

Making sure your WWTP runs and runs and runs

Efficient and effective wastewater treatment

The perfect ingredients for operation and maintenance of your WWTP

Optimum instrumentation:

Specialized analytical devices make your work easier, ensure the reliability of your processes and outlet values and help to reduce costs.

Plant maintenance with added value:

Perform sensor maintenance in the comfort of the lab, thus minimizing time spent in the field exposed to the elements.

Smart automation:

The Liquiline Control gets phosphate and nitrogen under control.

Customized solutions:

Bespoke measuring cabinets and containers provide space for anything needing protection.

Strong partner:

With measuring technology, consulting and service available from a single source, the operation and maintenance of your plant is straightforward and future-proof.



Fresh ideas for your wastewater treatment process

Even the ancient Romans were aware of the interrelation between wastewater and fresh water. They built viaducts to make fresh water sources located outside of the city available to the city. However, they also built the "Cloaca Maxima", a canal in the heart of Rome, which transported wastewater from the Forum Romanum into the River Tiber.

Nowadays, wastewater is treated prior to discharge into rivers and other surface waters, and this is done in accordance with legally prescribed outlet values. Compliance with these values protects the environment and our drinking water supplies and is therefore of paramount importance.

As a result, wastewater treatment has become a complex task. Not only is it necessary to maintain optimum conditions for the bacteria in the biological treatment phase and to figure out the correct precipitant dosage, there is usually also a requirement to reduce pollutants and nutrients as cost-efficiently as possible. At the same time, the plant must be able to cope with fluctuating levels of influent, depending on the weather, the time of year and the wastewater-producing companies in the catchment area, for example. Furthermore, industrial WWTPs often handle loads that require chemical rather than biological treatment.

These are all conditions that the operator and staff of the WWTP have to contend with, for example when maintaining measuring technology in all kinds of weather, when resolving faults in the middle of the night (emergency standby service) and when regulating oxygen and Co levels across a wide variety of loads. There is also the emergence of megatrends, such as the increasing scarcity of drinking water brought about in part by the rapidly increasing global population. Purified wastewater will therefore have an increasingly important role to play as a source of drinking water and industrial water. This calls for even stricter limit values for outflow water and creates and even greater need to operate wastewater treatment processes in a manner that is safe and trouble-free.

Take a look at the following pages to find out about the Memosens and Liquiline devices that have been specially developed with wastewater treatment in mind. Not only do they make your work at the WWTP easier, they also guarantee the reliability of your processes and outlet values and help to save costs. And if that isn't enough, take a look at the Liquiline Control automation solutions. They independently regulate your plant based on the incoming load, optimize the decomposition of pollutants and nutrients and offer exciting innovations such as remote control by tablet and smartphone.



Memosens and Liquiline – a dynamic duo for your WWTP

The Liquiline platform forms the basis for our transmitters, samplers and analyzers. With these devices, you can monitor, control and regulate your entire wastewater treatment process. Benefits include the convenient, standardized operation of all devices throughout your entire plant and the protection of your process against operating errors. And since we use same standardized hardware in all of the devices, you also benefit from a straightforward, cost-effective spare parts inventory. Furthermore, you can easily upgrade our Liquiline products to include relays, sensor inputs or fieldbuses, for example, ensuring flexibility for years to come.

A core component of the Liquiline platform is digital Memosens technology. Sensors equipped with Memosens technology store a wide range of data directly in the sensor head. This includes information such as sensor type, serial number, calibration results (e.g. slope and zero point) and much more. Liquiline devices can therefore automatically detect any sensor within seconds and adopt the saved data for use in operation. This is true plug and play functionality that makes your work easier and minimizes interruptions to measurement during sensor maintenance.



The cutting-edge
sensor technology

Memosens digitizes the measured value in the sensor and sends it to the transmitter via a non-contact, disturbance-free connection. Since its introduction in 2004, it has become the leading global standard in liquid analysis. A broad portfolio of Memosens products has been helping to improve the safety, efficiency, transparency and quality of processes in all industries ever since.

- 100% reliable: digital data transmission via inductive, corrosion-free bayonet lock
- Sensors easily connected
- Sensor head stores calibration and sensor information for predictive maintenance
- Plug and play with precalibrated sensors increases process and measurement availability
- International standard



Overview of Liquiline platform

- Hardware components and operating concepts are standardized across all transmitters, analyzers and samplers in the Liquiline series
- Ability to connect up to 8 sensors for different parameters
- Automatic sensor detection saves times during commissioning and when replacing worn sensors
- Control functions, e.g. precipitant dosing, oxygenation during sludge activation, disinfection of outflow water or sludge thickening
- Seamless integration into any process control system (PCS) via 0/4 to 20 mA, HART, PROFIBUS DP, Modbus RS485, Modbus TCP, EtherNet/IP
- Integrated web server enables remote access from any location, also via tablets and smartphones
- Easily extensible thanks to standardized hardware



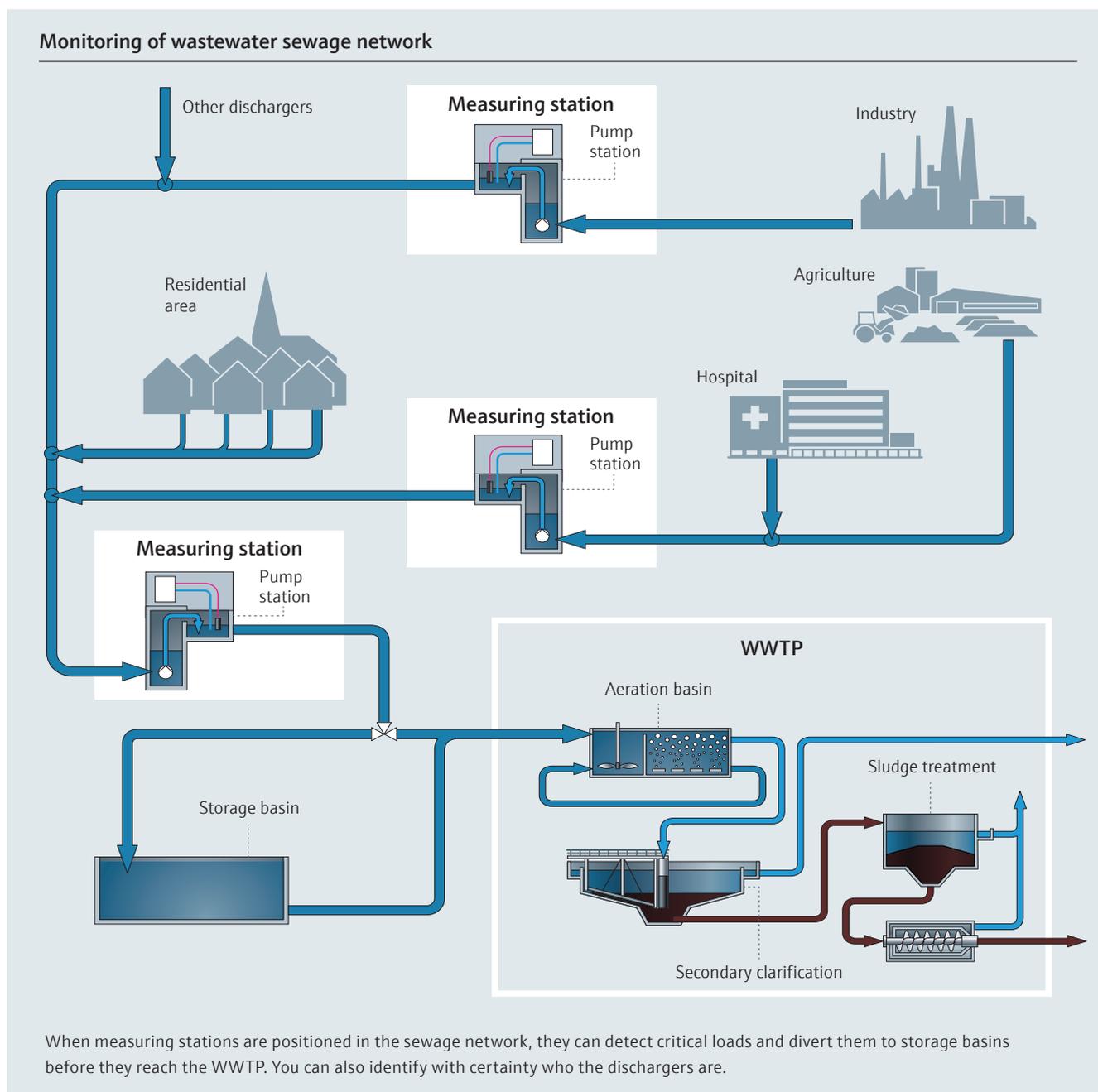
Advance detection of critical loads

If the measuring station is installed upstream from the WWTP inlet or in the sewage network, it will detect critical loads before they reach the plant. High loads can then be redirected to retention basins in good time and fed into the water treatment process in controlled amounts. This enables your process to run in a more stable and therefore more efficient and effective manner. Incidentally, the diversion of loads can be completely automated.

Convenient and quick: remote access from anywhere

The Liquiline platform offers you the widest range of communication options available on the market. This not only makes for easy integration in your process control

system, it also provides you with convenient remote access to the devices via the various fieldbuses and the integrated web server. You can therefore monitor all of the analytical measuring points at all times – from the control room as well as from outside the plant, e.g. during emergency standby service. Should a problem occur in the process, you can evaluate its urgency remotely. Does the problem need to be resolved immediately on site? Or can you wait until tomorrow to go on site? If you were to change a few parameters remotely, e.g. manipulated variables, would that eliminate the need for a site visit? You are therefore much less dependent on weather conditions and can avoid call-outs in the middle of the night and in extreme weather.



When measuring stations are positioned in the sewage network, they can detect critical loads and divert them to storage basins before they reach the WWTP. You can also identify with certainty who the dischargers are.

Plant maintenance with added value

Time is often in short supply when it comes to the day-to-day running of a WWTP. This applies even more to unmanned plants where staff visit the site only occasionally to carry out maintenance. From pH to solids, all sensors with Memosens technology can be precalibrated or preadjusted in the lab or factory. Since all of the important data including calibration information are stored in the sensor, there is no need to carry out maintenance on site. Instead, simply connect your own ready-to-use sensors.

In this way, plant maintenance and sensor calibration can be physically separated and performed at different times. This improves the quality and reliability of your process enormously and makes for more efficient maintenance.

Quality leap in sensor maintenance

Performing conventional sensor maintenance activities at the basin rim can leave you exposed to the elements. In certain types of weather, this is not only inconvenient but also affects the quality of the maintenance work and therefore the quality of the sensor's measured values. For example, if an analog pH sensor is detached from the cable while it is raining, its metal contacts may get wet and lead to a faulty measured value. And if the slope of an oxygen sensor is adjusted in air, exposure to bright sunlight or

strong winds may cause the sensor to heat up or cool down. This results in an incorrect adjustment and therefore incorrect measured values.

Performing maintenance in your lab or factory allows you to create constant conditions – without any external influences. This increases the quality of the calibration and therefore the accuracy of your sensors. And it also happens to be more convenient for you.

Maintenance you can schedule

Sensors prepared in this way can then be put into use at a time that suits you, e.g. during an scheduled planned maintenance activity. You simply take the sensors you replaced with you and prepare them at the next opportunity in your factory so that they can be used the next time a replacement is required. This type of maintenance strategy enables you to avoid measuring point failures, reduce unplanned call-outs in the field and therefore save considerable time and money. In the unlikely event of a failure, simply use a prepared sensor to get the measurement back up and running again. Since replacing a sensor in Liquiline devices is extremely easy, it can be done by staff members without any knowledge of analytics.



Reliable sensor cleaning

Automatable cleaning options add the finishing touch to the Memosens Liquiline team. A nozzle attached to the sensor head sprays the sensor with compressed air or water and an additional cleaning fluid if desired. This is a reliable way to prevent buildup on the sensor and ensures long and trouble-free operating times. It also eliminates the need for moving parts, such as wipers, in your process. Incidentally, this type of cleaning is suitable for all process stages and can be used even in fatty media.

The cleaning process is controlled by your Liquiline device. You can specify fixed time intervals and also stipulate that cleaning be performed in between times should the sensor become soiled. In this case, the Liquiline device receives a signal from the sensor that triggers the cleaning function.

Automated operation

With the available controllers (e.g. precipitant dosage), automatic sensor cleaning function and maintenance activities that can be planned, there is no reason why you cannot automate your wastewater cleaning process. You can even adjust the level of automation to suit your precise needs. It's just as feasible to automate the diversion of critical loads to retention basins as it is to set up an unmanned plant.



Air cleaning system of the Turbimax CUS52D turbidity sensor

Our Memosens sensors and Liquiline transmitters, analyzers and samplers actively support you in your daily work. It has never been easier, more convenient and safer to treat wastewater efficiently and to comply with outlet values.

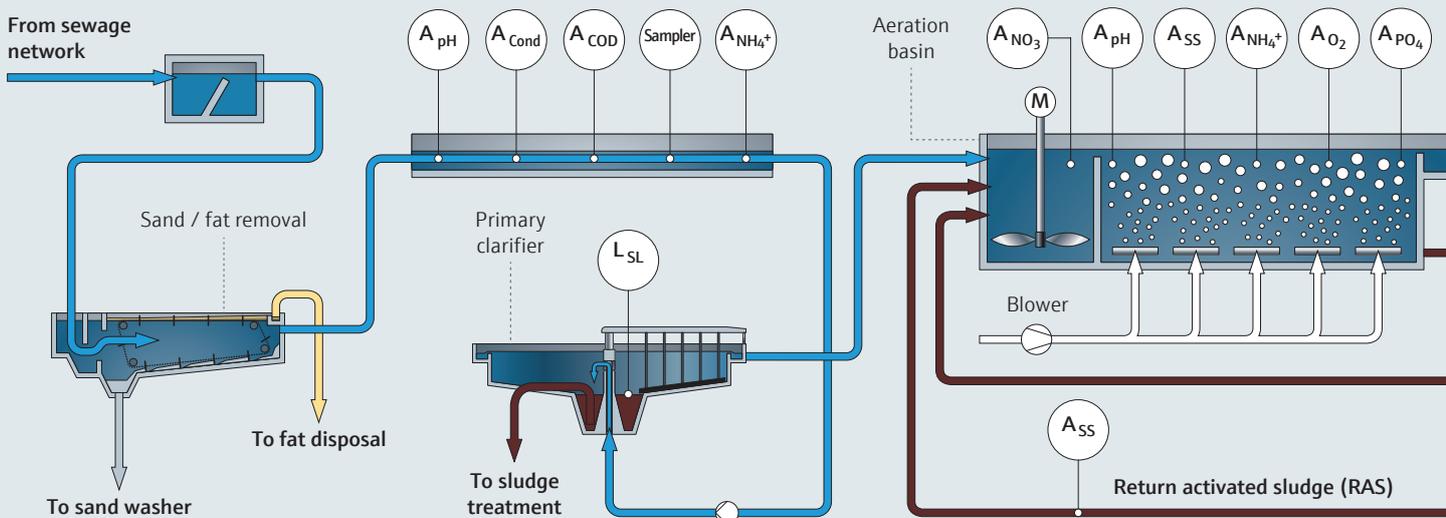
Why not give it a try?



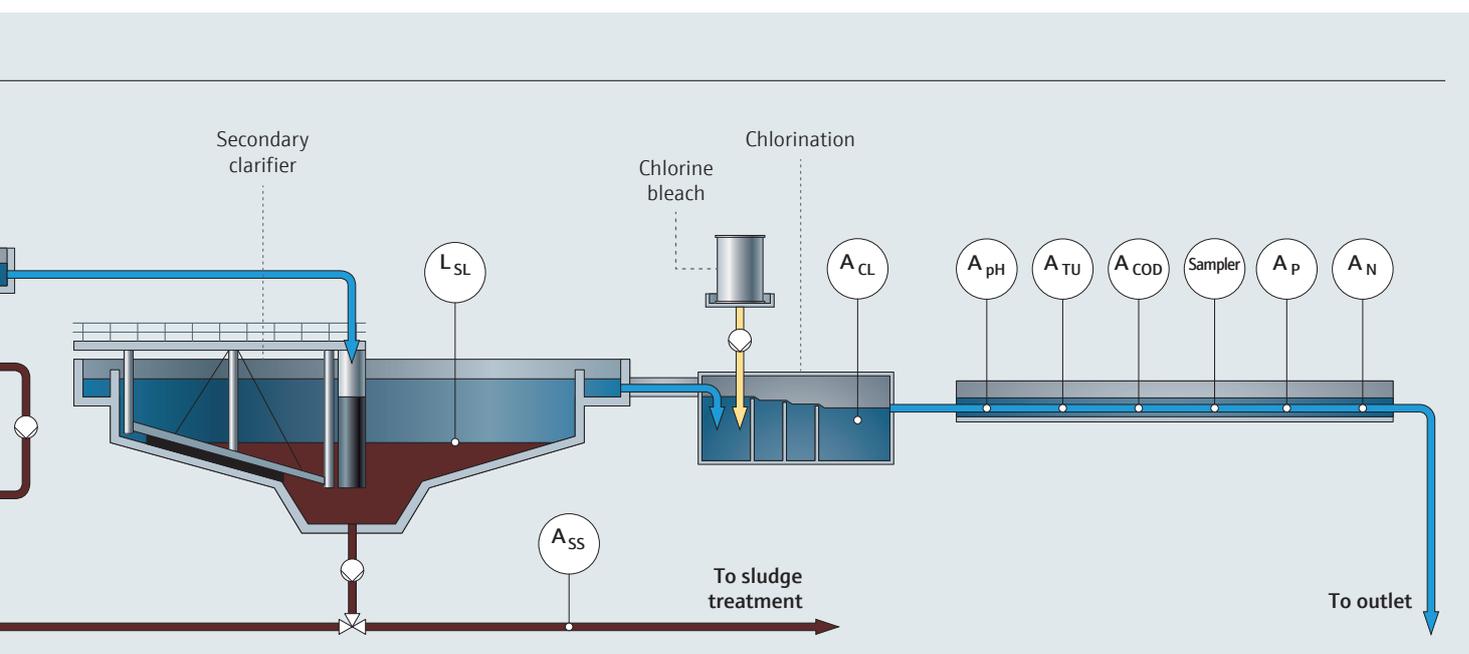
Products and solutions for all analytical measuring points in WWTPs

Inlet	Instrument	Information
pH	CPS11D	Robust sensor for all measuring points
Conductivity (Cond)	CLS50D	Particularly dirt-resistant sensor
COD	CA80COD CA72TOC CAS51D	Colorimetric COD analyzer High-temperature TOC analyzer Optical COD _{eq} sensor for trend identification
Ammonium (NH ₄ ⁺)	CA80AM CAS40D	Colorimetric ammonium analyzer Ion-selective sensor for trend identification
Sampler	CSF48	Automatic sampler
Primary and secondary clarification	Instrument	Information
Sludge level (SL)	CUS71D	Sensor for determining sludge deposit zone
Biological treatment	Instrument	Information
Nitrate (NO ₃)	CAS51D CAS40D	Optical sensor with longterm stability Ion-selective sensor for trend identification
pH	CPS11D	Robust sensor for all measuring points
pH/ORP	CPS16D	Combined pH/ORP sensor
Suspended solids (SS)	CUS51D	Low-maintenance, dirt-resistant sensor
Ammonium (NH ₄ ⁺)	CAS40D	Ion-selective sensor for trend identification
Oxygen (O ₂)	COS61D	Optical sensor for oxygen control
Orthophosphate (PO ₄)	CA80PH	Colorimetric orthophosphate analyzer
Chlorination / disinfection	Instrument	Information
Chlorine (CL)	CCS120	Total chlorine sensor for free and combined chlorine

Overview of analytical measuring points in a WWTP



Outlet	Instrument	Information
pH	CPS11D	Robust sensor for all measuring points
Turbidity (TU)	CUS51D CUS52D	Sensor with wide measuring range Sensor for low turbidity (e.g. industrial water)
COD	CA80COD CA72TOC CAS51D	Colorimetric COD analyzer High-temperature TOC analyzer Optical COD _{eq} sensor for trend identification
Sampler	CSF48	Automatic sampler
Phosphorus (P)	CA80TP CA80PH	Colorimetric total phosphorus analyzer Colorimetric orthophosphate analyzer
Nitrogen (N)	CA80AM CAS51D	Colorimetric ammonium analyzer Optical nitrate sensor with longterm stability
Sludge treatment	Instrument	Information
Suspended solids (SS)	CUS51D	Low-maintenance, dirt-resistant sensor
Solutions and accessories	Instrument	Information
Measuring cabinet / container	As per customer specificat.	Turn-key solutions for all measuring tasks
Automation solution	Liquiline Control	Control of nitrogen and phosphate elimination
Transmitter	Liquiline CM44	Multi-parameter device with up to eight channels
Sample preparation	CAT810, CAT820, CAT860	Filter systems for analyzers of CA80 series
Measured value simulator	Memocheck Sim CYP03D	For quick and easy commissioning
Sensor management software	Memobase Plus CYZ71D	Measuring, calibration and documentation software
Asset management software	W@M	Life cycle management
Holder + immersion assembly	CYH112 + CYA112	For installing sensors in open basins
Standards and buffers	CPY20 / CPY3 COY8 CAY40	pH buffer / ORP buffer Gel for oxygen zero-point calibration Reference liquid for CAS40D (NO ₃ and NH ₄ ⁺)



The perfect formula for your WWTP: increased effectiveness, reduced costs

The ultimate goal of any WWTP is to treat wastewater in such a way that only clean water is released into the environment. If the wastewater is still contaminated with nutrients, this leads to eutrophication of the downstream surface water, thus causing excessive algae growth (see information box on right).

The volume of nutrients, such as phosphorus and nitrogen, that reach the inlet of a WWTP is referred to as the "nutrient load". For wastewater to be classed as "clean", this load must be reduced. Phosphorus is removed from the wastewater by adding precipitants, which can be dosed at various different points. However, phosphorus cannot be completely eliminated; only the proportion that is present in the form of phosphate can be removed. The phosphorus value is used to monitor the WWTP outlet while the phosphate value is used to control precipitation. Nitrogen is reduced in the biological phase of the WWTP by means of nitrification and denitrification.

Challenges of phosphate precipitation

Iron salts or aluminum salts are the precipitants usually used. If the dosage is too high, this can increase the salinity of the biology and result in increasing sludge volumes. Too much salt increases the number of ions in the water, which in turn changes the pH value and can ultimately lead to

i What is eutrophication?

The term eutrophication describes when water bodies become excessively enriched with nutrients (in particular phosphorus and nitrogen), causing a shift in the biodiversity. This oversupply of nutrients causes rapid algae growth, which in turn leads to a change in the oxygen content of the water.

Initially, the algae produce an oversupply of oxygen, while reproducing at a rapid pace. This continues until the algae no longer have a sufficient supply of nutrients. The algae then stop producing oxygen and die off in large numbers, thereby depleting any remaining oxygen in the water. This leads to the loss of other living organisms, e.g. fish, crabs, plants, etc., due to an inadequate supply of oxygen. The water turns green.

corrosion of the system. Higher sludge volumes mean increased disposal costs. Last but not least, overdosing means that the precipitant, which is usually very costly, goes to waste.



The orthophosphate analyzer, Liquline System CA80PH, provides reproducible measured values for reliable precipitant dosage.



With the ISEmax CAS40D ion-selective sensor, you can measure ammonium and nitrate directly in the aeration basin. This enables nitrogen reduction in the biological phase to be controlled based on load – and the process to be optimized.

The EU Water Framework Directive (WFD) specifies environmental objectives for surface waters that have a direct impact on the outlet values of WWTPs. The limit values for phosphorus in the outflow are dependent on plant size and typically range between 1 and 2 mg/l. If required by the local conditions, e.g. if the effluent from the WWTP is discharged into sensitive waters, the limit values may be significantly lower.

Full control of phosphate precipitation

If precipitant dosage is optimized, the potential for savings can be significant. The dosage is at an optimum level if your plant reliably adheres to the limit value but does not use more precipitant than required. How do we optimize phosphate precipitation? It can be done, for example, by using the Liquiline Control to automate the dosage. This involves a controller that doses the precipitant in accordance with the actual load and your individual phosphorus limit value. This results in phosphate precipitation that is reliable and easy on resources.

Challenges of nitrogen reduction

The main components of nitrogen are ammonium and nitrate. In the biology of the WWTP, bacteria convert the ammonium to nitrate through the addition of oxygen (nitrification). This continues until there is (almost) no ammonium left. Other bacteria then convert the nitrate to

molecular nitrogen (denitrification). This simply escapes into the atmosphere and is therefore eliminated from the wastewater. Incidentally, no more oxygen is added during the denitrification process. This to ensure that the bacteria consume the oxygen present in the nitrate.

The key issue is to establish when and how much oxygen is required for nitrification in order to achieve an optimum level of nitrogen reduction. The oxygen is injected into the aeration basin using compressors. These require enormous amounts of electricity – up to 70% of the entire energy requirement of a plant. If too much oxygen is added, energy and money are wasted. If too little is added, the outlet values deteriorate.

Full control of nitrogen reduction

Optimum nitrogen reduction requires optimum coordination of the nitrification and denitrification processes. On the one hand, this involves controlling oxygenation during sludge activation in accordance with the load and the individual limit values. On the other hand, it involves coordinating the duration of the nitrification and denitrification phases. In this way, your wastewater treatment process becomes more effective and more efficient. Our aeration control system, the Liquiline Control, will assist you here, ensuring that nitrogen is removed (effectiveness) and optimizing the amount of energy required to do so (efficiency).

To ensure that your WWTP runs and runs and runs, we have developed a solution called the Liquiline Control. This control system helps you to eliminate phosphate and/or nitrogen in a reliable and resource-efficient manner.

Automated phosphate precipitation with the Liquiline Control

Phosphate concentrations are usually subject to strong fluctuations, depending on the weather, time of day and the nature of the dischargers feeding into the wastewater network. To deal with these fluctuations, the Liquiline Control doses precipitant based on the load. This means that the control system takes the current phosphate value in the aeration basin into account along with the quantity of wastewater that is currently flowing through the WWTP. Precipitant continues to be added until the target value you have configured for phosphate is reached and the limit value for phosphorus is reliably adhered to. This also prevents overdosing of precipitant, thereby averting an increase in the salinity of the biology and an increase in sludge volumes.

Automated nitrogen reduction using the Liquiline Control

The Liquiline Control can also control the reduction of ammonium and nitrate based on the influent load. Depending on the nutrient concentration, the system controls the influx of air into the aeration basin, e.g. by regulating the speed of the compressors. This is regardless of whether the biological phase is operated continuously or intermittently.

The measured values taken into account are oxygen in the nitrification phase, ammonium (and nitrate, if necessary) in the transition zones as well as the quantity of wastewater currently flowing through the WWTP. The transition zones include the zones between the nitrification and denitrification phases as well as the zones at the inlet and outlet of the biological phase.

The target oxygen value, and therefore the influx of air into the aeration basin, is adapted dynamically to fluctuations in the influent load. At nighttime, during low-load phases, only a small amount of air is injected; during load peaks,

With the Liquiline Control...

- you can guarantee compliance with the prescribed outlet values
- you have dynamic influent and high load peaks under control at all times
- you can optimize precipitant dosage and therefore the amount of precipitant used
- you can control two dosing pumps at the same time
- you can use iron-based, aluminum-based as well as mixed precipitants
- you have complete control over the process, as you can switch to manual operation at any time.

With the Liquiline Control...

- you can guarantee compliance with the prescribed outlet values
- you can ensure that high load peaks are under control
- you can optimize oxygen dosage and therefore energy consumption
- you have an oxygen control system with automatic adjustment of the target value to the load
- you can control several biological phases simultaneously and operate these on a continuous or intermittent basis
- you can validate your process technology
- you have complete control over the process, as you can switch to manual operation at any time.

such as surges during wet weather, more air is injected. In the case of intermittently operated plants, minimum times for the nitrification and denitrification phases are also taken into account.





How the Liquiline Control is delivered to you

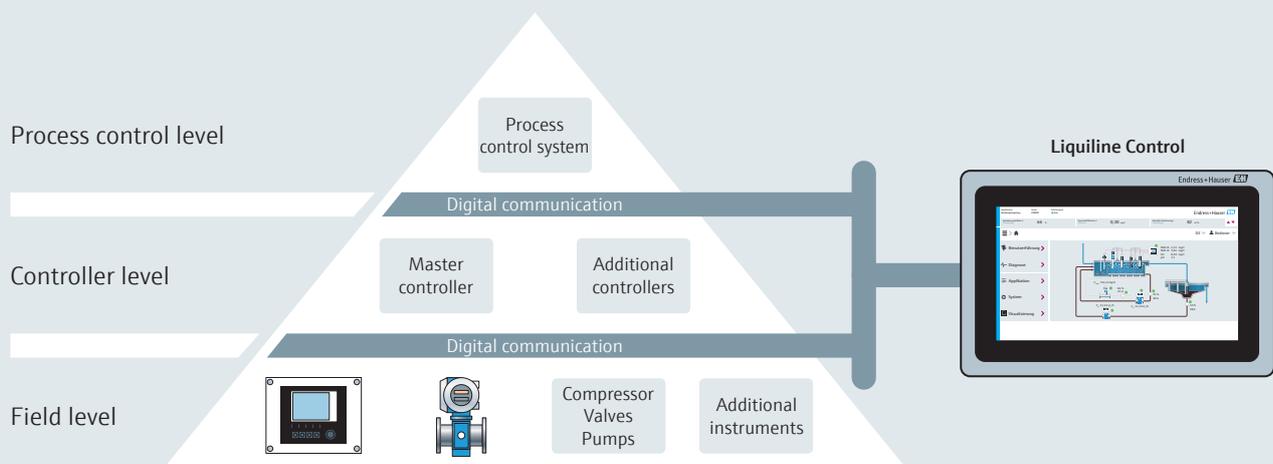
The control system can be integrated into your plant in a matter of minutes. Simply install the Liquiline Control system into an existing cabinet, connect it to your network (see information box below) and that's it! Visualization takes place in your process control center and/or on an on-site display. We can supply you with a touchscreen display if desired. However, you can also use your own monitor.

If you wish, you can also opt for a complete package, which includes all of the measuring and control technology enclosed in a cabinet that you can simply install on the basin rim or in a measuring container.

"I was amazed how quick and easy it all was. Within a few seconds, the controller was up and running. After just a few weeks, we saw that we were able to operate the system at a very stable level while almost halving aeration times. This of course saves on electricity."

Michael Szegedie, Plant Manager, WWTP Waldhausen (Germany)

Integrating the Liquiline Control system into your plant

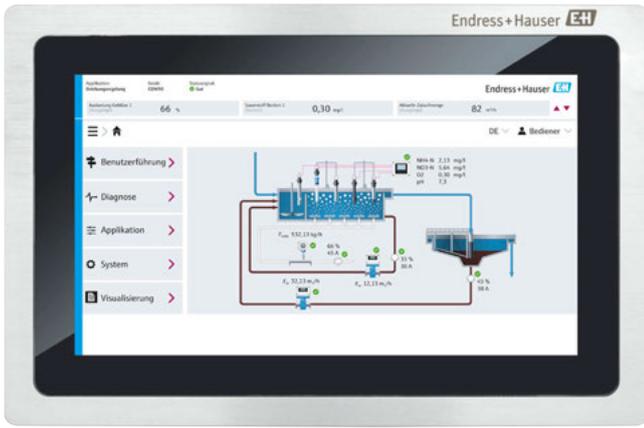


The Liquiline Control can be installed in parallel with existing controllers: in the most basic example, the Liquiline Control receives the required signals from the process control system via a digital communication protocol, such as OPC UA. Alternatively, the system can also process analog signals.

If the Liquiline Control system is integrated into your IIoT (Industrial Internet of Things), it obtains the required data from the field level. These are processed and returned to the field level to control the elimination of nitrogen or phosphate. Unlike the automation pyramid, there is no hierarchical arrangement. Instead, all connected devices work in parallel.



You can integrate the Liquiline Control into new or existing plants and continue to avail of your measuring technology that is already installed.



Liquiline Control operating menu

"Key advantages of the control system are its user-friendliness and transparency. It can be operated using only a few very explicit parameters. This makes things easy for us!"

Markus Pries, Electrician, WWTP Stadtlohn (Germany)

Your partner for the operation and maintenance of your WWTP



✓ Making your work easier

Whenever you need us, we are there to provide you with advice and assistance.

- Staff training: We provide training in our own training centers or on site in wastewater treatment methods, measuring technology handling (installation, calibration, etc.), digital fieldbus operation and much more.
- Extensive range of services: We will assist you with the design, commissioning and operation of your measuring points.
- Convenient all-round package: If you wish, we can take care of the maintenance of your measuring devices and ensure that your measurements are running reliably either on site or via remote maintenance.



Customized measuring cabinets and containers for all measuring activities

From time to time, situations arise in which the measuring technology requires protection – from the rain, cold, heat, dust or unauthorized access. In all of these cases, we can package complete measuring points in protective enclosures, ensuring that your measurements remain safe and available.

The spectrum ranges from small enclosures to walk-in measuring containers incorporating entire workstations. This means that you and your staff are protected from the elements while carrying out lab analyses and maintaining the measuring technology.

If you choose a measuring cabinet or container, you will receive a package tailored to your needs, containing everything you require for your measuring activity and its documentation.

✓ Space for everything that needs protection

- All of your measurements are located in one place and are protected against heat, cold, rain, snow, dust, unauthorized access and vandalism.
- From a small measuring cabinet to a walk-in measuring container with a fully equipped lab, anything is possible.
- Reliable operation in the field thanks to customized measured value management, decentralized access and a tele-alarm system.
- Optional air conditioning ensures optimum conditions for the measuring technology, whatever the weather.
- Our project team will provide you with expert advice throughout the entire project and will find the best solution for your individual circumstances.





"At our WWTP, the Liquiline Control controls both phosphate precipitation and nitrogen reduction. We can always rely on this control system. Even in difficult inflow conditions, it works as specified, thus ensuring that the outlet parameters are always adhered to."

Ewald Rathmer, Plant Manager, WWTP Stadtlohn (Germany)



For everything you need to know about our sensors, analyzers and samplers:
www.endress.com/Analysis

For more information on nitrogen and phosphate removal:
www.endress.com/Analytical-Solutions

Overview of our wastewater expertise:
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