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Recommendation for knowledge transfer in the area of improving wastewater treatment efficiency

Recommendation to support the transfer of knowledge between a given party (the developer of the solution) and organisations searching for solutions in the specific field of technology (wastewater treatment).

Keywords: Pitch, wastewater treatment, waste management, wastewater treatment, environmental pollution, microbiology, biofilm, biodegradation, enzymes, applied biosciences, EcoInn, knowledge transfer

Aims of this recommendation

This recommendation package aims to support the transfer of knowledge between a given party (the developer of the solution) and organisations searching for solutions in the specific field of technology (wastewater treatment).

Purpose: provide an eco-oriented company with unique biological materials and know-how in order to improve wastewater treatment efficiency

Target group of this recommendation package

This report addresses institutions in the fields of wastewater treatment/management, water pollution, microbiology-based cleaning strategies.

- Small and medium sized enterprises (SMEs)

Quick read

- A Hungarian wastewater treatment company seeked solutions to make its facilities and processes more efficient.
- The request was communicated via the EcoInn Virtual Lab Interconnection platform.
- An Austrian research institution elaborated a respective offer, comprising supply of unique microbial material and respective expertise, to facilitate an ecoinnovative biofilm-based degradation of diverse water pollutants.
- The recommendation package incl. biomaterials can be adapted for use in any private or state wastewater treatment plant wishing to improve efficiency and/or facing problems with specific pollutants.

Background to this recommendation package

The organisation featured in this recommendation packages has developed a solution that improves wastewater treatment efficiency through use of specific microbial consortia bacterial communities.

A successful technology transfer would result in increasing the efficiency of wastewater treatment facilities using unique microbial communities for pollutant biodegradation.

Initially, a Hungarian wastewater treatment company had deposited a demand for improving wastewater treatment efficiency, communicated via the EcoInn Virtual Lab interconnection platform

(see: http://ecoinnovative.eu/looking-for-a-number-of-eco-technology-solutions-and-component-parts-that-can-complement-its-business-and-solutions-technology-in-the-area-of-waste-management/).

The Austrian EcoInn partner Economica, together with an associated research institute developed a respective collaboration offer.

The Hungarian EcoInn project partner has been acting as negotiating entity to help establishing the anticipated collaboration between our research department and the wastewater treatment company.

Summary of party / parties

Research department (offer) and wastewater treatment company (demand)

Summary of eco-solutions/knowledge/technology

Application of unique bacterial consortia in wastewater treatment facilities is recommended. The biological material as well as relevant guidance for application can be provided by the offering entity.

Use of bacteria with diverse properties (biofilm formation, certain enzymes etc.) is recommended because of their potential benefit (accelerating waste compound decomposition/detoxification) for wastewater treatment.

Interested parties expect reduction of costs, materials, energy input and an overall “green shift” of their company´s performance. They are aware that the offer is not a ready-to-use solution but the first key component of an empirically developed solution adapted to individual conditions of company facilities.

The “solution” package comprises all required materials; both “hardware”, i.e. bacterial cultures, and “software”, i.e. microbiological knowhow and guidance to establish the ecoinnovative solution.

Summary of proposed collaboration / proposed partnership and knowledge transfer

The proposed collaboration offer comprises supply of unique microbial material, interactive planning, accompanying set-up and testing on existing wastewater treatment facilities, based on long-standing expertise in microbiology, biochemistry, and plant-microbe interactions.

Summary description

- Description: technology for improving wastewater treatment efficiency.
- Product or knowledge description: supply of unique biological material and diverse relevant knowhow
- Purpose: establish collaboration, match a demand, reduce environmental pollution, provide case study
- Considerations: The proposal can be adapted to match the need of any wastewater treatment companies. So far, despite efforts made by EcoInn partner as mediator, the “match” for a collaborative project still awaits feedback/approval/agreement from the company.

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Project co-funded by European Union funds (ERDF and IPA)

About the EcoInn Danube project

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- Sector: waste management, wastewater treatment, environmental pollution
- Results aimed to be achieved: ecoknowledge /ecomaterials transfer and implementation of R&D results. Long-term aim: cleaner water.

Summary of status of knowledge transfer

The trigger for pitch was an entry (category: demands) by a Hungarian wastewater treatment company on the Virtual Lab Interconnection platform. Economica contacted the EcoInn partner in Hungary, expressing interest and respective potential to match the demand. The Austrian partner was encouraged to elaborate a structured document with technical details etc; and offered to act as mediator/negotiator. The document was forwarded to the wastewater treatment company.

Status: awaiting response.

Options and scenarios

Since the request for improving wastewater treatment efficiency is not a company-specific one, the collaboration offer incl. transfer of biomaterials and knowhow is open to a wider target group.

Summary of recommendation(s)

Conclusions of recommendations

A wastewater treatment company willing to take up that solution needs to have a serious interest in science, innovative concepts and willingness to invest efforts into empirical optimization. Opportunities resulting therefrom are: entering a niche position, gaining market advantage

Annexes

Provide a list of documents supporting the recommendation.

The actual collaboration proposal, including scientific background, is provided as part of this RP in a separate document.

Date of recommendation package

28 Feb 2019

Author

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Recommendation packages relate to specific eco-solutions, specific problems or specific areas within technology transfer.

Partnership guidance recommendations aim to aid successful interaction between 2 or more specific demand and supply side stakeholders.

Pitch recommendations aim to aid successful knowledge transfer and/or commercialisation for a type of stakeholder.

Events, consultations and interactions recommendations aim to aid successful eco-knowledge transfer by focusing on a given issue, area or topic related to knowledge transfer.

Annex

Microbial Communities for Waste Water Treatment

Summary

Fixed bed biofilm-activated sludge (FBAS) technology is a comparatively young technology. Unlike conventional waste water treatment employing microbial suspensions for biodegradation, FBAS technology employs biofilm-forming microorganisms which can e.g. be attached to plant roots reaching into the reactor solution. Microorganism robustness, adaptiveness, metabolic activity, enzymatic setup, biofilm growth characteristics and plant-colonizing behavior are key parameters for further optimizing FBAS-based biodegradation in terms of costs and time efficiency, and accessibility of hitherto ´non-degradable´ substances. Our research efforts yielded naturally-evolved microbial communities exhibiting diverse morphological and metabolic characteristics clearly desirable for FBASbased waste water treatment. Microbial cell material as initial input can be generated within few days, and experimental data suggest direct compatibility with existing facilities, thus enabling set-up of pilot trials.

Though ORGANICA WATER successfully uses own microbial communities already, we see potential to further enhance the treatment process. Our contribution in a proposed collaboration encompasses supply of the microbial material, interactive planning, accompanying set-up and testing on ORGANICA WATER facilities, providing long-standing expertise in microbiology, biochemistry, plant physiology and plant-microbe interactions.

Background

Waste water usually contains a heterogenous mix of environmentally harmless and potentially harmful substances. Small particles and dissolved components escaping the filtering process ideally undergo decomposition under ecologically and economically sound conditions.

Efficient treatment of waste water -with frequently changing quantitative and qualitative composition- requires microorganisms with strong adaptiveness, diverse metabolic specifics and enzymatic capabilities. Reports exist on individual bacterial and fungal species that can e.g. degrade aliphatic hydrocarbons, secrete enzymes for breakdown of aromatic hydrocarbons or plastics materials. Reported performance tests were usually conducted on strain isolates and in clearly-defined media; far less complex than waste water. However, because single strains/species normally lack the enzyme portfolio needed for breakdown of complex polymer mixtures, degradation in teamwork engaging different strains is advisable. Incompatibility (e.g. mutual growth inhibition; diverging pH requirements) prohibits a simple mixing of selected microorganisms.

Efficient cleaning of waste water relies on concerted action of microorganism communities whose members tolerate each other, communicate, and flexibly respond (relative number of strains, enzyme profiles) to external conditions.

Invention

The invention relates to improving *fixed bed biofilm-activated sludge* (FBAS) technology-based waste water treatment. Naturally established microbial communities are employed for sustainable production of degradative enzymes and – simultaneously, for building high-surface biofilms. Rather than assembling selected microorganisms with diverse enzymatic capabilities into an artificial community, the approach engages an evolutionary-evolved naturally compatible microbial community. Members show desired degradative enzyme activities. The ability of these non-pathogenic microorganisms to colonize plant surfaces makes them particularly suitable for vegetation-equipped FBAS facilities. Their ability to colonize the plant Interior, to migrate in and between plant cells can facilitate swift establishment of functional FBAS ecosystems in newly constructed facilities. Secreted biosurfactants represent valuable by-products.

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Features & Benefits ○ technology differentiation compared to existing ones

1. Communities consist of non-GMO microorganisms that pose no harm to environment or human health. Based on DNA sequence data, members are phylogenetically related to beneficial species incl. probiotic bacteria, plant growth-promoting bacteria, microorganisms used for phytoremediation.
2. Community relative composition, enzyme activities and protein profiles flexibly change according to external conditions and nutrient availability. Tailor-made consortia can establish themselves.
3. Communities show rapid growth on/in diverse media (indicative of high metabolic activity) and biofilm formation on diverse materials, rendering them suitable for FBAS technology. The foldlike biofilm development yields biofilms with large surfaces; supporting waste compounds access to immobilized bacteria.
4. Microorganisms are highly robust, can cope with extreme pH conditions and other challenges such as hyper-/hypo-osmotic or heavy metal stress, high temperatures. These characteristics will enable fast recovery after e.g. temporary shut-down of TBAS facilities. Set-up of TBAS facilities exclusively for particular problem-waste-generating sectors might become feasible.
5. Experimental evidence exists for microbial degradation of e.g. paraffin, xylene, polyethylene glycol; there are also indications for polyethylene breakdown.
6. Microorganisms produce biosurfactants; compounds known to enhance waste water treatment efficiency. Collecting those biosurfactants as valuable by-product might further enhance economic efficiency of the FBAS-facility.
7. The microorganisms are able to colonize plants incl. plant roots. Neither diffusion-based colonization nor enforced (syringe) infiltration causes plant disease symptoms. There are indications of plant growth-promoting and resistance-supporting effects (plant immunity system is stimulated). There is evidence of microbial entering into and moving between plant cells. Such sustainable colonization of the plant interior can facilitate swift establishment of functional FBAS ecosystems in newly constructed facilities.
8. Long-term storage is possible (dried or frozen), enabling worldwide transport. Re-culturing requires no specific media or lag times.

Fields of Application

Above-described microorganisms have potential for application in waste water treatment; especially in facilities employing *fixed bed biofilm-activated sludge* (FBAS) technology. Given the extremely robust and adaptive features of the microbial community, potential exists for application in TBAS facilities dedicated to problematic types of waste water that so far have been inaccessible to biodegradation.

Principally, there are no restrictions in terms of geographic position, facility size, plant species selected for vegetation. Parallel use for biosurfactant production might further enhance economic efficiency of the FBAS-facility.

Development Status, Tech Readiness Level

Microbial communities have been isolated from natural material. Genetic and phylogenetic data exist, as well as evidence for protein profile adaptiveness and breakdown of diverse chemical substances, as well as for biofilm and biosurfactant production.

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Growth conditions for rapid generation of large biomass of microbial cells are known. From frozen culture aliquots it is possible to yield bacteria at the kilogram-scale within 2 weeks. The non-pathogenicity for and colonization of diverse plant species is verified, enabling first direct tests on FBAS facilities.

Proposal for Collaboration

Though ORGANICA WATER successfully uses own microbial communities already, we see potential to further enhance the treatment process. Our contribution in a proposed collaboration encompasses supply of the microbial material, interactive planning, accompanying set-up and testing on ORGANICA WATER facilities, providing long-standing expertise in microbiology, biochemistry, plant physiology and plant-microbe interactions. Detailed modalities of the envisaged collaboration may be discussed in a personal meeting.