

Addressee(s) :	Author :	Dominique Corbisier
	Verification :	Bart Vanherp/Sophie Polspoel/Lieve Verelst
	Approval :	Lieve Verelst

☎ :	+32 2 382 06 38	Ref.LBE-CTCT-06-Report-0001616v2	Linkebeek, 30/11/2006
Fax :	+32 2 382 02 41		
e-mail :	Dominique.corbisier@laborelec.com		

ELONITA[®]
Executive summary of the technical evaluation report



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This report summarizes the results that were obtained at semi-industrial scale during treatment of the regeneration effluent of anionic resins with the ELONITA technology. These tests were carried out in the frame of a EU LIFE Project, on the effluent coming from Langerbrugge power plant.

Doc Class:	SPRT - Chemistry-Envir-Water
Keywords:	
Power plant:	
Unit:	
Type of power plant:	
Circuit:	Wastewater
Subject:	Other

1. RESULTS OBTAINED FOR THE NITRATE REDUCTION:

- The **performances** are **similar** at **lab scale** and at **semi-industrial scale**, for trials performed at the same conditions (same effluent); the maximum nitrate reduction rate obtained was **40 g NO₃⁻/h/m²** for a final equivalent nitrate concentration varying from 30 to 60 mg NO₃⁻/l. The reaction yield never exceeded 30 %.
- The **organics content** of this effluent is **detrimental** to the nitrate reduction process, even when a pre-treatment is performed. Moreover, the **optimum pre-treatment duration** is very **difficult** to find and we could not find a suited parameter that can fix the end of the pre-treatment. For such an effluent, we would advice to perform a **pre-treatment of about 10 to 20h**. The pre-treatment will produce **by-products** that are not wanted (ClO⁻, ClO₃⁻, ClO₄⁻, Aox); as we take as reference the results obtained at lab scale with a lower organic content (COD of about 300 mg/l instead of 1000 mg/l), we can double the nitrate reduction rate. To reduce the organics concentration, we could imagine to treat the effluent coming from the regeneration of the whole demineralization chain, but :
 - this will imply treating an effluent containing a lower nitrate concentration, which will decrease the performances,
 - and this will imply the presence of Ca²⁺, which will cause Ca deposits on the cathode. This has to avoided, otherwise it will also require a periodic cleaning of the cathode.
- Performing the nitrate reduction step at the original pH value will lead to **NH₃ stripping**; the stripped ammonia could be adsorbed into an acid solution (HCl) that could be later used as acid solution for the ammonia oxidation sequence;
- The **frequency of cathode doping** is **difficult** to estimate; this frequency should be determined on basis of the nitrate reduction performances; as we show in this chapter these performances depend on a large variety of parameters (NO₃⁻ concentration, organics, ..). It was impossible for us to have the same effluent several times after each other, so it was difficult to assess the ageing of the copper deposit; We saw after opening of the cell that the RVC blocks weren't glued anymore on the stainless steel plate. We assume however that the physical contact between the stainless steel plate and the RVC blocks was sufficient to insure a good electrical contact.

2. RESULTS OBTAINED FOR THE AMMONIA OXIDATION

- The oxidation rate that could be achieved varied between **41 to 96 g NH₃/h/m²**, what is similar to what we achieved at lab scale (trials 149 to 151, oxidation rates varying from 58 to 72 g NH₃/h/m²) for the oxidation of ammonium ions coming from the reduction of nitrate (regeneration effluent of anionic resins).
- In the trials, when we achieved a low final NH₃ concentration (5 mg/l), we saw that the reaction end can be visualized by the **ORP measurement**. Indeed, we saw each time an increase of the ORP value. The evolution of this increase (sharp, slow) is however different in each trial, so the automation of detection of the increase can be difficult. Moreover, a high ORP value at the end of the sequence indicates that everything that could be oxidized has been oxidized, not that the ammonium ions have been oxidized. We do not know if the effect of the organics pre-treatment was totally achieved (which means oxidation of all the organics) and what occurs with the oxidized organics in the cathodic compartment during a nitrate reduction step. All that we know is that the pre-treatment has a positive effect on the nitrate reduction performances. It is then difficult to conclude that the ORP (oxydo-reduction potential) value could be a valuable parameter to assess the end of the ammonia oxidation.
- The **pH adjustment** before the ammonia oxidation was not precise enough (use of a PI); the minimum pH value (5) was often exceeded. **PH measurement** is difficult because of current leakages through the pH electrode (efficient grounding is needed).
- **By-products** were formed during the ammonia oxidation:
 - AOX: about 5 mg/l in 10 h
 - ClO₃⁻, ClO₄⁻, ClO₂⁻ : high concentrations (varying from 30 to 100 mg/l) were measured at the end of the ammonium oxidation. This is however partly due to the fact there was an accumulation in the tanks.
 - ClO⁻: the final concentration depends on the “oxidation degree” that we reached. Compounds that can be oxidized are ammonium ions and organics.
- **Chemicals consumption**
 - About 3 to 25 l/m³ HCl 30 %
 - About 2,5 l/m³ NaOH 50 %

3. INVESTMENT COSTS

- Investment cost for an ELONITA installation capable of treating 15 kg NO₃⁻/d: 722000 €
- Investment cost for an ELONITA installation capable of treating 100 kg NH₃⁻/d: 735800 €

4. APPLICABILITY

A typical effluent that could be directly treated with ELONITA is an effluent:

- With at least a conductivity of 3 mS/cm (> 10 mS/cm is better)
- With a high nitrate or ammonia concentration (at least 1 g/l)
- With a high chloride content (at least 3 g/l)
- With a low organic content
- Without any suspended solids (but a solid-liquid separation will be sufficient as pre-treatment)
- Without or with low Ca/Mg concentrations

Attention has to be paid to the global composition of the effluent, to avoid unwanted reactions (compounds that could also be possibly oxidized by hypochlorous acid or by direct anodic oxidation).

A nitrate containing effluent with high concentrations of biodegradable organic matter will be more economically treated with biology. At the contrary, a pure ammonia containing effluent could be more advantageously treated by ELONITA.

The ammonia oxidation will have better performances than the nitrate reaction because the nitrate reduction reaction is much more complex.