UNIVERSIDADE FEDERAL DA GRANDE DOURADOS
FACULDADE DE CIÊNCIAS EXATAS E TECNOLOGIA
Programa de Pós-Graduação em Ciência e Tecnologia Ambiental

Avaliação da Biotransformação dos Produtos da Reação Álcali-Sílica por *Bacillus clausii e Bacillus thuringiensis*

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DOURADOS
MATO GROSSO DO SUL
2023

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DOUTORADO EM CIÊNCIA E TECNOLOGIA AMBIENTAL

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Tese apresentada à Universidade Federal da Grande Dourados, como parte das exigências do Programa de Pós-Graduação em Ciência e Tecnologia Ambiental (área de concentração: ciência ambiental e tecnologia ambiental), para obtenção do título de doutor.

DOURADOS
MATO GROSSO DO SUL
2023

Dados Internacionais de Catalogação na Publicação (CIP).

S586a Silva, Domingos Jorge Ferreira Da

Avaliação da Biotransformação dos Produtos da Reação Álcali-Sílica por Bacillus clausii e Bacillus thuringiensis [recurso eletrônico] / Domingos Jorge Ferreira Da Silva. -- 2023.

Arquivo em formato pdf.

Orientadora: Kelly Cristina Da Silva Brabes.

Coorientadora: Evaristo Alexandre Falcão.

Tese (Doutorado em Ciência e Tecnologia Ambiental)-Universidade Federal da Grande Dourados, 2023.

Disponível no Repositório Institucional da UFGD em: https://portal.ufgd.edu.br/setor/biblioteca/repositorio

1. Gel da reação álcali-agregado. 2. Micro-organismos. 3. Reação álcali-agregado. 4. Síntese. I. Brabes, Kelly Cristina Da Silva. II. Falcão, Evaristo Alexandre. III. Título.

Ficha catalográfica elaborada automaticamente de acordo com os dados fornecidos pelo(a) autor(a).

Termo de Aprovação

Após apresentação, arguição e apreciação pela banca examinadora, foi emitido o parecer ____aprovado____, para a tese intitulada: **"Avaliação da Biotransformação dos Produtos da Reação Álcali-Sílica por *Bacillus clausii* e *Bacillus thuringiensis*",** de autoria de **DOMINGOS JORGE FERREIRA DA SILVA,** apresentada ao Programa de Doutorado em Ciência e Tecnologia Ambiental da Universidade Federal da Grande Dourados.

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DEDICATÓRIA

Para meus pais Almerinda e Italívio.

AGRADECIMENTOS

Agradeço a minha orientadora, Prof[a]. Dr[a]. Kelly Cristina Da Silva Brabes, e ao meu co-orientador, Prof. Dr. Evaristo Alexandre Falcão, pelo apoio, acompanhamento, incentivo, sugestões e comentários ao longo dessa pesquisa.

Ao Prof. Dr. Jorge Luís Akasaki, por fornecer o laboratório, materiais, equipamentos e pessoal para o desenvolvimento de análises e ensaios realizados na Universidade Estadual Paulista, Campus de Ilha Solteira, importantíssimos para essa pesquisa.

Um agradecimento a colega de Doutorado e amiga Maria Joyce dos Santos Silva pelo apoio incondicional nos desenvolvimentos experimentais que envolviam os micro-organismos, contribuindo de forma marcante nessa pesquisa.

A todos os professores, funcionários e colegas do Programa de Pós-Graduação em Ciência e Tecnologia Ambiental, que com seus ensinamentos contribuíram de forma efetiva para o meu crescimento profissional.

A todos os demais que, direta ou indiretamente, contribuíram para a realização deste trabalho.

RESUMO

SILVA, D. J. F. **Avaliação da biotransforção dos produtos da reação álcali-sílica por *Bacillus clausii* e *Bacillus thuringiensis***. 2023. 115f. Tese (Doutorado em Ciência e Tecnologia Ambiental). Programa de Pós-graduação em Ciência e Tecnologia Ambiental, Universidade Federal da Grande Dourados, Dourados, 2023.

Atualmente, existem vários meios de reduzir a possibilidade de ocorrência da reação álcali-sílica (RAS), quando adotadas medidas que atenuem as condições favoráveis à sua ocorrência, evitando possíveis danos às estruturas de concreto. Entretanto, depois da RAS instalada em uma estrutura de concreto, não existe uma solução totalmente eficiente e economicamente viável que atenue os efeitos expansivos da RAS. Na presente pesquisa foi estudado a capacidade dos micro-organismos *Bacillus clausii* e *Bacillus thuringiensis* em biotransformar os produtos da RAS, e assim contribuir com um estudo inicial e proposição de uma alternativa, para solucionar problemas causados por expansões em estruturas afetadas pela RAS. Os produtos da RAS foram sintetizados em condições controladas de laboratórios, a partir de fontes de sílica de natureza amorfa (pirex) e cristalina (seixo) e inoculados com os micro-organismos por um período de 40 dias, sendo submetidos a caracterização microestrutural utilizando as técnicas de DRX e FTIR nos períodos de 10, 20, 30 e 40 dias. Os resultados mostraram que as bactérias *B. clausii* e *B. thuringiensis* foram capazes de biotransformar os produtos da RAS, reduzindo a valores superiores a 80% do produto inicial. As bactérias apresentaram ser mais eficientes na biotransformação dos produtos da RAS produzidos a partir do agregado amorfo (pirex), biotransformando os produtos a valores superiores a 98% do produto inicial, indicando que a mineralogia dos agregados tem influência no processo de biotransformação. O *B. clausii* mostrou-se mais eficiente no processo de biotransformação da RAS do que o *B. thuringiensis*, principalmente por apresentar um crescimento populacional semelhante em ambas as amostras produzidas com diferentes fontes de sílica.

Palavras-chave: Gel da reação álcali-agregado; micro-organismos; reação álcali-agregado; síntese.

ABSTRACT

SILVA, D. J. F. **Evaluation of the biotransformation of alkali-silica reaction products by *Bacillus clausii* e *Bacillus thuringiensis***. 2023. 115f. Thesis (PhD in Environmental Science and Technology). Postgraduate Program in Environmental Science and Technology, Universidade Federal da Grande Dourados, Dourados, 2023.

Currently, there are several ways to reduce the possibility of the occurrence of the alkali-silica reaction (ASR), when measures are adopted to attenuate the favorable conditions for its occurrence, avoiding possible damage to concrete structures. However, after the ASR is installed in a concrete structure, there is no fully efficient and economically viable solution to mitigate the expansive effects of the ASR. In the present research, the ability of *Bacillus clausii* and *Bacillus thuringiensis* microorganisms to biotransform RAS products was studied, and thus contribute to an initial study and proposition of an alternative, to solve problems caused by expansions in structures affected by ASR. The ASR products were synthesized under controlled laboratory conditions, from sources of amorphous (pyrex) and crystalline (pebble) silica and inoculated with microorganisms for a period of 40 days, being submitted to microstructural characterization using the DRX and FTIR techniques in periods of 10, 20, 30 and 40 days. The results showed that the bacteria *B. clausii* and *B. thuringiensis* were able to biotransform the ASR products, reducing to values greater than 80% of the initial product. The bacterias showed to be more efficient in the biotransformation of the RAS products produced from the amorphous aggregate (pyrex), biotransforming the products at values greater than 98% of the initial product, indicating that the mineralogy of the aggregates influences the biotransformation process. *B. clausii* proved to be more efficient in the process of biotransformation of RAS than *B. thuringiensis*, mainly because it presented a similar population growth in both samples produced with different sources of silica.

Keywords: Alkali-aggregate reaction; alkali-aggregate reaction gel; microorganisms; synthesis.

II. Ampliar os estudos de biotransformação dos produtos da RAS em amostras retiradas de diferentes estruturas de concreto com a RAS já instalada com o intuito de corroborar todas as suposições apresentadas e abrir vertentes para formas de eliminar a reação e desenvolver métodos de reparo mais eficientes.

III. Estudar o conjunto agregado/cimento/micro-organismo com o objetivo de encontrar as espécies de micro-organismos mais eficientes no processo de biotransformação dos produtos da RAS e que melhor se adapte as condições do ambiente a qual serão expostas.

IV. Estudar a biotransformação dos produtos da RAS em estruturas de concreto com a RAS já instalada, variando: diversas condições ambientais como temperatura, umidade e submersão; o volume, a área superficial e a porosidade do concreto; as espécies, as concentrações e os métodos de aplicação dos micro-organismos. Fazer uma correlação entre as variáveis citadas de modo a encontrar a melhor espécie, concentração e aplicação de micro-organismo para que consiga mitigar ou inibir a RAS em estruturas de concretos afetados pela RAS encontrados em diferentes condições ambientais.

V. Propor novos métodos de análise do conjunto agregado/cimento/micro-organismo na mitigação da ação deletéria da RAS.

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