

# Recovery and reuse of alginate from granular Nereda sludge

● Research has been taking place to develop a polymer product from aerobic granular sludge, sourced from the Nereda wastewater treatment system. **HELLE VAN DER ROEST, MARK VAN LOOSDRECHT, ERIK JAN LANGKAMP** and **CORA UIJTERLINDE** discuss the opportunities around recovering this valuable resource.

**R**esearch at the Delft University of Technology in the Netherlands has shown that the substance responsible for the granular growth of micro-organisms in aerobic granular sludge (used for wastewater treatment) is a polymer termed ‘alginate-like exopolysaccharides’ (ALE).

This polymer binds strongly with water, can thicken or gel liquids and can be used as a basis for coatings. These properties make ALE a valuable raw material with many potential applications. Seaweed derived alginate is currently used extensively in the medical and food industries; however, the price for alginate is high due to the limited availability of seaweed. Wastewater derived alginate (with lower costs) could potentially be used in the chemical sector, paper and textile industries or as a soil enhancer in the agricultural sector to improve water retention in semi-arid areas.

The Nereda system (see p39-41) uses aerobic granular sludge to treat municipal and industrial wastewater in a sustainable and cost-effective manner. The full-scale Nereda system was developed between 2007 and 2013 in the Netherlands under the National Nereda Research Programme (NNOP). The NNOP was a collaborative undertaking involving the Delft University of Technology, Royal HaskoningDHV, the Dutch Foundation for Applied Water Research (STOWA) and several Dutch waterboards. Currently more than 20 full-scale Nereda systems are operational or under construction worldwide with many more plants planned for the near future.

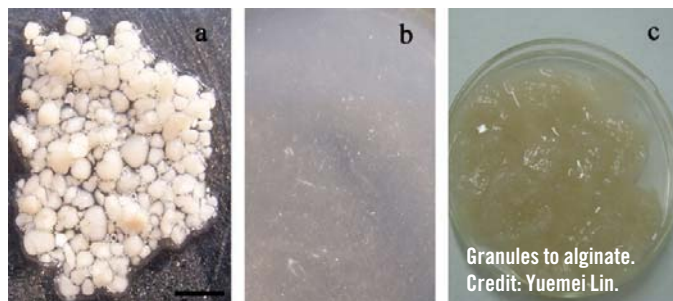
As with all biological wastewater treatment systems, Nereda treatment plants generate a constant stream of excess sludge

that requires further treatment. Given the discovery of ALE in aerobic granular sludge, the question that arises is: can the waste / excess sludge from Nereda systems be used for cost-effective ALE-extraction, enabling the sustainable bio-based reuse of a waste product? The success of the NNOP in the development of the Nereda system provided an example of the ideal structure and ‘already interested’ partners for research into and development of ALE-extraction from Nereda sludge – therefore in 2013 the NAOP (National Alginate Research Programme) commenced with the goal of realising commercially viable and sustainable ALE-extraction from aerobic granular Nereda excess sludge.

## Extracting alginate from Nereda sludge

Aerobic granular sludge contains 15-25 percent of ALE which, in principle, can be recovered with existing technologies used for alginate extraction of seaweed. Combining alginate extraction with the existing excess sludge treatment processes at wastewater treatment plants would not only yield a valuable raw material, but could also improve sludge treatment efficiency because alginate extraction reduces sludge volumes and the remaining (non-extracted) sludge has a higher digestibility and better dewaterability.

The Dutch waterboards are committed to striving for the transformation of wastewater treatment plants into ‘energy and resource factories’, i.e. sustainable recovery of all valuable resources in wastewater. The extraction of ALE from Nereda excess granular wastewater sludge would be an important step towards achieving this concept. It is seen as an innovative and sustainable development in the direction of a



bio-based economy and therefore warrants further research.

## The NAOP (National Alginate Research Programme) and market perspectives

In 2013 the private-public NAOP was started by the following partners: Royal HaskoningDHV, Delft University of Technology, STOWA and three Dutch waterboards (Rijn & IJssel, Vallei & Veluwe and Vechtstromen). From the outset, it was obvious that the partners should first focus on the interest of market parties in the ALE product(s). Further technological development towards full-scale ALE-extraction from excess granular wastewater sludge would not be tenable without commercial parties showing serious interest in the product(s). An exploratory market study showed promising interest from (large) companies across various industrial sectors. Furthermore, various government entities have also shown interest in the sustainability linked concept of a circular economy involving ALE-production from wastewater and subsequent reuse for industrial processes.

Selected companies, some acting as representatives for certain industrial sectors, others as direct consumers and intermediaries, are currently being consulted again. The participating companies receive an amount of dried alginate or granulate (dried granules with 20% ALE), to further explore the substances’ properties and potential use. At the same time a research project is underway to further develop and test the ALE-extraction methods. The promising developments and results achieved to date have not gone unnoticed and in 2013 the NAOP partners were awarded the prestigious Dutch Water Innovation Award 2013 for their work.

## The way forward

NAOP has plans for two full-scale demonstration installations for ALE extraction. One extraction installation will treat the granular excess sludge from municipal Dutch Nereda installations at Epe, Dinxperlo and Vroomshoop, while the other demo-installation will extract alginate from excess sludge from a planned industrial Nereda installation in the Netherlands. The cost for the research programme, including the demo-installations has been estimated at €14 million (\$14.8 million) and therefore careful planning and significant funding is required. Partners are currently discussing the best way forward to realise these demo-installations including the exploration of various revenue models.

## Conclusions

Alginate extraction from aerobic granular sludge and subsequent viable reuse is a promising development towards sustainable waste management and the realisation of bio-based economies. Key strides have been made towards achieving full-scale viable and sustainable alginate extraction from Nereda waste / excess sludge. In the short term future, key decision making, incorporating viable business cases, will be required with regard to the planned next step of realising two full-scale demonstration installations. The NAOP partners recently applied for financial support through European subsidy programmes in order to achieve the development and research targets, including the demo-plants. ●

**Helle van der Roest** is from Royal HaskoningDHV, **Mark van Loosdrecht** is from Delft University of Technology, **Erik Jan Langkamp** is from E+M Subsidy Consultants and **Cora Uijterlinde** is from STOWA.