration factor (the relationship between the quality of the feedwater and that of the boiler water) and, associated with that, a reduction in the ensuing continuous blowdown losses.
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A reduction in the continuous blowdown losses will also help to cut costs, because less fresh water will have to be produced by the water treatment plant, heated up in the deaerator or boiler, and then later cooled down by cooling water before it is discharged to the sewerage system.

With the continuous blowdown valve MPA 46-40, we now offer – to supplement the measurement functions – a valve which has a CANopen interface in conjunction with the actuator EF 1-40. The signals for communication, driving and feedback (such as valve position, temperature in the body, blockage detection) are sent directly via the CANbus.

You too can benefit from the possibilities of modern and reliable boiler safety technology. Why settle for anything less?

GESTRA – with Energy into the Future

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<tr>
<th>Conductivity [µS/cm]</th>
<th>€ / year</th>
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<tbody>
<tr>
<td>400,000</td>
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Intermittent blowdown valve MPA 46
Continuous blowdown valve BAE 46-40

Automatic monitoring of the boiler water quality with automatic temperature compensation, signalling of max. and min. continuous blowdown and integrated alarm/interlock functions

Set point according to TRD 611/EN 12953 (6000 µS/cm)
Conductivity with continuous control
Conductivity with control of operation /open position
Conductivity with manual blowdown

Concentrations
5 10 15 20 25
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