PRACTICE REPORT
PROCESS ANALYSIS
CONTROL SYSTEM
SC 1000 / NITRATAX PLUS / LDO

Cost savings with the latest control techology

Ladbergen has one of the most efficient sewage treatment plants in the whole region. This is remarkable, given the extremely **difficult inflow situation**, with COD values sometimes reaching 3,000 mg/l. Helped by considerable plant modifications, a bold and unusual sewage sludge humification process, and the **modern OptiNox control system from** KLEINE, the operations personnel have made the plant a regional leader in just a few years. The solid foundation for all successful improvements is the reliable analysis embodied in the **process measurement technology**.

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With OptiNox, the N_{inorg} values in the outflow fall below 5 mg/l

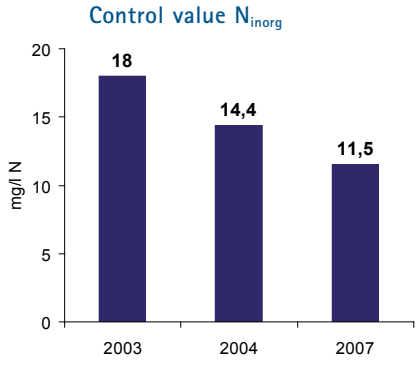

Fig. 1: The control values for N_{inorg} are being reduced step by step in Ladbergen

Fig. 2: Plant manager Gerold Thiemann has everything under control – including the NITRATAX plus sc nitrate probe.

Ladbergen sewage treatment plant	
Constructed	1972
Extended	1992-93
Design capacity	20,000 PE (aeration) 30,000 PE (secondary settlement)
Utilisation	15,000 PE
Inflow values	
Q_{DW} (dry weather flow)	1,000 m^3/d
COD	Up to 3,000 mg/l (up to 4 h)
NH_4-N	60-100 mg/l
N_{tot}	120-140 mg/l
Outflow values	mg/l (limit value)
COD	ø 33 (75)
N_{tot}	<5 (11.5)
NO_3-N	1.0
NH_4-N	0.2
P_{tot}	0.4 (2.0)

A COD of up to 3000 mg/l

Sometimes the COD concentration in the inflow to the sewage treatment plant at Ladbergen surges to 3,000 mg/l and stays at this level for up to 4 hours. Sometimes the ammonium concentration at this point reaches 100 mg/l NH_4-N, while the N_{tot} content never falls below 100 mg/l, even when no surges occur. There are a bakery, a butcher's and a dye works, and a camp site is open seasonally at Easter and in the summer months. Filamentous bacteria sometimes multiply rapidly there, so that in extreme cases only polyaluminium chloride can help. All in all, these are difficult circumstances in which to become one of the most efficient sewage treatment plants in the whole region. Before this was achieved, however, far-reaching changes had to be implemented.

The path to the top

The two former combined tanks (secondary settlement tank with surrounding aeration zone) were converted to pure aeration tanks with surrounding and intermittent aeration. Since 16 March 2004, the aeration times have been the responsibility of OptiNox, the control system of Hartmut Kleine GmbH. The indispensable inflow values are provided by process measurement instruments from HACH LANGE.

In tank 1:

- TS content (SOLITAX sc)
- Oxygen (LDO)
- pH (1200-S sc)
- Nitrate (NITRATAX plus sc, Fig. 2)
- Phosphate (PHOSPHAX compact)
- SC 1000 controller

In tank 2:

- Oxygen (LDO)
- SC 100 controller

To increase operational reliability and prevent limit values from ever being exceeded, the main priority was initially the aeration tanks.

Biological control system

OptiNox controlled the aeration times so well from the very beginning that just six months later the control value for nitrogen could be declared to be 20% lower (down from 18 to 14.4 mg/l Ninorg, Fig. 1) – including the setting off of this measure against the wastewater charge.
Fig. 3 clearly illustrates the continuous levelling out and reduction of the nitrogen load in the outflow.
Fig. 4 shows typical one-day time-course curves and explains the controller interventions.

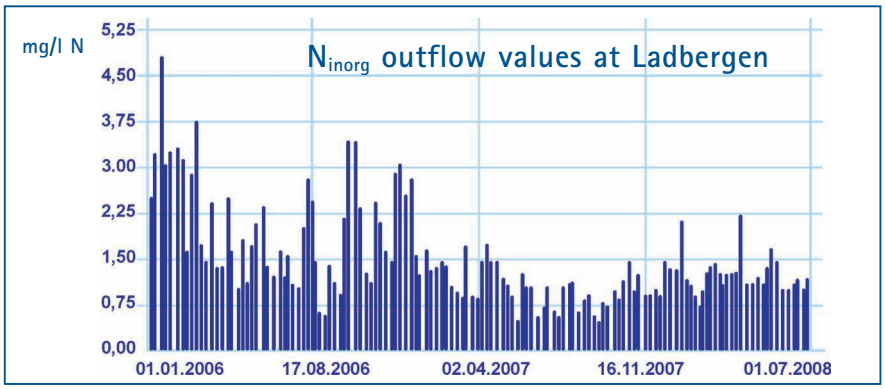

Fig. 3: The nitrogen load in the outflow becomes ever smaller and more even.

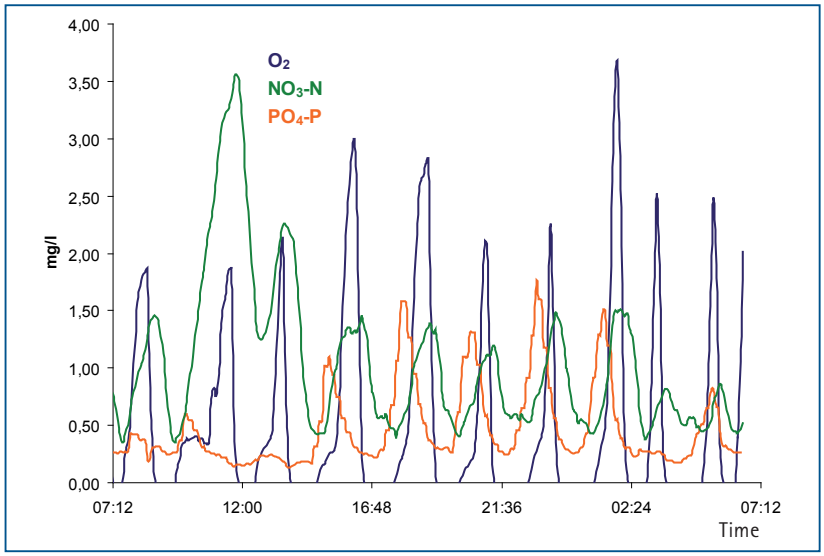

Fig. 4: One-day time-course curves from aeration tank 1 (oxygen, nitrate and orthophosphate).

The surge at about 9.30 am is easily recognisable thanks to the steep rise in the nitrate concentration (green). At the same time, the increased oxygen depletion prevents an immediate increase in the oxygen concentration (blue) to 2.5-3 mg/l, which is usual during low-load periods. Certainly the controller switches the aeration off again after about 2.5 hours, but it does not wait until the end of the denitrification (nitrate content approx. 0.5 mg/l). Instead, it starts the air supply again when a concentration of about 1.3 mg/l NO_3-N is reached. It therefore functions in accordance with the plant objective of avoiding increased COD and ammonium values in the outflow.
The situation returns to normal in the afternoon and the bacteria again have the opportunity to prepare themselves at the end of the denitrification phases, when phosphate clearly redissolves (orange), for the increased absorption of phosphorus.

Sludge control system

In 2007, OptiNox was upgraded with sludge control functions. The end of mobile sludge dewatering meant that sludge stabilisation had to be relocated to the two aeration tanks. For this purpose, the quantity of recycled sludge is set in relation to the plant inflow and the total solids in the aeration tank; the rest is a commercial secret.
There is nothing secret about the resulting success: it proved possible to reduce the amount of extracted sludge by up to 50% with the help of a “correctly calculated extraction quantity” (for the same mass!).
Since August 2007 the excess sludge, which is thickened to 2% in the thickener, has been pumped into the four beds of the first sewage sludge humification plant to be approved in NRW. Filling will continue for 7-10 years before further utilisation (incineration or road construction) can be considered. The collected leachate water passes through a distributor, together with the recycled sludge and the raw wastewater, into the two aeration tanks. An additional success, which demonstrates the close relationship between nitrogen degradation and the sludge cycle, is the further decrease in the nitrogen control value in autumn 2007 from 14.4 to 11.5 mg/l N_{inorg} – together with the setting off of the investment against the wastewater charge.

Fewer precipitants

Chemical precipitation is carried out using a mixed iron-aluminium product in the recycled sludge. A purely iron precipitant was previously used, but the increased grease load enabled the filamentous bacteria to multiply much faster. The OptiNox control functions take effect here, too, by promoting stable biological phosphorus elimination and adding the precipitant only to reduce the phosphate peaks. Fig. 6 illustrates the extraordinary success, with steadily decreasing amounts of precipitant.

Fig. 5: View of the first sewage sludge soil humification facility in NRW

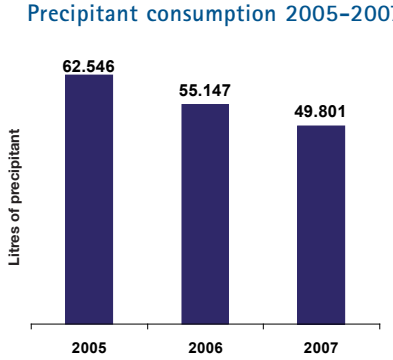

Fig. 6: Continuously decreasing precipitant demand

Optimisation objective at the sewage treatment plant: saving energy

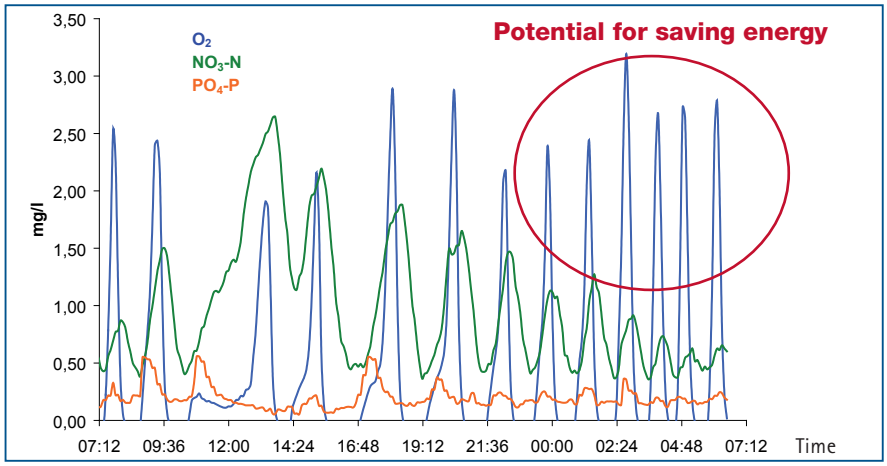

Fig. 7: Unnecessarily high oxygen concentrations (red marking) during low-load phases

Future cost cutting

Under the provisions of section 4, subsection 5 of the German Wastewater Charges Act, the wastewater charge can be reduced further, also in Ladbergen. The declared values for COD (48 mg/l), N_{inorg} (5 mg/l) and P_{tot} (1 mg/l) must never be exceeded, otherwise this attractive option is forfeited. The chances are good, as the average values for N_{inorg} from April to July 2007 were around 1.1 mg/l!

The delays before switching the aeration units on and off can also be optimised, as the unnecessarily high oxygen concentrations in low-load periods demonstrate (Fig. 7).

In all of this, reliable analysis is the basic prerequisite for intelligent control systems, high levels of plant reliability and maximum utilisation of potential for improvement.

OptiNox

Modular control system, consisting of a mounting plate and operator terminal (alternatively a PC). Full compatibility with the control system through a bus cable, intuitive operating capability, simple programming, and uncomplicated integration into the existing plant technology. Extensive adjustment options, which allow the individuality of the plant, configuration with individual measuring instruments and the current optimisation objectives of the plant to be taken into account.

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