

VACOMASS[®]

Technical Data VACOMASS[®] Measurement and Control System



 **BINDERGROUP**
MEASUREMENT & CONTROL

BETTER CONTROL. BETTER ENVIRONMENT.

THE SYSTEM VACOMASS®

COMPONENTS:

The design of the VACOMASS® measuring and control system operates on the building block principle. It can be used as a single component or a complete system. In the simplest case, there is only an air flow meter or a control valve being used.

The system can be a complex system of several control loops including dynamic header pressure control and further functionalities.

The **VACOMASS® system integration** and the precise calibration of the air control and distribution system in our **CAMASS® Calibration Lab** ensure always an optimum interaction of the system components and thus the highest precision for the control of the air supply at lowest possible costs.

MAIN ADVANTAGES

- modular system for optimization of air supply and improved nitrogen removal with lower energy consumption, independent of plant size, international references
- high-quality components for single use or use in a system - made in Germany
- precise air flow meter with customized calibration as a base for precise DO-control, for regular cleaning of the diffuser and further process improvements as well as replacement strategies
- unique, patented and highly precise control valves, especially developed and optimized for the use with aeration air, with much lower pressure drop in control operation proven, compared to all other available valves on the market, gas-tight closing
- specially developed advanced process controller for dynamic real-time control, can be used as an optimization tool for all common aeration processes in municipal and industrial treatment plants, very user-friendly, many options for substitute parameter and replacement strategies, easy for new installations and also retrofit projects
 - DO-control: the flexalgorithm with a self-learning & self-adjusting controller (based on AI) improves process stability, reduces significantly operation costs of the blowers, reduces operational disturbances, protects equipment (blower & diffuser) against e.g. overload
 - Advanced control of nutrient removal: described in the Advisory Leaflets of German Water and Wastewater Association DWA-A 268
 - Control of blowers: smart control algorithm (MCP) to run several blowers in a system, even with different technologies from different suppliers for stable pressure in the header pipe with lowest power consumption
 - Dynamic header pressure control – based on MOV / MIV / MDV
 - Strategies for maintenance of fine bubble diffuser: described in DWA-A 229
 - Flexible strategies for emission monitoring and reduction (based on N₂O and CH₄)
 - Further process control functionalities: for smart pump control, e.g. internal recirculation, RAS recirculation, pump control for dosage of precipitants to improve effluent quality, save energy and chemicals
 - for small installations is a classic DO-control (**flexcontrol-LITE**) available

TECHNICAL INFORMATION ABOUT COMPONENTS

VACOMASS® flow meter

Air flow meter

- based on thermal dispersion technology, for direct measurement of standard flow rate with customized calibration for best field accuracy
- robust stainless steel/ ceramic sensors made from one single bar stock
- enclosure is made of corrosion proof aluminum or stainless steel, protection class IP68
- available types: SS, AL, AL DIN, AL100, SS100
- depending on the type various inputs and outputs as well as Modbus RTU is available as a standard
- using several single sensors in a multi-point system, so precise results can be achieved even if there are flow profile distortions or big pipe sizes
- Reference for calibration: custody-transfer sensors or pipe sections in the **CAMASS® Calibration Lab** or in a DAkkS-certified Lab



VACOMASS® hot tapping unit

Hot tapping unit for the air flow meter with a ball valve:

- Standard version **OEIN-S** with flexible insertion depth
- Version **OEIN-F** for repeatable mounting position

VACOMASS® square dia- phragm con- trol valve

Gas-tight closing diaphragm control valve with actuator for precise control of air flow

with a falling flow axis and a square shaped diaphragm orifice (construction, design and manufacturing according to VDI/VDE 2173, EN 60534 und VDMA 24422)

supplied with the pre-mounted electrical **VACOMASS® actuator**, for easy replacement 1:1 of butterfly valves



VACOMASS® elliptic dia- phragm con- trol valve

Gas-tight closing air control valve with actuator for precise control of air flow

especially developed and patented for control of aeration air to control the air flow rate with 10-15 mbar only in the whole range of air flow requirements

optimized for extraordinary high air flow rates as required e.g. for diffuser flexing at comparable low pressure drop

with a falling flow axis implemented and a lenticular (elliptical) diaphragm orifice (construction, design and manufacturing according to VDI/VDE 2173, EN 60534 und VDMA 24422)

complies to all requirements described in the German Standard Paper DWA-M 229

supplied with the pre-mounted electrical **VACOMASS® actuator**, for new and retrofit projects



VACOMASS® Measurement and Control System

VACOMASS® jet control valve

World-wide unique, aerodynamically optimized control valve with a central control axis for sensitive control of air supply developed, patented and optimized for control of aeration air changes in stroke are made in/ against flow direction, flow is routed to the outside wall in order to avoid vortices, supports rapid and high pressure recovery and so leads to a very low pressure drop of the whole valve

moving body has a very low drag coefficient (only a small driving torque & actuator is required)

integrated flow conditioner for installation of flow meter directly upstream of the valve

closes gas-tight (can be used in swing zones and intermittend aeration, costs for an additional butterfly valve can be saved)

mainly made in stainless steel A4 (316), preventive maintenance free for 20 years + operation, ambient and gas temperatures can range from – 40°C up to +150°C

excellent repeatability (better than 0.2%)

complies to all requirements described in the German Standard Paper DWA-M 229

with a linear operational characteristic in more or less full operation range as best means for stable control in combination with an ideal amplification factor of nearly 1



VACOMASS® actuator

Sensitive electrical actuator for control purpose, directly connected with the valve using flanges

- With a comparable low torque for the jet control valve, due to its aerodynamically design
- Standard: AUMA SAR with high corrosion protection, 4-20 mA, thyristor control, options: control unit MATIC or AUTOMATIC, Profibus DP, Profinet, adaptive positioner
- Alternative actuators: AUMA Seven with variable speed option for pulse aeration (short time high flow), Rotork with control unit IQM, Limitorque
- Option: all other actuators can be used too, if they fit from a technical point of view



VACOMASS® tune valve

Hand-operated membrane valve for fine adjustment of air distribution (for small pipe diameters)



VACOMASS® blow-off valve

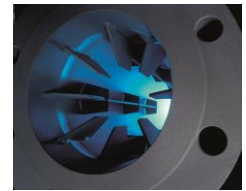
Safety blow-off valve to prevent blower trip-out



VACOMASS® Measurement and Control System

VACOMASS® flow conditioner

Flow-conditioner of different types and lengths reduce straight inlet pipe run to a few D only if piping has insufficient straight length
baffles in the inlet pipe section equalize flow and pressure distortions, flow metering becomes more precise.



VACOMASS® silencer

Used in systems where tanks have permanent different water levels or to reduce noise of flow



VACOMASS® convert

PLC-based customized electronics in a field housing or on an assembly plate, converting the 4-20 mA signal coming from a VACOMASS® flow meter to various kinds of bus signals, each field housing can be connected to one or more sensors

VACOMASS® flexcontrol

The optimization Tool with AI

modular PLC-based universal electronic modules in a stainless steel field housing or on assembly plate, contains various modules to realize DO-control, common control strategies for nitrogen removal and emission control, modules for blower control, control of further equipment like pumps, mixers etc., regular diffuser maintenance and sensor signal monitoring, which can be activated and configured customized standard: RITTAL cabinet for wall assembly, indoor/ outdoors visualization via 7, 10 or 15" graphic display (customized menus, error message screen, diagnosis, etc.)



all control parameter, damping & amplification factors are on the screen, can be changed by the experienced operator (no black box!), option: direct connection with any computer in the control room to display all menus and adjusts configurations password-protected with 3 security levels (READ ONLY viewer - READ/WRITE operator - READ/WRITE service), personalized identification via RFID technology and via user password access

data transmission to PLC (SCADA) via all common bus systems with an additional relays signal for communication error

with integrated remote dial-in via a secure VPN line (can be activated/ deactivated by the customer at any time): for fine tuning of the control parameters, for possible software updates, subsequent activation and parameterization of additional functions possible, remote maintenance, advice in the event of faults, etc.

high process reliability: monitoring of signals for signal quality and plausibility, maintenance reminder sensors, incl. function monitoring & redundancy hardware, incl. replacement parameters, emergency strategies, ...

high equipment safety, prevents compressor overload (tripping) or overload diffuser with further process-related adjustable details such as minimum air flow rate to prevent deposits, switching from continuous aeration to intermittent time phases in low-load operation, etc.

system is provided for a fixed price, no hidden license costs

There are two ways to control the valves:

Direct control of the valves

The valves are controlled directly by flexcontrol using running time (not stroke), all replacement parameters and control strategies are implemented in VACOMASS® flexcontrol.

Indirect control of the valves

All calculated stroke values of the control valves are recommendations, transmitted to the SCADA, SCADA can accept or overwrite, all replacement parameters and control strategies are programmed in the SCADA.

Overview Functions for control of air supply and air distribution

- **Air flow-based DO-control with a fixed DO-SET value - in combination with air flow meter for continuous aeration processes**
Type: VACOMASS® aeration controller-DO
Dynamic load-dependent calculation of the current air flow requirements for local control of the air supply based on a DO-ACT and DO-SET concentrations as well as the related valve stroke in real time, including automatic adaptation to high and low load phases and seasonal influences, using AI in a PIID closed control loop
 - **Classic DO-control with a fixed DO-SET value for small installations – without air flow meter, max. 4 valves in the system with a max. size of DN100**
Type: VACOMASS® aeration controller-DO LITE
Dynamic load-dependent calculation of the currently required stroke of the valve in real time, including automatic adaptation to high and low load phases and seasonal influences, using AI in a PIID control module, released for small plants
 - **Control of the valve's stroke based on AIR FLOW- SET - in combination with air flow meter for continuous aeration processes**
Type: VACOMASS® aeration controller-Q
Calculation of the required stroke of the valve based on a SET value of air flow rate, which is calculated and transmitted by another control loop or in the SCADA, considering the operating characteristic of the control valve and the current process situation (pressure in the manifold, ...), can be used for NEREDA® process
 - **Switch from continuous aeration to intermittent aeration at low load**
Type: VACOMASS® biocontrol-L
Monitors air flow demand and controls the switch from continuous to intermittent aeration with fixed time cycles and fixed air flow rates during off-peak periods, reduces energy consumption, while improving mixing, preventing deposits of sludge and carry-over of dissolved oxygen into anoxic zones (e.g. upstream denitrification)
 - **Switch ON/ OFF aerated fields in ditch shaped/ carroussel tanks**
Type: VACOMASS® VAer-SET-Flex
Calculation and adjustment of the aerated volume in carroussel tanks by switching butterfly valves of single diffuser grids (CLOSED/OPEN), based on actual process situation of DO/ NH₄-N/ NO₃-N/ P, incl. compensation of seasonal influences, increases process stability or allows to run the system in a compromise of effluent concentrations NH₄-N/ NO₃-N, operation of diffuser with high SOTE, incl. optimization of P-elimination or reduction of precipitant by avoiding re-dissolution of phosphates
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Overview Functions for control of aerated time phases ON/ OFF in intermittently aerated processes

- **Control of the air supply - in combination with air flow meter in intermittently aerated plants**
Type: VACOMASS® aeration controller-ID
Calculates 1. the time cycles Aeration ON/OFF either based on fixed times or dynamic & load-dependent, uses all available process information (e.g. DO/ NH₄-N, NO₃-N, ORP, ..., also available for SBR processes)
Calculates during aeration phase 2. the currently required air flow rate based on a DO-ACT and DO-SET concentrations as well as the related valve stroke in real time, using AI in a PIID closed control loop
Incl. dynamic control of the LAG phase
Can be combined with DIFF-MIX pulse aeration and with EQUIPSET-FLEX for START/ STOPP of mixers (smart control to save energy and prevent sedimentation of sludge)
- **Control of pulse aeration in non-aerated process phases**
Type: VACOMASS® DIFF-MIX
Pulse aeration for aeration pauses to maintain mixing if no mixers are installed in intermittently aerated tanks, based on a SET value air flow rate and fixed time sequences (a variable speed actuator is recommended to use, to keep air supply during pulses in the denitrification phase as low as possible).
- **Intelligent control of mixers in non-aerated process phases or other equipment**
Type: VACOMASS® EQUIP-SET-Flex
For e.g. smart control of mixers in the non-aerated process phases, with time-delayed energy-saving start after end of aeration phase & stop mixer before valve starts to open to prevent gear damages to the drives
For e.g. smart control of a pump to bypass primary clarifier, if C:N ration in the biological step is not favorable for biological denitrification process
For e.g. control of small drainage valves in diffuser grids, to remove condensate on a regular time base

Overview Functions for advanced biological nutrient removal, monitoring, control and reduction of GHG-emissions

- **Calculation and control of dynamic load-dependent DO-SET value**
Type: VACOMASS® DO-SET NH₄-N
Calculation of the currently required DO-SET concentrations for an adequate air supply based on the actual NH₄-N, prevents over-aeration and carryover of dissolved oxygen into the anoxic/ denitrification zone, directly reduces the total nitrogen in the system effluent, reduces energy costs significantly
DO-SET is calculated depending on the positioning of the sensors as
FEEDFORWARD CONTROL: measures/calculates the load at the inlet e.g. in kg/hr
FEEDBACK CONTROL: measures the concentration in mg/l in the tank/ zone outlet, optionally after 2/3 to ¾ of the flow path in the aeration line
FEEDFORWARD CONTROL-FEEDBACK MONITORING: calculation of DO-SET based on inlet load and monitoring of the concentration in the effluent, if necessary, damping/ amplification of the DO-SET

- **Monitoring and reduction of N₂O-production**

Type: VACOMASS® DO-SET N₂O

This is a new application. It is known from literature and measuring series, that too low DO-concentration in the aeration tanks in relation to the actual N-load (under-aeration) but also dissolved oxygen in anoxic zones (over-aeration) will lead to increased formation of N₂O. Due to its high GHG potential, more and more often (depending on country-specific situation) formation is monitored and should be reduced. Dissolved N₂O-concentration can be measured with a submerged sensor. Information can be used to recognize the tendency of formation. Really emitted N₂O can be analyzed with the help of a gas analyzer: air is taken from a swimming measuring hood with a known bottom area, placed in different zones of aeration lines. A combination with actual air flow rate allows a calculation of the real emission in kg/hr.

Signal of concentration or load must be transmitted from SCADA to flexcontrol. A flexible function is available to adjust the DO-concentrations as follows:

If N₂O increases in the first aerated zones (under-aerated) – increase DO.

If N₂O in the anoxic zone increases (over-aerated) – lower DO in the last aerated zone.

Damping/ amplification factors must be defined by the operator and can be adjusted at any time.

- **Optimization of load distribution in multi-stage plug flow tanks**

Type: VACOMASS® DO-SET KASK

Automatic adjustment of the DO-SET concentration in multi-stage plug flow nitrification tanks, improves load distribution to the zones, prevents over-aeration in the last zone and carryover of dissolved oxygen into the anoxic zones during off-peak periods, reduces the N_{tot}-concentration in the outlet and reduces energy consumption

- **Event-based adjustment of the aerated volume in swing zones during increased load times or e.g. colder water in winter season (reduced biological activity)**

Type: VACOMASS® VAer-SET

Calculates and adjusts the (usually upstream to permanently aerated ones) aerated volume in flexible/ swing zones, based inlet loads NH₄-N for high load phases or too poor cleaning performance, but also summer/winter seasons

Implementation of air flow-based DO-control to follow DO-SET (**VAer-SET-DO**) or in small tanks without DO-sensor follow a fixed air flow rate-SET (**VAer-SET-Q**)

Improves process stability and increases nitrification performance

- **Event-based control of other machines & units**

Type: VACOMASS® EQUIP-SET-Flex

Calculates START/ STOP (not control) other mechanical elements and machines such as mixers, pumps, drainage valves etc. based on events

Overview Functions for control of recirculating water flows and dosing chemicals

- **Control of the internal recirculation**

Type: VACOMASS® IntRezi-SET

Controls the internal recirculation rate based on actual nitrate concentration (preferred in the outlet of last permanent anoxic zone, but can be also in the recycle flow)

Reduces the dilution of the wastewater in the anoxic zones during off-peak periods

Increases the retention time in the anoxic zone and thus improves biological nitrogen removal (lower the N_{tot} concentration in the plant outlet)

Reduces energy consumption (oxygen from nitrate can be used for BOD removal)

- **Control of return sludge and excess sludge removal**

Type: VACOMASS® RASRezi-SET

Calculates the RAS recirculation rate of actually required return from the secondary clarifier back to the inlet of the biological stage

Version 1: Based on the current hydraulic inlet situation (fixed customized factor)

Version 2: Based on the sludge blanket level in the secondary clarifier and currently required MLSS concentration in the aeration tanks the removal rate of excess sludge is calculated (or any other customized formulation)

Improves process stability and biodegradation/nutrient removal as well as reduces energy consumption for aeration

- **Load and concentration-dependent dosing of an external carbon-source**

Type: VACOMASS® CDos-SET

Controls the dosing of an external C-source, if the nutrient ratio is unfavorable, the demand can be high or generally for downstream denitrification - various strategies possible

Depending on the positioning of the sensors

FEEDFORWARD CONTROL: analyzer and dosing point only in the denitrification

FEEDBACK CONTROL: analyzer and dosing point in the aeration outlet

FEEDFORWARD CONTROL-FEEDBACK MONITORING: analyzer and basic dosing in the inlet, additional analyzer in the outlet, damping/ amplification factor can be applied if required

FEEDFORWARD CONTROL-FEEDBACK CONTROL: analyzer and basic dosing in the inlet, analyzer and final dosing in the outlet, if necessary - otherwise adjustment of the basic dosing quantity based on the measurement result in the aeration outlet

- **Load-dependent dosing of precipitants to reduce P-concentration in the effluent**

Type: VACOMASS® PDos-SET

Controls the load-dependent dosing of chemicals according to requirements in the effluent and current demand - various strategies possible - see CDos-SET

Overview Functions for control of blowers

- **Dynamic header pressure control**

Type: VACOMASS® econtrol

Calculation and transmission of the recommended pressure in the header pipe (**econtrol-p**) or the required air flow rate (**econtrol-Q**) or blower's frequency for systems with only one blower (**econtrol-F**)

The SET value is calculated depending on the current air flow demand, based on the MOV (most open valve) principle, taking into account the MIV (most important valve) and MDV (most demanding valve), to reduce energy consumption at partial load without compromising process safety

Precise pressure and temperature sensors can also be supplied on request

- **Energy-optimized organization of the operation of several compressors in a group (compressor control)**

Type: VACOMASS® econtrol blower

Dynamic control of the combined operation of several compressors of different sizes and designs with simultaneously high energy efficiency or the same operating hours, based on the current energy efficiency characteristics (fields) of the compressors

Subsequent expansions easily possible, increased process reliability (consideration of minimum running and cooling times, etc.)

Including safety fallback levels and replacement algorithms for high operational reliability

There are two ways to control the compressors:

- *Direct control* of the compressors with hardware extension
- *Indirect control* of the valves as a pure software solution

Overview Functions for signal monitoring and maintenance sensors & diffuser elements

- **Monitoring of the signals used for DO-control**

Type: VACOMASS® SENS-CHCK

Monitoring of the signals from the sensors used for control for presence (incl. replacement value strategy), plausibility (measured value range) and signal quality (detection of frozen or suddenly jumping measured values) as well as maintenance reminders (cleaning, replacement of wearing parts), incl. alarm transmission to SCADA

- **Long-term monitoring of diffusers pressure drop**

Type: VACOMASS® DIFF-CHCK

Monitoring of diffusers for increase in pressure loss / reduction in air volume flow at a fixed pressure and opening of the control valve

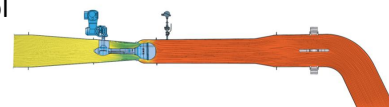
to detect the need for cleaning (increase in flexing/pressure relief cycles or need for chemical cleaning or replacement of diffusers)

incl. alarm transmission to SCADA

- **Mechanical cleaning of the diffusers by air purging (flexing)**
Type: VACOMASS® DIFF-FLEX
 Flushing mode for diffuser elements (flexing), cleans the diffusers by implementing a specific air flow rate for a specific time, at defined intervals (implementation of the manufacturer's specifications)
 cleans only one control loop at a time, if possible, without increasing the header pressure
 demonstrably reduces the pressure loss of the diffusers
 improves the bubble pattern / oxygen transfer efficiency
 reduces directly the required air flow rate & energy consumption
- **Mechanical cleaning of diffusers by pressure relief**
Type: VACOMASS® PRESS-REL
 Used to implement pressure relief of diffuser elements (implementation of manufacturer's specifications)
 closes the control valve at defined time intervals
 incl. signaling CLOSED to the SCADA, SCADA will control the solenoid valves
- **Chemical cleaning of the diffusers by dosing acid**
Type: VACOMASS® DIFF-CLEAN
 Cleaning cycle for diffuser elements with acid
 cleans the diffusers by dosing a defined amount of acid in relation to a specific amount of air for a certain time
 with manual start, if possible, without increasing the pressure in the header pipe

VACOMASS® simulation

CFD-simulation of flow in the piping section with control valve and flowmeter, considering detailed installation situation, piping geometry, further installations in the inlet and outlet pipe run



VACOMASS® calibration

The VACOMASS® calibration module is the integration of all individual components under simulation of the real plant conditions in the **CAMASS® Calibration Lab** for system integration. The air flow meter is calibrated by simulating the operating conditions (blower pressures, operating temperatures, load conditions, etc.) to achieve best measuring accuracy not only at the Calibration Lab but also under site conditions.

Level 1: Standard calibration as a single flow meter, if sufficient straight inlet and outlet pipe sections are available.

Level 2: Calibration compact installation, flow meter is placed directly in front of the control valve, not sufficient straight inlet and outlet pipe run available, with simultaneous flow profile compensation/ air flow compensation depending on the type and stroke of the **VACOMASS® control valve**.

Level 3: Calibration of the flow meter together with a **VACOMASS® flow conditioner** as a compact unit of flow meter, flow conditioner and possibly the control valve.



Level 4: Calibration of flow meter and control valve if there is a very small straight inlet and outlet pipe run only, done completely with the control valve and a piece of original pipe run.

Level 5: Calibration is carried out customized, e.g. at an external 3rd party test bench etc. (e.g. DAkkS-accredited or be recalibrated by PTB).

Level 6: If straight pipe run is very short and/or if pipe diameter is big and/or if requirements on accuracy are high, a multiple sensor calibration is used to improve accuracy of flow reading. Calibration is customized and considers all conditions at site.



VACOMASS® FAT Test	Customized Factory Acceptance Test of supplied equipment or system with presence of end user/ contractor/ consultant in Ulm, depending on the contract e.g. pressure drop of the valve at typical air flow rates and related strokes in measured to confirm warranted data / function of full system is checked incl. data transmission system, also available as VACOMASS® FAT Test REMOTE
VACOMASS® start-up	Technical support during start-up phase and commissioning by Binder specialists, available as VACOMASS® start-up SITE or VACOMASS® start-up REMOTE
VACOMASS® fine-tuning	Technical support/ fine-tuning of control parameters in the control system based on local conditions by Binder specialists after start-up or also during operation on demand, available as REMOTE

INVESTIGATION OF POTENTIAL IMPROVEMENT

We analyze the actual situation regarding available hardware blowers, valves, flow meter, diffuser,...) and control performance.

Based on the results, we develop together with the customer, special control strategies based on local situation related to the number of aeration tanks and their geometry, scope of supply (integration of existing equipment if possible, from technical point of view) and process requirements on the **VACOMASS® system**.

IMPRINT

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VACOMASS

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