

Article

Experimental Study on the Permeability of Microbial-Solidified Calcareous Sand Based on MICP

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Abstract: In the construction of artificial islands in distant seas, calcareous sand has been widely used as a foundation filler due to its excellent mechanical properties and extensive availability in the marine environment. How to store more fresh water on the artificial islands by reducing its permeability is currently a great challenge. Microbial-induced carbonate precipitation (MICP) has always been considered as a great potential method to improve the cemented properties of calcareous sand, but the effect of grain gradation on the permeability of MICP-improved calcareous sand remains unclear. In this research, a self-made device was developed to conduct MICP grouting and permeability tests, where the permeability coefficient (k) under different grain gradations (curvature coefficient (C_u) and uniformity coefficient (C_u)) was measured. A CT scan was conducted to investigate the variation in the porosity (n) of sand samples before and after MICP treatment. The weighting method was adopted to measure the content of induced calcium carbonate (M). A scanning electron microscopy (SEM) technique was used to further study the micromechanism of the MICP treatment. Finally, the correlations between the k of MICP-treated sand and C_u , as well as C_u , were semiquantitatively analyzed. The results show that the magnitude of M , k and n changes are closely related to C_u and C_u . The reduction amount of k and n increased with the rise in C_u and C_u , and the increased amount of M increased with the rise in C_u and C_u . The SEM results show that the particle surface became rough due to the coating effect of CaCO_3 crystals, and the pore spaces were reduced because of the partially filling effect of the crystals, which was responsible for the decrease in permeability and porosity. Furthermore, k fitted well with C_u and C_u , respectively, and the fitting curve reveals that larger C_u ($C_u \geq 6.0$) and smaller C_u ($2.0 > C_u > 0.5$) were more suitable for MICP treatments and lead to a large reduction in permeability. The above results indicate that the grain gradation of calcareous sand had a significant influence on its permeability improved by MICP.

Keywords: MICP; calcareous sand; grain gradation; permeability coefficient; porosity



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1. Introduction

The construction of artificial islands is in full swing all over the world due to space limitation in coastal areas [1,2] and transfer transportation requirements in distant seas (e.g., Fiery Cross Island in the South China Sea). On the artificial islands, the storage and access of fresh water are important fundamental conditions for human living [3,4]. In China, it has been reported that the cost of transporting high-quality tap water from the mainland to one island reaches USD 370 thousand per year [5]. How to store more fresh water on the artificial islands is of great significance to cost savings. Previous efforts have found that the permeability of island-building materials dominates the water storage on the island. General consensus has been achieved that the application of less permeable island-building materials can increase freshwater storage [6,7].

Regarding island-building materials, calcareous sand, formed by the accumulation of coral debris and other biological debris, has been widely used as a foundation filler [8–10] due to its excellent mechanical properties and extensive availability in marine environments [11,12]. However, the reclamation in distant seas using sand is often carried out via

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Theory and Practice in Microbial Enhanced Oil Recovery Kun Sang Lee, Tae-Hyuk Kwon, Taehyung Park, Moon Sik Jeong, 2020-07-18 Selection of the optimal recovery method is significantly influenced by economic issues in today's oil and gas markets. Consequently, the development of cost-effective technologies which bring maximum oil recovery is the main interest in today's petroleum research communities. *Theory and Practice in Microbial Enhanced Oil Recovery* provides the fundamentals, latest research, and creditable field applications. Microbial Enhanced Oil Recovery (MEOR) is potentially a low-priced and eco-friendly technique in which different microorganisms and their metabolic products are implemented to recover the remaining oil in the reservoir. Despite drastic advantages of MEOR technology, it is still not fully supported in the industry due to lack of knowledge on microbial activities and their complexity of the process. While some selected strategies have demonstrated the feasibility to be used on a mass scale through both lab and field trials, more research remains to implement MEOR into more oil industry practices. This reference delivers comprehensive descriptions on the fundamentals, including basic theories on geomicrobiology, experiments, and modeling, as well as current tested field applications. *Theory and Practice in Microbial Enhanced Oil Recovery* gives engineers and researchers the tool needed to stay up to date on this evolving and more sustainable technology. Covers fundamental screening criteria and theories, selective plugging, and mobility control mechanisms. Describes the basic effects on environmental parameters and the mechanics of simulation, including microbial growth kinetics. Applies up to date practical applications proven in both the lab and the field. Fundamentals of Enhanced Oil and Gas Recovery from Conventional and Unconventional Reservoirs Alireza Bahadori, 2018-08-18 *Fundamentals of Enhanced Oil and Gas Recovery from Conventional and Unconventional Reservoirs* delivers the proper foundation on all types of currently utilized and upcoming enhanced oil recovery, including methods used in emerging unconventional reservoirs. Going beyond traditional secondary methods, this reference includes advanced water-based EOR methods which are becoming more popular due to CO₂ injection methods used in EOR and methods specific to target shale oil and gas activity. Rounding out with a chapter devoted to optimizing the application and economy of EOR methods, the book brings reservoir and petroleum engineers up to speed on the latest studies to apply. Enhanced oil recovery continues to grow in technology and with ongoing unconventional reservoir activity underway, enhanced oil recovery methods of many kinds will continue to gain in studies and scientific advancements. Reservoir engineers currently have multiple outlets to gain knowledge and are in need of one product to go to for reference. Explains enhanced oil recovery methods focusing specifically on those used for unconventional reservoirs. Includes real-world case studies and examples to further illustrate points. Creates a practical and theoretical foundation with multiple contributors from various backgrounds. Includes a full range of the latest and future methods for enhanced oil recovery, including chemical waterflooding, CO₂ injection, and thermal. **Microbial Permeability** John P. Reeves, 1973 Antifungal and Antiparasitic Drug Delivery Juan José Torrado Durán, Dolores R.

Serrano,Javier Capilla,2020-07-01 Fungal and parasitic diseases affect more than one billion people across the globe This is one sixth of the world s population mostly located in developing countries The lack of effective and safe treatments combined with inefficient diagnosis leads to serious chronic illness or even death There is a discrepancy between the rate of drug resistance and the development of new medicines Formulation of antifungal and antiparasitic drugs adapted to different administration routes is challenging bearing in mind the poor water solubility that limits their bioavailability and efficacy There is an unmet clinical need to develop vaccines novel formulations and drug delivery strategies that can improve the bioavailability and therapeutic effects by enhancing their dissolution increasing their chemical potency stabilizing the drug and targeting high concentrations of the drug to infection sites This Special Issue includes ten research articles of antifungal and antiparasitic drug delivery systems

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Abstracts of Bacteriology Society of American Bacteriologists, 1923 Includes Scientific proceedings of the Society of
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