APPLICATION REPORT

PHOSPHAX SC

PHOSPHATE ELIMINATION

Optimised Dosing of Precipitation Agent with PHOSPHAX sc

Advantages:

- Reduction of precipitation agent
- Targeted addition of precipitation agent
- Secure compliance with limit values
- Dynamic reaction on current conditions
- Saving of contribution

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Addition of a precipitant

In the case of phosphorus elimination, the costs of precipitants and, to a far greater extent, the sludge disposal costs are the key factors in a cost-benefit calculation. The consumption of precipitants FM [kg Fe] and the amount of sludge formed TS [kg TS] by the dosage of metal salts can be calculated, for example, as described in /1/:

$FM = P_{ges,0} \cdot ß \cdot (1-\eta_{Bio\text{-}P}) \cdot f_{stö}$

$P_{ges,0}$: Total phosphorus precipitate [kg P]

ß : ß value

$\eta_{Bio\text{-}P}$: Efficiency of bio-P elimination

$f_{Stö}$: : Stoichiometric factor

$TS = FM \cdot f_{TS}$

$TS = P_{ges,0} \cdot ß \cdot (1-\eta_{Bio\text{-}P}) \cdot f_{stö} \cdot f_{TS}$

f_{TS}: : Stoichiometric factor

According to the “ATV Handbuch” /2/ the consumption of precipitants can be reduced by 10 to 25% if a set-point control system is employed rather than uncontrolled operation. On the basis of the annual costs shown in Table 1 and depending on the costs of sludge disposal and the degree of biological phosphorus elimination, it is possible to arrive at a rough estimate of the plant size (assumed level of phosphorus loading: 2 g P/PE/day) at which the controlled addition of precipitants would be economically worthwhile (Table 1, calculated with savings of precipitation agent of 10% !).

	bio-P [%]		
Disposal (€/tTS)	30	50	70
200	17.000	24.000	39.000
300	15.000	20.000	33.000
400	13.000	18.000	29.000
500	11.000	16.000	26.000
600	10.000	14.000	23.000
700	9.000	13.000	21.000

Assumptions

Savings:
Precipitation agent: 10%
40% Fe_3Cl, 130 €/t
Active substance: 13,8%
ß = 1,5
f_{TS} = 2,5 kg TS / kg Fe

Table 1: Cost-effectiveness of the use of a process measurement instrument for controlling precipitation

The first step to optimised precipitant dosage

The targeted addition of precipitants as phosphate loading fluctuates is not possible without the help of continuous measurement technology. The ability to respond at any time to changes is dependent on real-time information about the inflow volume and phosphate concentration. A study /3/, which compared different dosage methods, produced concrete figures demonstrating how efficiently they utilise the precipitant.

Process engineering	Added precipitation agent
Loading based control system	100% (basis for the comparison)
Constant dosage	264%
Flow proportional dosage	209%
Load proportional dosage	201%

The identified savings potential of the selected process technology can now be used to calculate the exact investment costs and amortisation period.

Concentration-based control system

The simplest type of control system is shown in Fig. 2. A precipitant dosage pump is activated by a small control element, which continuously compares a measured value with a set point and sends appropriate control signals to the pump. The effect of the precipitant dosage is continuously monitored by a measuring instrument at the end of the precipitation process, but the loading is not taken into consideration and the system cannot cope with sudden surges.

+ Reaction to concentration changes

- Takes no account of inflow volume

- Late reaction to concentration surges

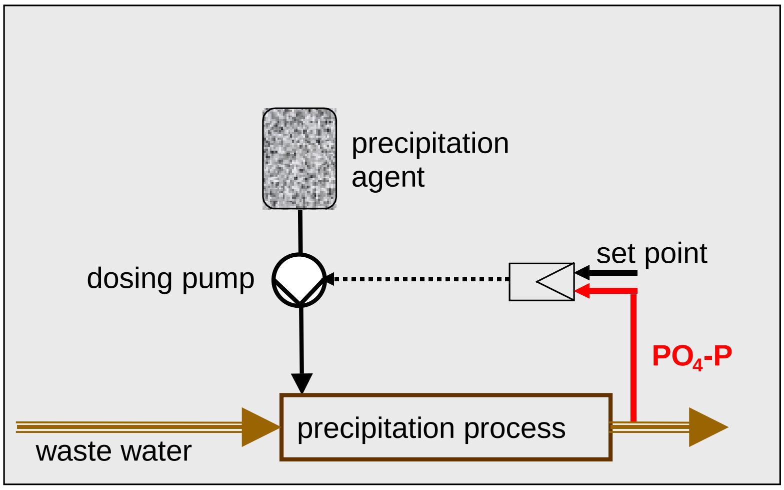


Fig 2: Simplest control strategy with a number of weaknesses

Loading-based control system

Small to medium sized plants should choose a variant of the loading-based control system. Except for sudden concentration surges, this method can handle all types of challenge and offers the best cost-performance ratio.

+ Fast reaction to changes in the inflow volume

+ Reaction to concentration changes

+ Best cost-performance ratio

- Late reaction to concentration surges

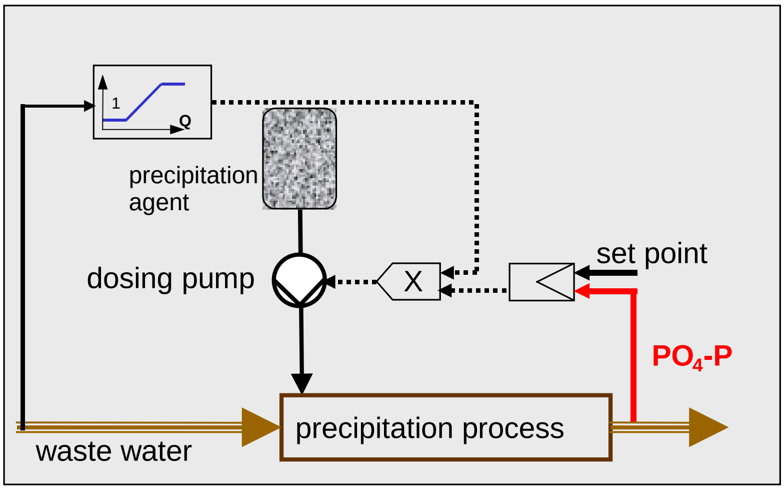


Fig 3: Best variant for small to medium sized plants

Loading-based control without feedback

Control systems generally have the problem that they rapidly register changes but do not provide any feedback about the results of the action taken. Volume and phosphate measurements provide immediate information about the loading, but the action of the added precipitate remains uncertain.

+ Rapid reaction to all changes in the loading

- No feedback after the precipitant is added

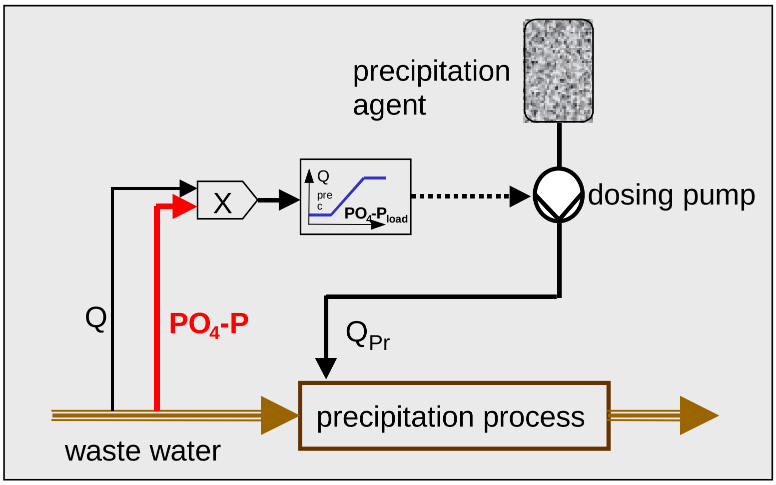


Fig 4: Conventional control system without any feedback after the recipitant is added

Loading-based control system with feedback

This variant was rightly selected as the reference method. The actual situation is monitored by measuring the volume and phosphate in the inflow. When changes are registered, precipitant is added. The phosphate concentration is measured downstream of the precipitant dosage point to provide immediate feedback about the success of the added precipitant. Chemical phosphate elimination could not be regulated more efficiently.

+ Best method (reference)

- Investment costs are justifiable only for large plants

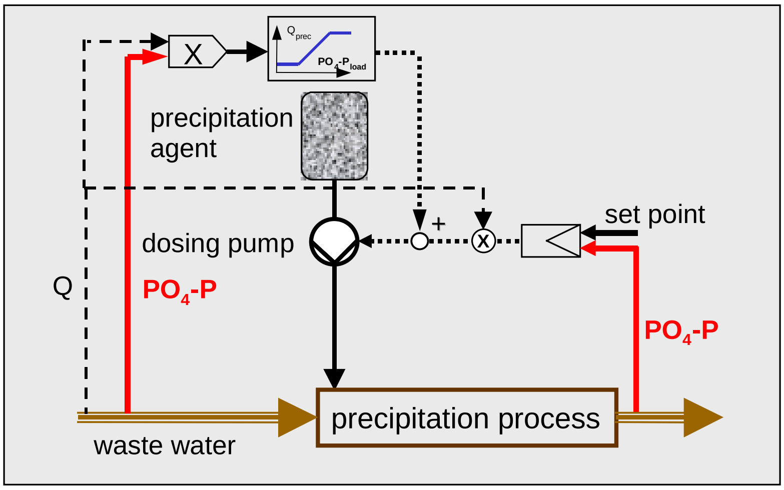
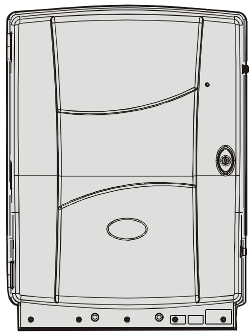


Fig. 5: Reference method: loading-based control with feedback

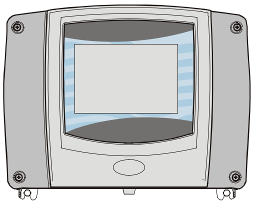
Applied process instruments

PHOSPHAX sc on-site



High precision process measurement instrument for the continuous quantitative determination of phosphate in water, wastewater and active sludge. The measurement is carried out using the photometric yellow method. Sample conditioning is carried out with the help of a self-cleaning membrane filter probe, which is integrated in the system.
The analyser is housed in an isolated weatherproof enclosure which can be installed outdoors. Evaluation and operation and carried out via a SC1000 Controller. Up to 2 AMTAX/PHOSPHAX sc systems can be connected to a SC1000 probe module. Up to 6 other SC probes can also be connected.

SC 1000 Controller



Universal controller, consisting of a portable display module for operating purposes and a probe module for the connection of up to 8 digital sc sensors via splashproof connectors. Several probe modules can be connected to create a SC1000 network. The system is modularly configured in accordance with the customer's wishes, and can be upgraded with additional measuring stations, sensors, inputs, outputs and BUS interfaces at any time.

/1/ *Wedi, Detlef*:
Einsatz von Messtechnik auf Kläranlagen, notwendig oder nicht
Angewandte Prozess Messtechnik Nr. 16, Dr. Lange Eigenverlag (1996)

/2/ *ATV-Handbuch:*
Betriebstechnik, Kosten und Rechtsgrundlagen der Abwasserreinigung,
Ernst & Sohn, 4. Auflage (1995)

/3/ *IWA Publishing:*
Scientific and Technical Report No. 15
Instrumentation, Control and Automation in Wastewater Systems (2005)

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