WATERAGRI

FACTSHEET

NANOCELLULOSE MEMBRANES FOR NUTRIENT RECOVERY

Key information

Functionalized nanocellulose membranes can take up nitrate and phosphate. These membranes can be put in a water treatment unit. As the membranes are biobased, degradable materials, they can after use be added to the soil, thus returning the leached nutrients back for their original purpose providing fertilizers (nutrient recycling).

Target audience: future farmers and advisors.

This project has received funding from the European Union's Horizon 2020 research and innovation program under Grant Agreement No 858735.

A. Brief Introduction:

Biobased nutrient capture agents provide a sustainable means to diminish the nutrient load from fields by capturing these elements from agricultural drainage water. Here, a new surface -tailored nanocellulose-based membrane was designed and developed further for the purification of runoffs from agricultural areas. The aim was to design the membrane for selective nutrient capture and to configure the runoff treatment to eliminate the need for additional pumping, thereby reducing energy costs.

The biological structure opens the possibility to use the nutrient-rich membrane material after recovery for soil amendment and/or fertilization, thereby developing a full circular solution for the nutrients which otherwise could be considered pollutants impairing surrounding freshwater reserves.

In WATERAGRI, the system was tested for the first time in laboratory conditions. The nutrient uptake of the fabricated biobased membrane was ~ 8 mg for potassium and nitrate ions and ~ 11 mg for phosphate ions per gram of dry membrane.

Further testing is ongoing to increase nutrient uptake.

B. Testing and design concept:

The membranes should be used in a configuration which allows efficient removal, and at the same time, causes zero back pressure, in order to enable free flow of the runoff water and no need of extra pumping.

The system has been tested at a width of 60 cm and 2.5 m length, rolled in a spiral with a distance of 1 cm between the layers. Its performance has been assessed with 4 L/h flow rate and a hydraulic retention time of about 3.5 hours and 16 L/h, implying a hydraulic retention time of around 1 hour respectively.

C. Technical information:

The technology is still in development and detailed technical information for full-scale operation is not yet available.

No special skills are required to operate the system, but an indication of when the membranes are saturated and need to be replaced is required by assessing the nutrient concentration after treatment. Quick test indicators are available for this purpose. Otherwise, the goal is a solution that requires minimal maintenance.

The nanocellulose membrane material has been produced in sheets (length 10 m, width 30 cm, thickness ~25 µm) of uniform and functionalized for enhanced affinity using roll-to-roll (R2R) manufacturing. The membrane production method is based on casting a water-based suspension of nanocellulose, thus enabling R2R production on a pre-industrial scale.

The membrane production method is green and up-scalable and can therefore be produced at VTT in different scales and configurations.

D. Costs and Benefits:

As the method is still under development and new configurations are still to be tested, we cannot yet provide estimates of the cost of installation, operation and/or maintenance. However, most probably, no costs of disposal will be applicable.

For the farmer, the innovation provides a sustainable means to minimize the environmental impact of cultivation with decreasing risk of impairing the water quality in the surrounding ground and freshwater bodies. In addition, the recovered nutrients can safely be returned to the fields.

The social consequences are related to environmentally sounder agriculture (for the farmer, and increased wellbeing for the people in the environment due to less input of nutrients to the freshwater bodies and consequently lower eutrophication). Moreover, if /when the biomembrane production is scaled up to commercial level, it will create new entrepreneurship and job opportunities in the green sector.

E. Challenges and opportunities

The technology is still in development and test programme on-going, thus statements on technical limitations cannot be given. The current TRL level is 6-7.

However, no legal requirements are foreseen. Depending on the region, it is possible that farmers can apply for subsidies or investment support for such environmentally benign installations.

F. Reference and demonstration:

https://www.vttresearch.com/en/ourservices/cellulose-films-and-coatings

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