Phosphate removal optimized, discharge value reduced

Phosphorus is an important plant nutrient. Excessive concentrations in water bodies lead to eutrophication and strong growth of algae and aquatic plants. The death of this biomass in turn then leads to a strong oxygen depletion; the water quality deteriorates.

In order to achieve the "good ecological status" of a water body as required by the Water Framework Directive1) , the input of phosphorus must be reduced, among other things. With regard to point loads from wastewater treatment plants, numerous German states have drawn up stricter requirements that go beyond the requirements of the Wastewater Ordinance. For Bavaria, these additional requirements are published in Factsheet 4.4/22 of the State Office for Environment. The requirements mainly refer to total phosphorus (P_{ges}). Since orthophosphate accounts for the largest share of P_{ges} in wastewater (PO4-P), the precipitation of PO4-P plays an important role.

The following report uses the example of the Hilpoltstein wastewater treatment plant to show how WTW brand PO4 measurement technology helped to solve this challenge.

The Hilpoltstein wastewater treatment plant

The Hilpoltstein wastewater treatment plant (Fig. 1), with a capacity of 25,000 p.e., falls under size class 4 and treats the wastewater of the core city of Hilpoltstein and its districts (approx. 13,000 inhabitants).

Fig. 1: View of Sewage treatment plant Hilpoltstein

The mechanical treatment stage consists of a screen and a grit trap, followed by primary treatment. The biological treatment is operated intermittently in the active street. The second street is not used due to the current capacity utilization of approx. 18,000 p.e. currently not in operation. Chemical purification takes place between the biology and secondary clarification tanks.

Total phosphorus in the outlet
without control: 1.6 mg/L
with control: 0.6 mg/L

After leaving the digestion tower, the sludge produced is stored on site together with the sludge from the Meckenhausen external plant. Since there is no sludge drying facility of its own, the sludge is dried twice a year by a mobile chamber filter press.
The process water from the approx. 4,000 m³ of sludge produced per half year is buffered and gradually fed to the biological stage.

Since 2003, the plant has been equipped with the IQ Sensor Net analyzer system of the WTW brand and controls the intermittent biology by means of oxygen and nitrate/ ammonium measurements (with the FDO® 700 IQ and VARiON® 700 IQ sensors, respectively).

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Challenge P action area

KA Hilpoltstein is located in the central Franconian district of Roth and thus in a so-called "P-Area of Action".
The combination of size class 4 and location in the P handling area requires a discharge value for total phosphorus of 1.0 mg/L according to the regulations mentioned at the beginning of this section. This was then also demanded by the responsible water management office in Nuremberg.
In order to be able to monitor compliance with the new specification more closely than before, the plant saw fit to upgrade its measurement technology.

New challenge

The precipitant for phosphate elimination is dosed in the waste out-let of the biology approx. 30 m before the secondary clarifier. For a good mixing and reaction path is thus ensured. The previous P_{ges} limit of 1.6 mg/L was exceeded by a more or less unregulated and consequently high addition of sodium aluminate solution (Fig. 2, precipitant tank). The selective monitoring of the P_{ges} value was carried out using the laboratory analyses specified in the Self-Monitoring Ordinance (see section „Laboratory Analyses"); the consumption of precipitant has so far been about 10 L per hour.

The new measurement technology and dynamic control

In spring 2020, a new MIQ/MC3 converter with Profibus output was installed in addition to the Alyza IQ PO_4 orthophosphate analyzer. "The expansion went without a hitch," confirms deputy plant manager Michael Rupp. "We were able to connect the analyzer very quickly and easily to an existing IQ SENSOR NET module 10 m away." With the commissioning of the Alyza IQ PO_4 and the transmission of the measured value via Profibus to the PLC, the changeover was also carried out.
The precipitant dosing system is based on the current dynamic control system. The sampling of the Alyza takes place in the inlet of the secondary settling tank, approx. 30 m behind the dosing point (feed-backward strategy).

Fig. 2: Precipitant tank at the Hilpoltstein wastewater treatment plant with Alyza IQ PO_4 (next to it on the right).

For the control, a setpoint of 0.55 mg/L was defined for PO_4-P in order to have sufficient buffer during feed peaks. The dosing takes place depending on the measured value (15-minute interval) equally via two pumps already installed before the retrofit. Figure 3 shows very clearly how a higher measured value (magenta) causes both pumps (light blue and dark blue, respectively) to increase the flow rate from about 3 liters per hour to about 4 liters.
Due to the stroke rate of the pumps, the minimum dosing volume was stored at approx. 3 liters per hour for each pump. The set maximum dosing volume is 8 liters per hour. For the new regulation, the pumps are somewhat too large dimensioned, but in the event of failure of one pump, the other could also pump the required volume on its own.

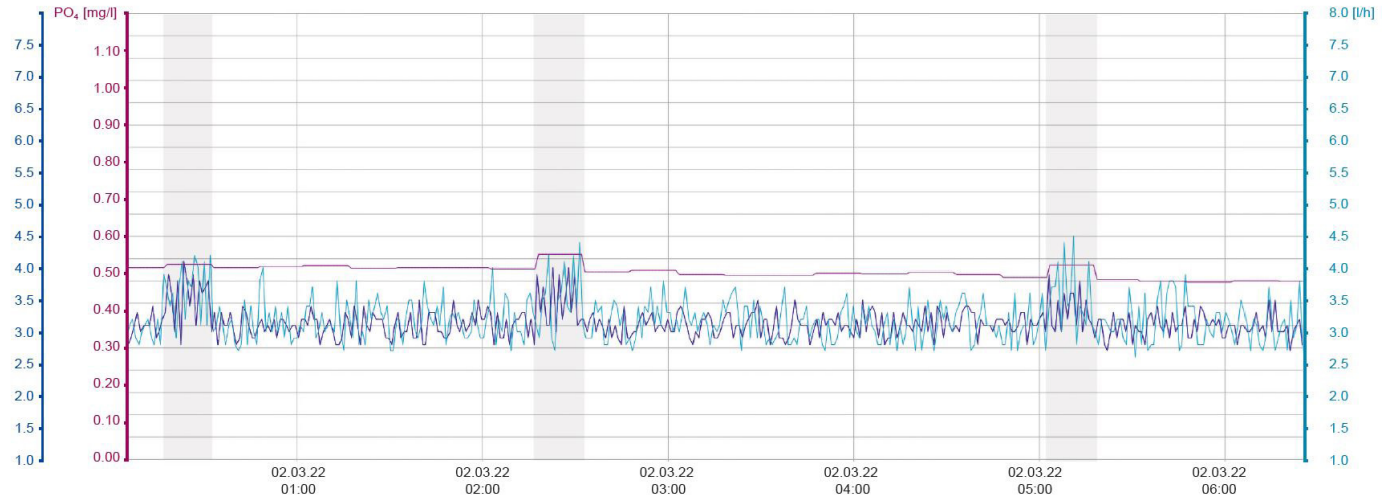

Fig. 3: The dosing volume of the two precipitant pumps (light and dark blue) in L/h depending on the PO_4-P measured value (magenta) in mg/L. An increase in PO_4-P concentration is quickly followed by an increased dosing volume (areas marked in grey).

Laboratory analyses

The process monitoring required by the Self-Monitoring Ordinance continues to be carried out by means of weekly and monthly two-hour and 24-hour composite samples.
Since the installation of the Alyza IQ PO_4, weekly photometric reference measurements have been carried out. For this purpose, a sample is taken from the overflow vessel of the analyzer and the PO_4-P value is determined by means of a cuvette test.
A double determination is carried out with subsequent calculation of the mean value. The results are satisfactory; if necessary, an offset value is set on the Alyza IQ.

Result

Since the installation of the Alyza IQ PO_2 and the new control, the discharge value for P_{ges} could be reduced to about 0.6 mg/L. This is even considerably below the new specification of 1.0 mg/L. In addition, the plant assumes a reduced consumption of precipitant due to the demand-oriented dosing. This is currently at 10 L/hour. According to Michael Rupp's assessment a reduction to approx. 7 L/hour could be possible. "However, due to various inflow peaks that are difficult to estimate, this can only be seriously assessed in about three years," he qualifies. These inflow peaks are caused by the addition of process water (see above) and a seasonal proportion of non-municipal wastewater. Michael Rupp is also very satisfied with the Alyza IQ PO_4:

"It runs very reliably and makes a contribution to environmental protection."

Conclusion and outlook

The investment in measurement technology and in the programming of a new dynamic control system has paid off even for this relatively small plant. "The Alyza runs without any problems and we meet the new specification. If we then also achieve the expected precipitant savings, it's perfect," Michael Rupp sums up proudly. "And if the plant should also have to put the second road into operation, this would also be taken care of: our Alyza is, after all, a two-channel device."

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You will find more information about the Alyza IQ PO_4 on the landing page
https://www.wtw.com/en/landingpages/alyza-iq

Do you have further questions? Please contact our Customer Care Center:

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