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Translation of the publication by

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EGGER

Utilizing potentials for energy saving

Controlling the air feed to aeration basins

Uwe Pohl, Remo Biegert

A combination of thermal mass flowmeters and Iris diaphragm control valves provides the possibility to control the air feed to the aeration in a process-stable and energetically optimized way.

Considering the power consumption of a sewage plant it is obvious that the water treatment definitely is a process with a lot of potential of energy saving. Energy is mainly required to aerate the aeration basin. Any optimization of the aeration can therefore considerably influence the energy consumption and therefore also the process costs. It is necessary to consider both the process technology and the defined cleaning target.

The amount of air fed into the aeration basin is usually controlled in dependence of the solved oxygen concentration in the basin. The ATV bulletin specifies for this parameter a target value of 2 mg/l O_2. A lower concentration influences the activity of bacteria and the decomposition performance, while an excessive concentration increases the costs of air generation.

The pressurized air is generated in central generator stations via compressors and fed into the pressurized air network to supply the individual basins. Area diffusers on the floor are used to feed the air oxygen into the sewage. Control of the air feed requires measurement of both the oxygen concentration and the supply network pressure. Iris diaphragm control valves with air flow metering, installed in the feed lines to the basins, are used as control devices.

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Thermal mass flow meter for air flow

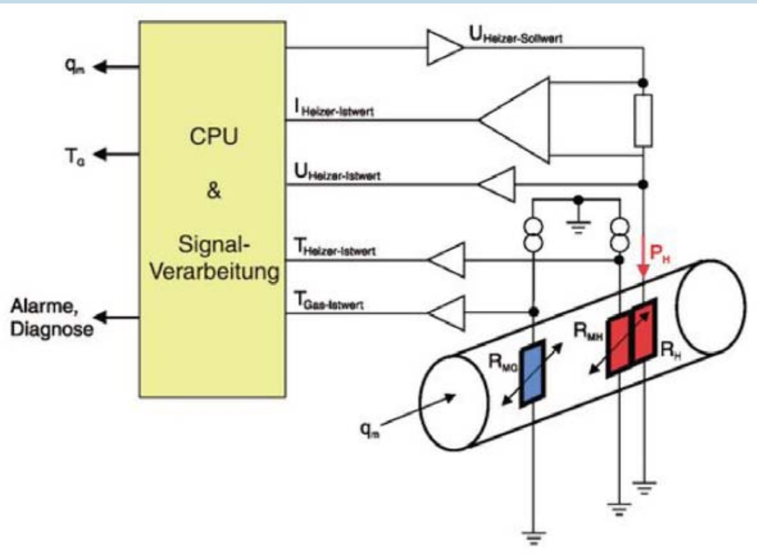
Due to their special properties, ABB Sensyflow thermal air flow meters are ideally suited for air flow metering. In addition to a large measurement range, these devices offer a low pressure loss of approx. 1 mbar. Their fast response time of 0.5 s, as well as a high measurement accuracy and reproducibility, are the basis for an ideal use in the air feed control cycle.

Thermal mass flowmeters operate on the hot film anemometer principle. Two PT100 thermal resistance sensors, centrally placed in the air stream of the pipe, are part of a bridge circuit. One PT100 thermal resistance sensor measures the temperature of the medium, while the second sensor is heated and cooled by the air flow. A control cycle provides a constant temperature difference between the two thermal resistance sensors. The heating energy thus is a measure of the air flow.

It is not necessary to additionally correct the density in case pressure or temperature is changed

The Sensyflow FMT500-IG product family for thermal mass flow measurement

because Sensyflow directly measures the mass flow. However, in case of volume mass flow meters a density correction is required, causing an increase of system error and also additional cabling and mechanical installation expenses.
Similar to all other flowmeters, device-specific smoothing sections must be foreseen before the device. In case this is not possible for reasons related to the system, a calibration can be perfor-



Measurement principle of the Sensyflow thermal mass flow meter

med under consideration of the pipeline components. The influence of the flow profile is also taken into consideration with the result of an error-free air flow measurement.
Due to the placement of the sensor in the pipe center, the device is particularly suited in combination with an IRIS diaphragm control valve. Even if the sensor is installed at a distance of just one nominal width in front of the diaphragm control valve, the measurement result will not be influenced by the degree of armature opening.

Diaphragm control valve complements sensor

The Iris diaphragm control valve manufactured by Emile Egger & Co. GmbH has a structure similar to that of previously used diaphragms. Six segments are arranged so that they form a circular opening that can be steplessly adjusted via convex/concave shaped edges sliding on each other. The segments can be pushed out of the housing completely so that there are no narrowing components in the cross section once the armature is opened. This design has the following benefits:

- Rugged design, specified for large numbers of operating cycles
- Large adjust and control range with high reproducibility (hysteresis-free)
- Energetically ideal control curve according to DIN EN 60534
- High flow capacity due to retractable diaphragm control valve
- Ideal design of flow profile due to central flow axis and rounded flow edges
- Savings in energy costs and low noise emission due to flow-optimized design

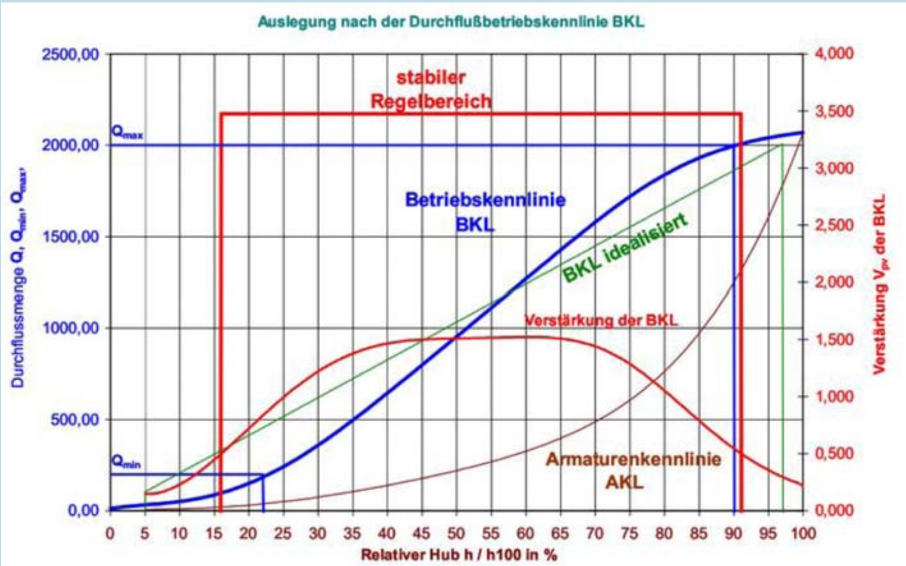
Fixed components reducing the cross section and imprecise control characteristics cause unnecessary pressure loss and energy costs. Thanks to the almost uninhibited flow and the low amount of turbulence generated at the armature, these are reduced to a minimum. Based on the basic curve of the Iris diaphragm control valve, users can control in an energy-saving manner with the largest possible opening.

Design and control characteristics of control armatures

The controllability of partial flows in a system is a physical function of the material data of the environmental conditions of the system curve of a compressor or pump's supply pressure curve and of the armature curve. The system data mentioned above is required to correctly design a control armature. To be able to display the control characteristics of a control armature it is essential to know the flow curve/armature curve. The flow curve/armature curve must be determined – according to DIN EN 60534 – using a test bed according to DIN EN 60534. At the test bed, the flows (KV values) are measured at the control armature with a constant pressure difference (1 bar), with as many opening degrees as possible at the armature. Other types of curve determination do not allow for any comparison among control armatures.
If installed, the control armature becomes a part of the pipeline system. This means that the control characteristic is not just determined by the armature curve, but also by the dynamic losses of the pipeline system, the static part of pressure in the pipeline system, total amount of pressure, ratio between dynamic pressure losses of control armature to dynamic pressure loss in the pipeline system and the required permissible pressure loss of the control armature at Q_{max}. Considering all these factors you get the operating curve of the

pressure system/pipeline system with installed control armature.
The difference to a theoretical, ideal, linear operating curve (linear ratio flow change to change of opening angle) is called gain. A system control characteristic is considered stable at gain factors between 0.5 and 2.0. The range within these limits is called a stable control area. A steadily rising armature curve is required for an uninterrupted, large (almost over the entire opening range of the control armature) and stable control area. Stable and efficient control cycles can be implemented using control armatures such as Iris diaphragm control valves.

ent of compressor control. The excellent total efficiency factor is advantageous as it remains constant even in the partial load range. The following controller equalizes pressure variations in the supply system and ensures the required air supply without any delay. The resulting savings in energy costs are highly important for sewage treatment systems.
Such control systems require the use of control armatures with highly precise control behaviour and highly precise air flow measurement with fast response times. Both requirements are ideally met both by Iris diaphragm control valves and by the ABB Sensyflow air flow measurement.



IRIS diaphragm control valve

Control characteristic: the operational curve highlighted in blue

Design of a control cycle

The oxygen controllers should be operated as cascaded control system according to DWA Bulletin M265 provided that the air flow is available as measurement value. The O_2 control signal is not used to directly trigger the operating displacement of the control armature, but it is rather used as reference variable for flow control. Using the subordinate control cycle, it is possible to considerably improve the control characteristics in terms of linearity, stability and dynamics. Pressure failures in the distribution network caused by consumers or by switching processes of the compressor can thus be quickly offset.
Due to the mass flow control, the calculated mass flow cannot be exceeded. Mass flow data are available for balancing, for energetic evaluation and for control of system outages.
The individual oxygen control cycles reach a high control quality since they are basically independent of compressor control. [continued above]

In addition to the special control features and the possibility of energy-efficient air feed, the use of a combination of IRIS diaphragm control valve and Sensyflow thermal mass flow meter provides some more benefits:

- Lower energy costs in daily operation due to the low pressure loss of the Sensyflow devices of just 1 mbar
- Easy installation and minimum cabling work when using thermal mass flow meters – just a single sensor to be integrated into the pipeline
- Combination of IRIS diaphragm control valve and Sensyflow can be used as compact unit
- Users can monitor the system and initiate targeted maintenance work of the aeration areas.

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