Efficient and economical plant operation made possible by precise control of air supply and distribution.

VACOMASS®

The modular air supply system in wastewater treatment plants

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When the biological stage of a sewage plant is undersupplied with oxygen, this will lead to process disruptions and consequently, the legally required limits for the effluent quality can be exceeded. However, if too much air is supplied, a significantly higher amount of energy is consumed, resulting in uneconomical operation of the sewage treatment plant, maybe the denitrification process becomes worse because of surplus dissolved oxygen in the recirculated water flow.

Therefore, only innovative control of the air supply and distribution according to actual demand can ensure both a controlled and economical plant operation.

The modular VACOMASS® system comprises several system components which are optimized for this application and matched to each other for precise measurement, control and distribution of air in sewage treatment plants.

VACOMASS® ensures, depending on the pollution level and oxygen requirement that controlled air is supplied according to actual demand in the various basins, zones and cascades of the plant.

VACOMASS® therefore guarantees
- optimized degradation performance
- avoidance of disruptions to plant operation
- compliance with legally required limits in the discharge and
- economical operation of your sewage treatment plant.

With VACOMASS® your biological stage is under control and energy consumption is significantly reduced.
Moving towards the biological basin, the air must overcome several static and dynamic counter pressures, e.g. changes in water level, condition of the aerators and pressure drop of the piping. These counter pressures vary in time and can only be controlled with much difficulty. Therefore, even very small changes will have a significant influence on the air distribution. This is precisely where the VACOMASS® concept can be applied: Each VACOMASS® system continuously monitors the local air supply and, therefore, can immediately detect even the smallest deviation from setpoint. The local control immediately intervenes and consequently compensates the influence of external disruptions on the air distribution. The system integration guarantees always an optimum interaction of the components and ensures the transmission of important data for the functioning of the whole control system even for complex installations.

Simultaneous flow profile correction
In the case of a compact VACOMASS® system, the thermal sensor is positioned directly upstream of the control valve. If the square diaphragm control valve with a falling flow axis is used, the flow profile will fluctuate steadily during system operation. Without correction, this will lead to errors when measuring the air supply. The information about the current valve position must be constantly exchanged in order to correct for these flow profile distortions. With this information, the flow signal, the decisive variable for precise control of the air supply, can be corrected automatically. If the VACOMASS® jet control valve is used in a compact system, simultaneous flow profile correction is not required.

Optimized operation of the control valve
Conventional controllers change the stroke of the control valve in a stepwise fashion. This inevitably leads to high switching frequencies as well as premature wear and tear of the actuator and the valve. However, the control characteristic curve of the valve and specific process data of the sewage plant are stored in each VACOMASS® electronic module. During setpoint deviations, the electronics calculates exactly the new opening position of the control valve, thus giving precise control in only a single step.

Plausibility check
Each VACOMASS® system continuously monitors the air supply and checks this value for plausibility in relation to the valve position. In this way, any disruptions, such as at the aerators, can be detected immediately. The VACOMASS® system reacts to each disruption without delay and automatically initiates appropriate countermeasures. To reduce the pressure drop on the aerators, a cyclic and selective cleaning procedure can be implemented. Thus not only efficiency of oxygen transfer can be improved but also pressure drop and power consumption can be reduced. Life time of aerators can be extended.

Redundant monitoring of the process parameters
The control of the air supply is carried out based on certain process parameters (e.g. O₂, Redox, NH₄-N, etc.). False measurements of these parameters, however, can indicate an oxygen demand which is too low thus resulting in an undersupply of activation air. In order to prevent this, VACOMASS® allows for redundant monitoring of specific process parameters. Thus, any malfunction or failure of a measuring probe can be detected immediately. For determination of the oxygen demand, only signals of the properly functioning probes continue to be considered.

Comprehensive alarm and safety functions
VACOMASS® provides comprehensive monitoring functions allowing each process disruption to be indicated immediately. Additionally, the control of the air supply can always be taken over via the process control system. Upon the occurrence of a fault, the control valve will automatically move into a safe position. In this way, VACOMASS® ensures a surplus of oxygen at any time. Consequently, a VACOMASS® installation improves significantly the operational safety of a sewage plant. Process disruptions, as well as unnecessary cost due to late detection of failures can be prevented.
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System components

The modular design of the VACOMASS® measuring and control system operates on the building block principle. Depending on plant size, control concept and specific requirements, the system components of the VACOMASS® product family can be supplied either individually or in combination with each other. The VACOMASS® system integration and precise calibration of the combined air flow measuring system in our CAMASS® Flow Calibration Lab guarantees that all components fit to each other in a perfect manner ensuring highest precision for controlling the air supply.

VACOMASS® flow meter
Thermal dispersion flow meter for precise monitoring of the air flow at standard conditions

VACOMASS® hot tapping unit
Hot tapping unit for the flow meter in different versions

VACOMASS® flow conditioner
Flow conditioner for swirl reduction, damping of pulsations and equalization of flow profile at unfavorable installation points

VACOMASS® jet control valve
Gas-tight shutoff, aerodynamically optimized stainless steel control valve with a linear working characteristic over full stroke range for highly precise air supply at lowest pressure drop

VACOMASS® square diaphragm control valve
Gas-tight shutoff, proven for many years square diaphragm control valve with falling flow axis and high-grade materials

VACOMASS® actuator
Electrical or pneumatic actuator for precise control of air supply, mounted on the control valves

VACOMASS® control cabinet
Field housing with microprocessor based electronics

VACOMASS® master
Electronic module featuring autonomous determination of the actual oxygen demand and local control of the air supply

VACOMASS® slave
Electronic module featuring local control of air supply according to external air flow setting via VACOMASS® master or the main PLC

VACOMASS® basic
Electronic module for simultaneous flow profile correction due to control valves and/or difficult piping situation

VACOMASS® econtrol
Electronic module for control and adjustment of minimum required header pressure according to actual air requirement

VACOMASS® tune valve
Hand operated diaphragm valve with measuring stub for fine adjustment of air distribution into the drop pipes of the diffuser grids

VACOMASS® damper
Reduces noise level, used in systems where the tanks have a permanent different water levels
VACOMASS® simulation
Computational fluid dynamic simulations of the real piping layout, to improve the design of the measuring and control section

VACOMASS® flexcontrol
Control cabinet with integrated SPC to monitor all relevant data of the local control loop, with all standards for data transmission, external access and further functions like biocontrol and/or blower management

VACOMASS® biocontrol
Electronic module for the control of biological processes such as the load-depending calculation of aeration time for intermittent nitrification/denitrification, load-depending calculation of the required DO-setpoint, the recirculation rate and required aerated volume

VACOMASS® blower management
Electronic module for automatic and energy saving operation of blower and compressor stations

VACOMASS® calibration
Single or system calibration, considering the real piping layout and operating conditions

VACOMASS® start-up/fine tuning
Support during installation and start-up of the system, including adaptation of control parameter to the local situation and loads by Binder Service personnel at site or via external access

VACOMASS® blow-off valve
Safety blow-off valve to prevent blower trip-out
VACOMASS®
Valves and actuators

The heart of any air distribution and control loop is the valve. It should have a linear working characteristic preferably over its full stroke and all this with a low pressure drop in the measuring and control pipe section. Furthermore, the air should exit from the valve with low turbulence, to achieve a low noise level and keep the pipe section to the first drop pipe of the aeration grid as short as possible.

VACOMASS® offers two different types of control valves:
- the long proven square diaphragm control valve in two different material versions with revised design and the new energy and control-specific superior VACOMASS® jet control valve.

VACOMASS® square diaphragm control valve – proven for many years
The VACOMASS® square diaphragm control valve has a gas-tight control gate for precise control of air with low losses. It has a falling type flow axis for sensitive control of normal and tangential air flows (e.g. after elbows) according to DIN EN 60534-2-3 and has a stable area proportional opening from 0 to 100%. The operation range on site is typically from 15 to 85% stroke.

Depending on ambient conditions at the installation site, there are different materials for the gaskets, spindle and slide plate cover. The spindle is equipped with a fully automatic lubrication system.

VACOMASS® jet control valve – for high precision
The VACOMASS® jet control valve is unique worldwide and combines aerodynamically optimized design with high-tech manufacturing. It has a central control axis and an actuator for sensitive control of air supply. The stroke adjustment is done along the axis of the flow. So the flow moves all the time along the wall and this allows a fast and high pressure recovery.

The closing element has a very low drag coefficient and requires therefore only a small driving torque. It moves with low friction and so a smaller size actuator can be used. Usually the valve can be connected directly to the pipe without additional reduction and expansion pieces.

The working characteristic of the new valve is fully linear over nearly the complete range of stroke. Due to the resulting highly precise control characteristic, smallest control steps become possible and it can be adapted to the dynamic pressure drop of the plant. The pressure drop is very low due to its flow-optimized geometry as compared to other valves. The jet control valve closes 100% gas-tight. All parts in contact with the air are made of stainless steel type A4 and therefore is practically maintenance-free.

Flow and pressure are already equalized at the outlet of the valve so that the first drop pipe to an aeration field can be placed immediately after the measuring and control section directly after the valve. This is a big advantage in refurbishment projects and will reduce tremendously the costs for pipe adaptation and improve even air distribution.

The air flow meter can be placed directly 1/2 x D upstream of the valve as this position has proven high repeatability of the flow profile. So an easy and cost-effective installation without the usual straight inlet and outlet pipe sections becomes possible.

The development was supported by a 3-D-flow simulation and parallel flow experiments in the CAMASS® Calibration Lab on a scale 1:1. Therefore, real operational conditions of a plant could be simulated. In addition to piping orientation, pipe size, pressure, temperature, air mass flow and noise level measurement, the dynamic pressure drop of a plant could be simulated. VACOMASS® jet control valve has in all stroke positions, significantly less turbulence and therefore also a lower pressure drop. This leads to a significant reduction in the operating costs.

VACOMASS® actuator
The two control valves of the VACOMASS® series can be combined with various electrical as well as pneumatic actuators taking into consideration that the drive of the actuator is optimized for the smallest steps to achieve a sensitive air adjustment.

Depending on ambient conditions at the site, there can be different requirements in corrosion protection, kind of operation, data transmission and actuating time.
Official acceptance of the VACOMASS® air supply systems for the municipal sewage treatment plant of Vienna in our CAMASS® Calibration Center. Due to the precise simulation of the field operating conditions and its piping layout during the calibration of the VACOMASS® systems, an accuracy of 1.5% of the reading could be guaranteed for the measurement of the air supply despite the difficult piping.

VACOMASS® Calibration

Only the exact calibration of an air supply system can provide a precise control of the air flow to the aeration basins of a sewage treatment plant. In order to ensure this, we simulate in detail, the operating conditions at which our VACOMASS® air supply and distribution systems will finally be operated, in our CAMASS® Calibration Center. For this purpose, the pressure and temperature conditions as well as the various flow rates that will also occur later in the sewage plant, are reproduced exactly during calibration.

In order to allow for simultaneous flow profile correction, the VACOMASS® air supply and distribution systems are mostly calibrated as a compact unit of square diaphragm control valve and flow meter. On the test stands of our CAMASS® Calibration Center, the influence of different valve positions on the raw signal of the thermal flow sensor will be determined precisely during that calibration. This data will be used to calculate the correction factors, which allow for precise air supply measurements even during fluctuating operating conditions and varying utilization rates of the sewage plant.

When using the VACOMASS® jet control valve with the flow meter positioned only 1/2 x D in front of the valve, there will be no impact on the flow signal when the stroke of the valve is changing. Only when the flow meter is directly integrated in the control valve, a compact calibration is necessary. Also when replicating the original piping, this influence can be determined and compensated for during the calibration process.
VACOMASS® Control concepts

Depending on capacity and the conditions at each plant, individual design concepts are required for controlling the air supply. In addition, the investment cost as well as the available potential for energy savings play a decisive role. By combining the VACOMASS® system components you will be able to implement individual control concepts for regulation of the air supply including suitable control. This starts with simple installations to ensure homogenous distribution, extending further to the implementation of a conventional oxygen control system, up to complex installations with local control of the air supply taking into consideration NH₃-N concentration, control of internal recirculation of sewage flow, and suitably controlled pressure level of the blower during aeration process and the load-bearing control of nitrification/denitrification time phases based on further process parameters like pH- or Redox value.

Reduction of power consumption with VACOMASS®

Cutting down the energy costs!

Approximately two thirds of the total power consumption of a sewage treatment plant are applied only for providing aeration air. VACOMASS® ensures air supply and distribution according to actual demand. Depending on the degree of utilization of the sewage plant, the control system makes an automatic adjustment of the blower pressure setpoint. Thus a VACOMASS® installation often results in power savings of up to 30%.

Lowering the oxygen concentration

Conventional control systems for the air supply intervene only after a certain time delay. For this reason, the oxygen concentration fluctuates continuously around the specified setpoint. To keep the O₂-concentration above a certain critical level, a higher setpoint must be set.

In contrast, VACOMASS® reacts immediately to any disruption and ensures a regulated air supply at all times. In most cases, the setpoint for DO-level in the aeration basins can be decreased. As a result, even at the same load, less air is required due to the smaller saturation deficit which results in lower power consumption.

Control and automatic adjustment of header pressure setpoint

When operating a plant under partial load conditions, the flow dependent counter pressures will decrease. At constant blower pressure, this is compensated by closing the control valve which results in a higher back pressure.

Instead of throttling the air supply via the valve, however, it makes more sense to provide a variable adjustment of the blower pressure according to the actual air demand. For this, the VACOMASS® econtrol monitors the current operating state of all the control valves and determines the required pressure level to maintain just sufficient air supply for the whole installation.

Lowering the compressor pressure reduces the power consumption. VACOMASS® econtrol ensures an economical plant operation.

VACOMASS® biocontrol controls the processes of nitrification and denitrification in intermittently aerated tanks. Based on further actual process parameters like pH-value, dissolved ammonia/nitrate concentration in the aeration tanks, it can be detected when the nitrification process has almost finished and aeration can be interrupted. By switching off the aeration in time, over-aeration can be prevented and energy costs will be reduced. Furthermore, the “saved” time can then be used for an improved denitrification which will then reduce the total nitrogen concentration in the effluent. In treatment plants with nitrification and upstream denitrification as well as multistage nitrification, biocontrol can determine and control the load-bearing setpoint. The amount of sewage to be recirculated, the required aerated volume and if necessary the dosing of an external carbon source. Undesirable carryover of dissolved oxygen to the denitrification tanks can be avoided or reduced depending on plant configuration.
In modern sewage treatment plants, frequency controlled rotary piston blowers and highly efficient turbo compressors are readily in use. However, the push for greater efficiency and lower energy consumption with accurate control even under fluctuating conditions is still on-going. The effectiveness of the compressed air supply depends substantially on the blower management. An effective blower management system supervises not only the operation of the individual blowers, but takes over the automatic control of several blowers simultaneously in its system.

The combination of different capacity blowers with different operation modes (frequency-controlled, pole-changeable, without regulation), of different ages and possibly from various manufacturers as well as adaptation to the fluctuating air demand are amongst others, some of the challenges faced.

VACOMASS® blower management controls the supply of aeration air at a required pressure level, so that each of the compressors run as far as possible at the optimum operating point. Thus a high efficiency and low energy costs can be realized.

Only the complete interaction of all components together make a safe and efficient operation possible, to supply the right amount of oxygen to the aeration tanks; from the compressor management to the load depending distribution of aeration air and finally to the process control of the intermittent denitrification process.

VACOMASS® components or supplied as a complete system, guarantee this in your sewage treatment plant.