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Study of emerging aerobic biotechnologies for sewage treatment and resource recovery

Fonte: Repositório Institucional UFC · Publicação original

INOVAÇÃO	APLICABILIDADE	POTENCIAL ECONÔMICO	MATURIDADE
8/10	9/10	8/10	Média

This paper from UFC evaluates emerging aerobic biotechnologies (MBBR, IFAS, AGS, AGS-BF) for sewage treatment and resource recovery. The research demonstrates that AGS and AGS-BF systems significantly outperform traditional methods in nitrogen removal (>70%) and phosphorus removal (>80%), while also enabling resource recovery opportunities that could reduce costs and support decentralized treatment approaches.

NÚCLEO DA ANÁLISE

Ideia de startup ou produto

A Brazilian startup focused on implementing modular, decentralized AGS-BF systems with integrated resource recovery capabilities. The company would offer 'treatment-as-a-service' models to municipalities and industrial clients, particularly in regions with aging infrastructure. The business model would include revenue streams from treatment services, sale of recovered nutrients (phosphorus, nitrogen), and potentially biogas production, leveraging the UFC research to optimize system configurations for Brazilian conditions.

Aplicações práticas

These technologies can be implemented in municipal and industrial wastewater treatment plants, particularly where nutrient removal is critical. The resource recovery aspects enable circular economy approaches within sewage treatment, potentially reducing operational costs while generating valuable byproducts. The decentralized potential of these technologies could be particularly valuable for smaller communities or industrial sites.

Potencial de mercado

The global wastewater treatment market was valued at around $270 billion in 2022 and is expected to grow at a CAGR of 6-8% through 2030. With increasing environmental regulations globally, there's significant demand for advanced treatment technologies. The resource recovery aspect opens additional market opportunities, with the market for nutrient recovery alone projected to reach $15 billion by 2030. In Brazil, the need for upgrading existing infrastructure creates substantial opportunities for these technologies.

FUNDAMENTO CIENTÍFICO

Problema abordado

The global challenge of improving sewage treatment efficiency amid increasing population growth, industrial advances, and changing consumption patterns that have led to more complex effluents. Traditional activated sludge technology struggles to meet increasingly stringent regulatory requirements for water body discharge, particularly in nitrogen and phosphorus removal.

Metodologia

The study employed a multi-faceted approach including experimental evaluation of AGS-BF compared to conventional AGS, comparative analysis of four emerging technologies (MBBR, IFAS, AGS, AGS-BF) for COD removal, nitrification, total nitrogen removal, and phosphorus removal, and a systematic review of resource recovery possibilities in AGS systems.

Principais descobertas

AGS-BF systems provide high-quality effluent with excellent total suspended solids and turbidity removal; AGS-BF achieved over 80% total nitrogen removal; AGS and AGS-BF systems showed superior nitrogen removal (>70%) compared to MBBR (48%) and IFAS (54%); Phosphorus removal exceeded 80% in AGS systems versus below 52% in MBBR and IFAS; Resource recovery possibilities include water reuse, sludge as inoculum, phosphorus recovery, and extraction of valuable compounds like alginate, tryptophan, and polyhydroxyalkanoates.

LEITURA PARA GESTÃO PÚBLICA

The study supports policies aimed at modernizing Brazil's sanitation infrastructure, particularly in the context of the National Sanitation Plan (PNS). The research can inform regulations for more stringent nutrient discharge limits, particularly for nitrogen and phosphorus. It also supports policies promoting circular economy approaches in sanitation, including incentives for resource recovery from wastewater and support for decentralized treatment systems in rural and peri-urban areas.

PARCERIA UNIVERSIDADE × EMPRESA

Collaboration between sanitation companies, water utilities, and the UFC to implement pilot projects demonstrating these technologies under Brazilian conditions. This could involve technology licensing, joint R&D initiatives focused on adapting these technologies for local wastewater characteristics, and knowledge transfer programs. Public-private partnerships could leverage federal and state funding for sanitation infrastructure modernization while incorporating these advanced treatment approaches with resource recovery components.

OPORTUNIDADES DERIVADAS

4 direções estratégicas identificadas

STARTUP · IMPACTO ALTO · GERAL

Modular Decentralized Treatment Systems

Development and implementation of compact, modular AGS-BF systems with integrated resource recovery capabilities for municipalities and industries in Brazil.

PARCERIA · IMPACTO MÉDIO · GERAL

UWC-UFC Technology Transfer Initiative

Collaboration between water utilities and UFC for technology adaptation, implementation, and optimization of these advanced treatment systems for Brazilian conditions.

POLÍTICA PÚBLICA · IMPACTO ALTO · GERAL

Modernization of Sanitation Infrastructure

Development of policies and regulations supporting the implementation of advanced treatment technologies with resource recovery components in Brazil's National Sanitation Plan.

PRODUTO CORPORATIVO · IMPACTO MÉDIO · GERAL

Advanced Treatment Technology Package

Engineering firms incorporating these emerging aerobic technologies as part of their portfolio for municipal and industrial wastewater treatment projects.

ABSTRACT ORIGINAL

Título: Study of emerging aerobic biotechnologies for sewage treatment and resource recovery Autor(es): Ferreira, Tasso Jorge Tavares Abstract: Activated sludge (AS) technology is the most used in sewage treatment plants (STPs) worldwide. However, with the population growth of recent decades, industrial advances, and changes in consumption patterns, the generation and complexity of effluents have also increased. Thus, STPs face the challenge of increasing treatment efficiency, often to comply with legal requirements for water bodies discharge increasingly restrictive. The search for improvements resulted in the emergence of new technologies such as MBBR (Moving Bed Biofilm Reactor), IFAS (Integrated Fixed FilmActivated Sludge), and AGS (Aerobic Granular Sludge). Therefore, this study was carried out to compare the above emerging aerobic technologies in sanitary sewage treatment to contribute to decision-making in designing future ETEs. In addition, several ways of recovering resources were pointed out to assist in introducing the circular economy within sewage treatment. The first investigation evaluated the influence of including a biofilter layer in a sequential batch reactor with AGS. This study observed that theAGS-BF (R2) system provided a high-quality effluent in terms of total suspended solids and turbidity, in addition to obtaining Total Nitrogen removals above 80% throughout the experimental period. Another fact observed was that the sludge production was evaluated, and the yield coefficient (Y, gVSS/gCODrem) and sludge concentration were higher in the AGS-BF reactor than in the conventional AGS reactor. The new reactor configuration proved to be an alternative to improve some aspects of conventional AGS reactors, such as denitrification and nitrite accumulation, the concentration of TSS in the effluent, and increased system reliability during periods of instability and granule breakage. The second investigation compared four emerging aerobic technologies (MBBR - R1, IFAS - R2, AGS - R3, and AGS-BF - R4) for sanitary sewage treatment and resource recovery. In this study, COD removal and nitrification were high for all reactors. However, total nitrogen removal was moderate for reactors R1 (48%) and R2 (54%), but values above 70% were observed for R3 and R4. Phosphorous removal was also possible, reaching values below 52% for the MBBR (R1) and IFAS (R2) systems but with values above 80% in the aerobic granulation systems R3 and R4. The concentration of volatile solids in the effluent was also higher in R1 and R2 (6.1 and 6.7 mg/L, respectively) when compared to R3 (4.2 mg/L) and R4 (5.4 mg/L). The third study consisted of a systematic review of the recovery of resources such as water, energy,

chemicals, raw materials, and nutrients in AGS systems. In this study, several ways of recovering resources were shown, such as water reuse, the use of sludge as inoculum in AGS WWTPs, recovery of phosphorus, recovery of alginate, tryptophan, polyhydroxyalkanoates, biogas, and other compounds found in AGS. Finally, this study highlighted that the recovery of resources inAGS systems could be a solution to reduce treatment costs, making the technology more viable and decentralized. Tipo: Dissertação