1st Iran InterPore Conference

Report of Contributions

Contribution ID: **4** Type: **Poster Presentation**

The study of drug release processes: modeling

The advent of drug delivery systems has garnered considerable attention from researchers as a novel method for drug delivery. Among the advantages of such systems is the gradual release of drugs at a constant rate, which significantly reduces the frequency of drug administration and associated adverse effects.

This article aims to provide a comprehensive review of existing mathematical models which correspond to the known drug release mechanisms, classified as diffusion-, swelling-, and erosion-controlled systems. The modeling of drug transport through drug release systems involving chemical reactions and polymer erosion on the skin has been investigated for transdermal drug delivery systems. A mathematical model has been developed to predict the drug release rate and the position of the moving boundary layer within the system at any moment.

The presented model, considering linear and nonlinear changes in polymer matrix erosion, has been semi-analytically solved using the Galerkin and Lee methods; The outcome provides curves illustrating the relationship between the drug release rate, the amount of drug released, the position of the moving boundary, and system performance over time.

The results indicate that the drug release rate and the amount of drug released, augment with the increase in the ratio of the reaction rate constant to the diffusion coefficient and the initial drug concentration. Additionally, the system performance time decreases as the ratio of the reaction rate constant to the diffusion coefficient and the initial drug concentration increases. The solution of the presented model using the Galerkin and Lee methods yields similar results.

Student presentation contest

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Journal Submission

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Student Poster Contest

Opt In

Primary author: Ms DEHGHAN, Shiva

Presenter: Ms DEHGHAN, Shiva

Track Classification: New Energies / Underground Gas Storage

Contribution ID: **5** Type: **Poster Presentation**

Injection and storage of carbon dioxide gas in depleted oil and gas reservoirs in order to enhance oil recovery and preserve the environment

Lately, the increasing discharge of greenhouse gases from burning fossil fuels has brought irreversible environmental damage, and global warming has been triggered by this environmental problem. The greenhouse gases, particularly carbon dioxide, have become the primary reason for global warming. Consequently, carbon dioxide has become an environmental pollutant of a grave nature and deserves careful analysis, as it has such an important role in the climate change processes. As a result, researchers have come up with a number of potential strategies, one of which is injecting carbon dioxide into depleted oil and gas reservoirs. Research projects have identified that the rock cap used for containing oil and gas in past events can be re-used to restrain the newly introduced carbon dioxide and would stop upward migration. Depleted oil and gas reservoirs offer superior geologic storage opportunities compared to deep saline reservoirs. A key component to the potential storage capacity of the reservoirs is to understand the ideal pressure to inject carbon dioxide, a matter pertinent to reservoir engineers. In fact, the injection and storage of carbon dioxide in depleted oil and gas reservoirs not only contributes to reducing greenhouse gases but can also potentially benefit in enhancing oil recovery from depleted reservoirs, ultimately achieving a profitable economic level for the oil-producing country.
Keywords: greenhouse gases, carbon dioxide, depleted reservoirs, storage, enhancing oil recovery

Student presentation contest

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Journal Submission

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Student Poster Contest

Opt In

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Track Classification: Geotechnique/Soil Mechanics

Contribution ID: **6** Type: **Oral Presentation**

Investigation of natural surfactants in interaction with divalent ions and their effects on the environment

Tuesday, 24 September 2024 09:45 (15 minutes)

Although the realm of water and gas injection within enhanced oil recovery has garnered considerable attention in the contemporary era, some engineers believe that alternative and cost-effective methods could play a more pivotal role in this field. Utilization of substances like surfactants and polymers is seen as an innovative technique that has made a substantial impact on the oil sector; however, the large-scale production of such materials proves to be financially burdensome. Furthermore, the manufacture of these substances results in hazardous wastes, posing risks to both human health and the environment, ultimately leading to extensive and irreversible pollution. The adoption of natural surfactants emerges as a viable solution with relatively high efficacy. These plant-derived surfactants, extracted from indigenous plant leaves, are cost-effective, biodegradable, and pose no threat to human health or the environment. The incorporation of these natural surfactants in oil-related experiments has yielded satisfactory outcomes, showcasing their effectiveness in reducing the interfacial tension between water and oil, modifying crude oil viscosity, enhancing the extraction rate of asphaltene, and isolating heavy components of crude oil.

Student presentation contest

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Journal Submission

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Student Poster Contest

Opt In

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Session Classification: Parallel Session 1

Track Classification: Hydrocarbon Recovery / Flow in Porous Media

Contribution ID: **8** Type: **Oral Presentation**

Investigating Cohesion Influence on Fine Particle Transport via Pore Doublet Model A CFD-DEM Analysis

Tuesday, 24 September 2024 10:00 (15 minutes)

This research delves into the transportation of micro-sized particles within a doublet pore model featuring two distinct pore throat sizes. To simulate a two-phase particle-fluid suspension, the CFD-DEM method is employed, combining the Navier-Stokes equation with Newton's second law of particle motion. Cohesion forces between particles and pore throats are characterized using the Simplified Johnson-Kendall-Roberts (SJKR) contact model, which is applied in our simulation to identify locations of agglomerations. Results reveal that altering cohesive energy density, from 10,000 J/m^3 to 100,000 J/m^3 , significantly increases the likelihood of agglomeration in the smaller pore throat. It becomes evident that areas in close proximity to the throats are the most prone to particle agglomerations, leading to pressure drops over time. The formation of particle clusters within the pore throats intensifies with both an increase in the number of particles and fluid velocity from 0.001 m/s to 0.01 m/s . Nevertheless, low flow rates (0.001 m/s) are insufficient to mitigate blockages.

Student presentation contest

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Journal Submission

Not Interested

Student Poster Contest

Opt In

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Session Classification: Parallel Session 1

Track Classification: Hydrocarbon Recovery / Flow in Porous Media

Contribution ID: **9** Type: **Oral Presentation**

Exploring the Influence of Porous Media Morphology and Capillary Number on Immiscible Oil Recovery

Tuesday, 24 September 2024 09:45 (15 minutes)

Pore-scale simulation and analysis of oil displacement in digital rocks has shown great promise in tracking oil recovery in porous media. This paper examines three digital rocks with varying pore and throat radii but the same porosities, studying their behavior under immiscible oil recovery through waterflooding. Computational fluid dynamics was used to conduct numerical simulations to observe the impact of rock morphology on breakthrough times, residual oil saturations, and oil displacement patterns. The validity of the simulation mechanism is confirmed in both imbibition and drainage conditions through the pore doublet Chatzis' experiment. This study consisted of 33 separate simulations which varied in mobility ratios, interfacial tensions, and injection velocities. The findings suggest that smaller pore and throat radii result in higher oil recovery and water percolation and faster breakthrough times that facilitates the effects of viscous fingering. An increase in capillary number was found to have a significant impact on oil recovery in larger pores and throats.

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Journal Submission

Not Interested

Student Poster Contest

Opt In

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Session Classification: Parallel Session 2

Track Classification: Hydrocarbon Recovery / Flow in Porous Media

Contribution ID: **10** Type: **Oral Presentation**

The Relationship between Pore Types and Reservoir Flow Units in a Heterogeneous Carbonate Reservoir

Tuesday, 24 September 2024 10:00 (15 minutes)

Heterogeneity in carbonate reservoirs, originating from various depositional, diagenetic, and fracturing processes, presents a significant challenge in identifying flow units and reservoir zonation. In this study, to identify the main productive units and understand the relationship between the pore nature and their role in development of different reservoir zones, core data and petrophysical logs from a well were used. Based on the modified Lorenz Plot, the reservoir rock was initially divided into 10 reservoir units. Reservoir heterogeneity assessments indicated that some zones still exhibit high heterogeneity. Therefore, using other methods such as cumulative permeability plot, normalized cumulative reservoir quality index, and calculation of pore throat radius, the identified zones were further divided into 20 sub-zones or flow units: high-speed, baffle, and barrier flow units.

The high-speed flow units (eight units), which approximately have a cumulative thickness of about 102 meters and contribute to over three-quarters of the well's production, correspond to dolomitized grainstone facies with interparticle and intercrystalline pores and an average pore throat radius of over 5 microns (macro and megapores). The baffle units correspond to grainstones with oomoldic porosity and predominantly dolomitized mud-dominated facies with pore sizes less than one micron (meso- and micropores). The barrier units, contributing less than one percent to the well's production, account for one-third of the reservoir rock thickness and predominantly correspond to low-porosity facies of reservoir units K3 and K1 and extend near the Permo-Triassic boundary sequence.

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Student Poster Contest

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Session Classification: Parallel Session 2

Track Classification: Hydrocarbon Recovery / Flow in Porous Media

Contribution ID: **11** Type: **Poster Presentation**

A review of the application of image processing in porous media

Nowadays, the study of fluid flow and transfer phenomena in porous media has received much attention due to its importance in industrial, engineering, biological and environmental applications. Geometry, cavity space and topology are among the key characteristics of porous media. These components play an important role in determining the characteristics of the porous medium. Image processing, as one of the sub-branches of artificial intelligence and machine learning, has unique capabilities in image analysis. Image recognition is becoming a very important step in most problem solving systems in the modern world. There are many methods of image acquisition, analysis and classification available. Image processing methods and algorithms are satellite and remote imaging, video images, 3D images. In porous environments, image processing can help to separate and identify materials in the environment, calculate physical parameters such as density, weather in the environment, improve processes related to porous environments, etc. Image processing in porous environments is a powerful tool for analyzing and recognizing the characteristics of the environment. In this research, the studies conducted in the field of porous media and various applications of image processing in porous media have been discussed. Image processing-based measurement techniques have the advantages of non-destructive, easy operation, deep 3D visibility and high resolution. The application area of porous materials can be extended by using suitable imaging techniques. Image processing techniques include image alignment, image stitching, contrast enhancement, thresholding, image separation, 3D reconstruction, etc. The use of these materials is strongly influenced by the properties of the measured materials. Image processing methods can be transferred to other areas with similar image characteristics. To achieve accurate results, image processing-based measurement needs to be improved in terms of hardware, testing, and image processing algorithms.

Student presentation contest

Not Interested

Journal Submission

Not Interested

Student Poster Contest

Not Interested

Primary authors: AKBARZADEH, Alireza; Dr AGHDASINIA, Hassan; Dr AHMADLOUYDARAB, Majid

Presenter: Dr AGHDASINIA, Hassan

Track Classification: Geotechnique/Soil Mechanics

Contribution ID: **12** Type: **Oral Presentation**

[illegible]

Tuesday, 24 September 2024 09:45 (15 minutes)

This study focuses on the characterization of reservoir rock characteristics to improve hydrocarbon recovery, groundwater management, and geothermal energy extraction. Traditional methods for determining properties such as porosity, permeability, and pore size distribution are often labor-intensive and time-consuming. Instead, this research uses a pore network model to simulate and analyze fluid flow in porous networks. This study describes the process of creating digital pore network models from microCT images, calibrating them with experimental data, and extracting petrophysical properties through simulation. Analysis of a carbonate rock formation shows a porosity of 14.03%, which indicates limited pore space for fluid storage and flow. The tortuosity value of 2.96 indicates a complex pore network that prevents fluid movement. Despite the low formation resistance factor (0.2), which implies good continuity, the molar flow rate is low, which corresponds to the reduction of effective porosity. 1.00046 ohm meter as rock resistance and 0.20009 ohm meter indicates the presence of hydrocarbon. The effective release value of 2.1879 is an effective factor in fluid extraction due to the inherent properties of the reservoir, which causes the level of this parameter to be low. Overall, these findings indicate that the reservoir has limited productivity, which requires improved mining techniques.

Student presentation contest

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Journal Submission

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Student Poster Contest

Not Interested

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Session Classification: Parallel Session 4

Track Classification: Digital Rocks / Machine Learning

Contribution ID: **13** Type: **Poster Presentation**

Direct numerical simulation of single-phase fluid flow in two-dimensional porous media

The present study investigates the simulation of incompressible fluid flow of water using the OpenFOAM software in a porous medium. The solid phase is imported into the software via an ".stl" file format, and the solid region is extracted from the raw geometry utilizing the snappyHexMesh utility. To analyze the problem in two dimensions, a single cell layer is generated perpendicular to the plane. Subsequently, a mesh study is conducted, and an optimal mesh is selected. The results indicate that a pressure drop of one pascal is established between the inlet and outlet under laminar flow conditions. Furthermore, as the cross-sectional area available for flow decreases, the fluid velocity increases.

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Opt In

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Presenter: POURFAROKH, Mohammad Reza (School of Mechanical Engineering, Iran University of Science and Technology, 16846-13114, Tehran, Iran)

Track Classification: Geotechnique/Soil Mechanics

Contribution ID: **14** Type: **Poster Presentation**

Direct numerical simulation of two-phase fluid flow in two-dimensional porous media

The current research investigates the numerical simulation of incompressible two-phase flow of water and oil in a porous medium using the OpenFOAM software. The methodology for generating the porous geometry and grid study is explored. To facilitate a two-dimensional analysis, a single grid cell is constructed in the direction perpendicular to the planar domain. Subsequently, a water-oil mixture with an oil phase volume fraction of 0.5 is introduced from the left boundary of the computational domain. Owing to the imposed pressure gradient between the left and right boundaries, the multiphase fluid flow is driven towards the outlet, ultimately exiting through the right boundary. The numerical results demonstrate that a pressure differential of one pascal is maintained between the inlet and outlet flows. Additionally, due to the lower density of the oil phase relative to water, the oil phase exhibits a tendency to progressively stratify above the water phase within the porous medium.

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Student Poster Contest

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Track Classification: Geotechnique/Soil Mechanics

Contribution ID: **15** Type: **Poster Presentation**

Comparison of the catalytic activity of a zirconium-based metal-organic framework and its defective structure in hydrogen production

In this research, a zirconium-based metal-organic framework (MOF-801) and its post-synthetically produced modified structure (Quasi-801) were used to access unsaturated metal centers as active catalytic sites for hydrogen gas production using sodium borohydride (NaBH4). For this purpose, the zirconium-based metal-organic framework was first synthesized in dimethylformamide (DMF) solvent. Then, through controlled thermal treatment, the structure was modified, and the related quasi- metal-organic framework with unsaturated metal sites was created. The presence of these metal sites as Lewis acids in the catalytic reaction of hydrogen production from the hydrolysis of sodium borohydride proved to be effective and increased the catalytic efficiency. Additionally, the effects of temperature change on the catalytic activity of the metal-organic framework (and its modified structure) and the amount of hydrogen produced were investigated. An increase in reaction temperature activates some of the metal sites that are inactive at lower temperatures. Consequently, thermal modification added to the number of available sites for hydrogen production, two-fold increasing the process yield. According to the results, the thermal modification process effectively impacts the catalytic performance of the structure and improves the catalytic behavior of the structure. Therefore, the development of quasi- metal-organic frameworks can be an attractive method for developing hydrogen production catalysts as a clean fuel.

Student presentation contest

Not Interested

Journal Submission

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Student Poster Contest

Opt In

Primary authors: ROUHANI, Farzaneh; ZEIRANI GASHTI, Maryam

Presenter: ZEIRANI GASHTI, Maryam

Track Classification: Hydrocarbon Recovery / Flow in Porous Media

Contribution ID: **16** Type: **Oral Presentation**

Investigating the fluid behavior of the mixture of smoke and air in the porous filter part of the cigarette

Wednesday, 25 September 2024 10:00 (15 minutes)

Investigation of cigarette rod's fluid behavior and flow regime has a high importance regarding the concerns of human health and environmental perspectives. The simulation study in the case of cigarette smoke can be performed in time-dependent calculations for tobacco part and stationary calculations for the filter part. In this study, the modeling was tried to be accomplished in the filter part through COMSOL-Multiphysics software. Equations that were utilized for modeling contains the formulas of filter porosity and permeability in the fibrous beds. Employing the mentioned simulation tool, velocity and pressure contours, heat transfer behavior and some other elements can be obtained. By the comparison of the mentioned contours, the difference in the values of parameters such as velocity and pressure could be obviously observed (suction terminal to tobacco terminal).

Student presentation contest

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Journal Submission

Consider for Journal Submission

Student Poster Contest

Opt In

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Presenter: HOSSEINI, Seyyed Reza (University of Tabriz, Department of Chemical Engineering and Petroleum)

Session Classification: Parallel Session 7

Track Classification: Diverse Topics in Porous Media

Contribution ID: **17** Type: **Oral Presentation**

Numerical Investigation of Spontaneous Imbibition of Power Law Fluids in Partially Saturated Porous Mediums

Tuesday, 24 September 2024 09:45 (15 minutes)

In this study, numerical investigation of Richard's equation of physiological liquids obeying power law rheological behavior has been investigated in partially double layered porous mediums based on effective viscosity concept. COMSOL Multiphysics has been selected to numerical solution of governing equations. Based on the obtained numerical results, the range of Reynolds number (which is defined based on averaged channel's inlet velocity) has always shown the values too smaller unity for different values of power law indexes which is an implicitly credential of validity of Darcy equation governed in porous mediums. Beside this, the results have shown the value of absorbed mass by the system has notably increased lower power law indexes (described as an improvement in the fluid's shear thinning behavior). Similarly, for a given power law fluid, increase on the thickness of the layer including larger permeability, leads to increase on the value of absorbed mass by the double layer porous mediums.
Keywords: Richard's Equation; Physiological Fluids; Power law model; Effective Viscosity; COMSOL Software.

Student presentation contest

Opt in

Journal Submission

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Student Poster Contest

Opt In

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Session Classification: Parallel Session 3

Track Classification: Geotechnique/Soil Mechanics

Contribution ID: **18** Type: **Oral Presentation**

[illegible]

Tuesday, 24 September 2024 10:00 (15 minutes)

[illegible]

Student presentation contest

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Journal Submission

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Student Poster Contest

Opt In

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Session Classification: Parallel Session 3

Track Classification: Geotechnique/Soil Mechanics

Contribution ID: **20** Type: **Oral Presentation**

[illegible]

Tuesday, 24 September 2024 10:00 (15 minutes)

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1. [illegible]
[illegible]
2. [illegible]
[illegible]

1. [illegible]

(dBMDSR-UNet3Plus) Avizo 1) 2).

Table 1.
(macroporosity)
(microporosity)

HR-Watershed	1781/0 (0.00%)	1266/0 (0.00%)	6953/0 (0.00%)	0433/0 (0.00%)	1065/0 (0.00%)	1287/0 (0.00%) 15833- (0.00%)
EDSR-UResNet	1881/0 (61/5 %)	1413/0 (61/11 %)	6706/0 (12/1- %)	0375/0 (4/13- %)	0803/0 (6/24- %)	0867/0 (6/32- %) 11278- (7/28 %)
dBMDSR-UNet3Plus	1802/0 (18/1 %)	1289/0 (82/1 %)	6909/0 (23/2- %)	0369/0 (8/14- %)	0777/0 (1/27- %)	0777/0 (6/39- %) 10673- (6/32 %)

Table 2.
()
()

HR-Watershed	1058 (0.00%)	1359 (0.00%)
EDSR-UResNet	1424 (61/34 %)	1526 (32/12 %)
dBMDSR-UNet3Plus	1140 (74/7 %)	1252 (78/7- %)

4.

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Student presentation contest

Not Interested

Journal Submission

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Student Poster Contest

Opt In

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Session Classification: Parallel Session 4

Track Classification: Digital Rocks / Machine Learning

Contribution ID: **21** Type: **Oral Presentation**

Controlling Factors of Porosity and Reservoir Quality in Carbonate Reservoirs

Wednesday, 25 September 2024 09:45 (15 minutes)

In terms of geology and reservoir characteristics, carbonate reservoir rocks are very complex and heterogeneous due to the influence of diagenetic processes. This article studies the Fahliyan Formation oil reservoir in one of the largest hydrocarbon fields in southwestern Iran. Based on core data and petrophysical logs from two wells, the factors controlling the development of porosity and reservoir heterogeneity in this field have been examined. The study results indicate that the reservoir heterogeneity in this field is not inherited from the depositional environment and its prevailing conditions, but diagenetic processes have played a more prominent role. Most of the primary pores have been lost through diagenetic processes such as cementation and compaction, and the reservoir has a higher abundance of pores smaller than 4 microns (mesopores and micropores). Additionally, the integration of core data, XRD, and petrophysical logs shows that due to dolomitization in the middle parts of the reservoir rock, fractures have been created and developed, which is an important factor in oil production in the field.

Student presentation contest

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Journal Submission

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Student Poster Contest

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Presenter: Mrs IMANI, Roghayeh (Student)

Session Classification: Parallel Session 7

Track Classification: Diverse Topics in Porous Media

Contribution ID: **22** Type: **Oral Presentation**

Investigating the impact of slope angle on the effectiveness of the slit barriers in dissipating the kinetic energy of debris flows

Tuesday, 24 September 2024 10:15 (15 minutes)

Debris flows are comprised of water and loose sedimentary deposits that occur in mountainous regions as a result of intense precipitation. Due to the rapid speed and massive volume of these flows, rigid barriers are installed along the flow path to dissipate the energy of the flow and prevent damage to downstream infrastructures. Nevertheless, the efficiency of these barriers is significantly affected by the velocity of the flow. Ignoring the approach velocity may even contribute to an increase in the energy and destructive power of the flow downstream. Hence, in this study, the influence of the slope angle of the bed, which is a crucial determinant of flow velocity, on the effectiveness of the barriers is investigated. According to findings from the FLOW-3D software, the installation of a row of cubic barriers on steep slopes leads to an increase in flow kinetic energy. However, barriers have no impact on energy dissipation on moderate slopes. In contrast, the construction of cubic barriers lowers the flow kinetic energy by more than 50% on moderate slopes.

Keywords
Debris flow, Rigid barriers, Slit barriers, Energy dissipator, FLOW-3D

Student presentation contest

Opt in

Journal Submission

Consider for Journal Submission

Student Poster Contest

Not Interested

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Session Classification: Parallel Session 3

Track Classification: Geotechnique/Soil Mechanics

Contribution ID: **23** Type: **Poster Presentation**

Comparative Analysis of Porous Organic and Inorganic Materials for Drug Delivery

This review examines the properties and applications of porous organic and inorganic materials in drug delivery systems. Porous organic materials, such as Poly(D,L-lactide-co-glycolide), (PLGA) and chitosan, are valuable due to their biocompatibility and biodegradability, and they are suitable for integration with biological tissues. In contrast, porous minerals such as silica and alumina offer superior thermal and chemical stability, ideal for demanding medical environments such as cancer treatment. This comparative analysis addresses their synthesis, functionalization, and specific applications and highlights the necessity of selecting materials based on therapeutic needs and drug delivery requirements. This review emphasizes the ongoing developments that increase the effectiveness of these materials in medical applications focusing on the pore properties of the compounds.

Student presentation contest

Not Interested

Journal Submission

Consider for Journal Submission

Student Poster Contest

Opt In

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Track Classification: New Energies / Underground Gas Storage

Contribution ID: **24** Type: **Oral Presentation**

Effect of Salinity on Foam Flow Behavior for Conformance Control in Gas-Based Injection Processes: A Micro-scale Study

Tuesday, 24 September 2024 10:15 (15 minutes)

Foam injection is an effective technique for enhancing the performance of gas-based processes in porous media. However, brine salinity is one of the factors that can significantly impact foam performance for subsurface applications. This study investigates the flow performance of foam generated using sodium dodecyl sulfate (SDS) as a foaming agent in two brine salinity levels (5000 and 35000 ppm NaCl) within a heterogeneous layered porous medium. A glass micromodel consisting of two layers with different permeabilities and fluid connectivity was used to conduct the experiments. The results revealed that the foam formed under low salinity conditions exhibited smaller bubbles, leading to increased apparent viscosity and consequently better control of gas phase mobility in both layers. The formation of a stable foam effectively controlled gas flow conformance in the high-permeability layer, resulting in the foam front advancing through both low-permeability and high-permeability layers. In contrast, under high salinity conditions, foam bubbles were larger and less stable, leading to faster gas phase breakthrough in the high-permeability layer and consequently reducing the effectiveness of foam injection for conformance control. The findings of this study demonstrate the superior performance of foam under low salinity conditions for conformance control in gas injection processes in a heterogeneous layered system. This can lead to improved sweep efficiency of the injected gas in the porous medium.

Student presentation contest

Opt in

Journal Submission

Consider for Journal Submission

Student Poster Contest

Opt In

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Presenter: Mr SHAHIN, Matin

Session Classification: Parallel Session 2

Track Classification: Hydrocarbon Recovery / Flow in Porous Media

Contribution ID: **25** Type: **Oral Presentation**

Improving the challenge of imaging resolution and field of view in permeability estimation by integrating multiscale imaging of carbonate rocks and Deep Learning

Digital rock physics, as a pioneering technology in characterizing porous structures by integrating state of the art tomographic imaging and advanced numerical simulations, extracts key rock properties such as permeability. However, limitations in imaging resolution and field of view (FOV) at the pore scale pose significant challenges. Direct numerical simulations at larger scales are either computationally impractical or prohibitively expensive. This trade-off between FOV and image resolution is particularly evident in the complex and multiscale pore structures of carbonate rocks. To address this issue, a novel machine learning approach has been developed to integrate multiscale imaging data of various resolutions. This method uniquely employs an optimized three-dimensional convolutional neural network (CNN) model to identify intricate cross-scale correlations, facilitating accurate predictions of transport properties at larger scales beyond the reach of traditional direct simulation techniques. Additionally, by utilizing a cross-scale transfer learning method during the training phase, the developed model achieves robust performance with an R^2 exceeding 0.96 when evaluated on lower-resolution domains with larger FOVs. The proposed workflow, initially designed for the complex porous media of carbonate rocks, demonstrates adaptability to various multiscale porous materials, thereby offering a promising solution to the inherent limitation of the trade-off between imaging resolution and FOV in digital rock physics.
Keywords: Digital Rock Physics; Multiscale Tomographic Imaging; Carbonate Reservoirs; Deep Learning; Transfer Learning

Student presentation contest

Not Interested

Journal Submission

Not Interested

Student Poster Contest

Opt In

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Track Classification: Geotechnique/Soil Mechanics

Contribution ID: **26** Type: **Oral Presentation**

Geothermal recovery of abandoned oil wells: The effect of insulation on the efficiency of coaxial borehole heat exchangers

Wednesday, 25 September 2024 09:45 (15 minutes)

Using abandoned oil and gas wells as coaxial borehole heat exchangers paves the way for reusing these wells for geothermal energy extraction and low-carbon electricity generation. In this study, 150 different scenarios of such energy extraction processes have been modelled to examine the impact of inner tube's insulation on the output energy. It is shown that, on average, the performance coefficient of the exchanger is 3 times higher with the use of effective insulation. The results of this research lead to more effective use of abandoned wells and increased economic and energy efficiency of these systems.

Student presentation contest

Opt in

Journal Submission

Consider for Journal Submission

Student Poster Contest

Opt In

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Session Classification: Parallel Session 6

Track Classification: New Energies / Underground Gas Storage

Contribution ID: **27** Type: **Poster Presentation**

Simultaneous investigation of the effect of Rock morphology and capillary number on water breakthrough time

The current study focuses on pore-scale simulation and analysis of oil displacement in digital rocks, a novel approach for tracking and enhancing oil recovery in porous media. This research explores the impact of water flooding on oil recovery in three digital rock samples with identical porosity but varying morphologies. Utilizing computational fluid dynamics, numerical simulations were conducted to assess the influence of pore and throat sizes on water breakthrough time, residual oil saturation, and oil displacement patterns. Injection speed, mobility ratio, and interfacial tension were manipulated to investigate these effects further. The findings reveal that rocks with smaller pores and throats facilitate faster water breakthrough and reduced breakthrough time. Conversely, enlarging these features leads to increased fingering time. The morphology of the rock significantly influences the oil recovery process, influencing the fingering regime based on breakthrough time and pore injection.

Student presentation contest

Opt in

Journal Submission

Not Interested

Student Poster Contest

Opt In

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Track Classification: Geotechnique/Soil Mechanics

Contribution ID: **28** Type: **Oral Presentation**

Investigating the Effects of Porous Media on the Minimum Miscibility Pressure of an Asphaltenic Oil Sample and Gas

Tuesday, 24 September 2024 10:15 (15 minutes)

Gas injection into oil reservoirs encounters several challenges, including the presence of nanopores, asphaltene precipitation, and adsorption of fluid molecules on the porous medium. Miscible gas injection has been shown to be the most efficient method in many cases. Therefore, estimating the minimum miscibility pressure (MMP) is crucial in this process. However, the presence of fluid in the porous medium significantly affects its phase behavior, leading to differences in parameters such as MMP compared to the bulk phase. This study investigates the simultaneous effects of confinement (shift in critical properties of components, adsorption of fluid molecules on the porous medium, and capillary pressure) and asphaltene precipitation on the miscibility of an asphaltenic oil sample with CO2 and NGL gases using modified Peng-Robinson (PR) and cubic-plus-association (CPA) equations of state. The results indicated that asphaltene precipitation significantly delays the miscibility process, with this phenomenon occurring more intensely for CO2. Additionally, the effects of the porous medium on MMP are not negligible at radii less than 100 nm, while at radii greater than this value, the phase behavior approaches the bulk phase.

Student presentation contest

Opt in

Journal Submission

Consider for Journal Submission

Student Poster Contest

Opt In

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Session Classification: Parallel Session 1

Track Classification: Hydrocarbon Recovery / Flow in Porous Media

Contribution ID: **29** Type: **Oral Presentation**

Effect of time constant and rock pore complexity on the shift factor for non-Newtonian fluid flow in porous media

Tuesday, 24 September 2024 10:30 (15 minutes)

Non-Newtonian fluid flow within porous media, exemplified by polymer remediation of contaminated groundwater/aquifer systems, presents complex challenges due to the fluids' complex rheological behavior within 3D tortuous pore structures. This paper introduces a pore-scale flow simulator based on the OpenFOAM open-source library, designed to model shear-thinning flow within porous media. Leveraging this developed solver, extensive pore-scale flow simulations were conducted on μ-CT images of various real porous media with varying complexity for Cross-fluid model. We focused on the macroscale-averaged deviation between bulk viscosity and the in-situ viscosity, commonly denoted by a shift factor. We provided an in-depth evaluation of the shift factor's dependency on the time constant and the rock's pore space complexity. The effect of time constant on shift factor is very small. Also demonstrate how the shift factor fluctuates based on tortuosity, characteristic pore length, and the cementation exponent. In particular, less porous/permeable systems with smaller characteristic pore lengths exhibited larger shift factors due to higher variations of shear rate and local viscosity in narrower flow paths. Additionally, the shift factor increased as rock became more tortuous and heterogeneous.

Student presentation contest

Not Interested

Journal Submission

Consider for Journal Submission

Student Poster Contest

Opt In

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Presenter: AMIRI, Mehdi

Session Classification: Parallel Session 1

Track Classification: Hydrocarbon Recovery / Flow in Porous Media

Contribution ID: **30** Type: **Oral Presentation**

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Tuesday, 24 September 2024 10:30 (15 minutes)

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Student presentation contest

Opt in

Journal Submission

Consider for Journal Submission

Student Poster Contest

Opt In

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Presenters: Mr ALMASIYAN, Pouriya (Sharif University of Technology); Prof. MAHANI, Hassan (Sharif University of Technology)

Session Classification: Parallel Session 2

Track Classification: Hydrocarbon Recovery / Flow in Porous Media

Contribution ID: **31** Type: **Oral Presentation**

Benchmarking the potential of Super-Resolution Convolutional Neural Networks in Improving the Resolution of Digital Rock Images

Tuesday, 24 September 2024 10:30 (15 minutes)

Abstract
The ultimate objective of digital rock physics is to accurately predict rock properties. However, the resolution of rock images obtained from imaging techniques often involves a trade-off between image resolution and field of view (FoV) (Bai, Berezovsky et al. 2020, Sadeghnejad, Enzmann et al. 2021). The presence of heterogeneous rocks presents a significant challenge in accurate modeling due to the need to capture information at various scales. Various multi-scale modeling approaches have been employed to address this issue. In response, alternative methods have been explored to reconstruct rock images using advanced artificial intelligence algorithms, such as artificial neural networks. These state-of-the-art methods offer improved connectivity features in final images, reduced computational costs, and the ability to incorporate large-scale heterogeneities into reconstructed structures (Da Wang, Armstrong et al. 2019). However, it is crucial to recognize the challenges associated with these approaches. Super-resolution (SR) methods have emerged as a prominent solution to enhance resolution (Da Wang, Shabaninejad et al. 2021). Super resolution (SR) is an eminent system in the field of computer vison and image processing to improve the visual perception of the poor-quality images (Lepcha, Dawa Chyophel, et al. 2023).
This research aims to evaluate the speed and accuracy of deep learning methods, specifically the SR-Convolutional Neural Network (SRCNN), its modified counterpart, and the Fast-SRCNN (FSRCNN). The dataset for model evaluation consisted of a Berea sandstone sample that was scanned at the DESY PETRA-III X-ray synchrotron light source in Hamburg, Germany. In this study, an SRCNN architecture underwent two significant modifications (referred to as transient architectures) to transform into an FSRCNN architecture. Firstly, an additional deconvolution layer was integrated into the last layer of the network, enabling direct mapping between input and output images and eliminating the need for pre-processing on Low-Resolution (LR) images. Secondly, a mapping layer was formulated to compress and expand input features to enhance the mapping process. Lastly, smaller-sized filters with additional mapping layers were employed.
The results demonstrate that the FSRCNN surpasses the SRCNN and all transient architectures in terms of speed and resolution enhancement, achieving a significant improvement of over 20 times. Additionally, the petrophysical properties of super-resolved images generated by FSRCNN, SRCNN, and the modified architectures, as well as the HR images, were calculated. The porosity and permeability of the digital twins reconstructed by the FSRCNN exhibit similar values to HR images, underscoring the superiority of the FSRCNN approach in accurately capturing the intricate details of digital rocks and enhancing the reliability of subsequent petrophysical analysis.

Keywords: Digital Rock Physics; Super Resolution; Convolutional Neural Network; Petrophysical Analysis; Accuracy, Speed

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Lepcha, Dawa Chyophel, et al. "Image super-resolution: A comprehensive review, recent trends, challenges and applications." Information Fusion 91 (2023): 230-260.

Student presentation contest

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Journal Submission

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Student Poster Contest

Opt In

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Session Classification: Parallel Session 4

Track Classification: Digital Rocks / Machine Learning

Contribution ID: **32** Type: **Oral Presentation**

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Wednesday, 25 September 2024 10:30 (15 minutes)

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[illegible]
[illegible] (corridors) [illegible]

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Student presentation contest

Not Interested

Journal Submission

Consider for Journal Submission

Student Poster Contest

Not Interested

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Session Classification: Parallel Session 5

Track Classification: Hydrocarbon Recovery / Flow in Porous Media

Contribution ID: **33** Type: **Oral Presentation**

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Tuesday, 24 September 2024 10:15 (15 minutes)

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Student presentation contest

Opt in

Journal Submission

Not Interested

Student Poster Contest

Not Interested

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Session Classification: Parallel Session 4

Track Classification: Digital Rocks / Machine Learning

Contribution ID: **34** Type: **Poster Presentation**

A comprehensive investigation of bubble flow regime behavior for equipment optimization and pipeline design

Bubbly flow is one of the types of gas-liquid two-phase flow regimes, in which the gas phase is dispersed in the liquid phase in the form of small bubbles. This type of flow is usually observed at low gas velocities and high liquid velocities, and it can play an important role in the oil and gas industry. In bubbly flow, the gas bubbles tend to accumulate in the upper part of the pipe due to their lower density compared to the liquid. This non-uniform distribution of the gas phase in the liquid can affect the flow parameters such as pressure drop and mass transfer. Accurate knowledge of the bubbly flow regime and the factors affecting it, such as the gas-to-liquid volume ratio, fluid velocities, and their physical properties, is crucial for the design and optimal operation of industrial equipment like bubble reactors and heat exchangers that utilize this type of flow. Experimental studies and numerical modeling in this field have led to significant progress in understanding and predicting the behavior of bubbly flow. These advancements can contribute to the improvement of the design and efficiency of these industrial equipment. This research aims to provide a comprehensive understanding of the factors influencing the regime transition of bubbly flow, exploring its various applications across different fields, and proposing detection methods. By doing so, a novel perspective for designing, operating, and optimizing the safety and efficiency of pipeline systems will be fulfilled.

Student presentation contest

Opt in

Journal Submission

Consider for Journal Submission

Student Poster Contest

Opt In

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Track Classification: Digital Rocks / Machine Learning

Contribution ID: **35** Type: **Oral Presentation**

Simulation study to account for the anisotropy due to oblique fractures in fractured porous media

The presence of fractures in the fractured porous media requires the use of appropriate numerical methods to consider their effects. The conventional approach in simulating fracture reservoirs is to use the Warren and Root model which assumes a homogeneous medium. In reality, the presence of heterogeneous reservoirs with complex characteristics causes a large deviation in the results of the basic models with the field results. In this work, the method of considering the anisotropy due to the presence of oblique fractures with respect to the flow direction is investigated with a numerical approach. One way to include this factor is to consider the effective correction factor to generalize Warren Root's approach. Modeling is done in COMSOL Multiphysics software, which has been investigated using single-phase and two-phase models. The simulation results under the same boundary conditions and rock and fluid properties show that different equivalent correction coefficients are obtained for fractures with different angles. Examination of the fluid pressure inside the fracture network shows that this equivalent coefficient depends on the fracture orientation, matrix shape and size and the density of the fractures. The results of this study can be used for the suitable simulation of heterogeneous fracture reservoirs.

Student presentation contest

Not Interested

Journal Submission

Consider for Journal Submission

Student Poster Contest

Opt In

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Presenter: Mr ZARE, mohammad

Track Classification: Geotechnique/Soil Mechanics

Contribution ID: **36** Type: **Oral Presentation**

Numerical Simulation of density-driven flow in fractured porous media using extended finite element method

Tuesday, 24 September 2024 10:30 (15 minutes)

Understanding mass transport in fractured geological formations is crucial for various applications, including predicting contaminant migration, managing subsurface hydrology, sequestering CO2 to mitigate climate change, and potentially storing hydrogen for clean energy applications. This study presents a computational model using the eXtended Finite Element Method (X-FEM) to tackle the complexities introduced by variable-density flow within fractured porous media.
Density variations in fluids, arising from temperature differences (thermal buoyancy) or changes in solute concentration (e.g., saltwater intrusion or CO2), are the primary driving forces for these phenomena. The model incorporates an advection-diffusion equation to capture various transport regimes (diffusion, dispersion, and advection) while considering these density-driven flow processes. Additionally, the X-FEM effectively handles the discontinuity of material properties across fractures, which can significantly impact flow behavior.
The model's performance is validated by solving benchmark problems (Schincariol and Elder) and a modified Elder problem incorporating fractures. The influence of fracture patterns (horizontal and vertical) and fracture density variations are explored on transport behavior.
This research offers a powerful tool for simulating solute transport in fractured media, considering coupled processes that can further influence flow dynamics. This improved understanding will pave the way for more accurate predictions in environmental and geological applications, such as optimizing geothermal energy extraction and designing safe geological carbon sequestration projects.

Student presentation contest

Opt in

Journal Submission

Consider for Journal Submission

Student Poster Contest

Not Interested

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Session Classification: Parallel Session 3

Track Classification: Geotechnique/Soil Mechanics

Contribution ID: **37** Type: **Oral Presentation**

Smart Proxy Model Development for foam injection in a fractured carbonate reservoir for Enhanced Oil Recovery

Wednesday, 25 September 2024 11:00 (15 minutes)

Most of the world's oil reservoirs are carbonate and are often in the secondary stage of production. Foam injection could be a highly effective method for improving displacement efficiency, increasing production rates, and enhancing oil recovery mainly by reducing issues like fingering and channeling during gas-injection based processes. In this study, a fractured carbonate reservoir was simulated using a reservoir simulator to investigate the foam behavior through carbonate, fractured porous media. Sensitivity analysis was performed on key foam injection parameters such as foam viscosity, foam flow rate, oil saturation, and matrix width and height to estimate oil recovery factor. Then, a smart proxy model was developed using two machine learning algorithms, Support Vector Machine (SVM) and Random Forest (RF), to predict oil recovery as a replacement for the complex reservoir simulation model. Among these algorithms, RF showed better performance with a R^2 of 0.9990 and RMSE of 0.2564 for predicting oil recovery. Finally, it was found that the smart proxy model could be used as an alternative to complex fractured carbonate simulation model for predicting and optimizing oil recovery factor using foam injection, reducing the computation time and optimizing the process.

Student presentation contest

Opt in

Journal Submission

Consider for Journal Submission

Student Poster Contest

Opt In

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Presenter: Ms MAJD TEYMOURI, Hamdam (sahand university of technology)

Session Classification: Parallel Session 8

Track Classification: Digital Rocks / Machine Learning

Contribution ID: **38** Type: **Poster Presentation**

Reconstruction of Highly-Heterogeneous Porous Media: Fractured Shale

In the 3D reconstruction of micro CT scan images of porous media for heterogeneous samples (with fractures), the texture of the heterogeneous (fracture) space differs from that of the rock. In this type of problem, a new method should be provided for reconstructing the porous media. Some shale rock samples exhibit fractures of this type, and their reconstruction is considered here. In this research, two artificial intelligence algorithms are employed to reconstruct the pore space of shale. The first algorithm is based on a generative method (a type of generative adversarial neural network) to reconstruct the rock texture space. The second algorithm, which utilizes the output of the first algorithm, attempts to reconstruct the fracture space using a geometry-informed deep learning framework. The reconstruction results indicate a satisfactory level of quality in the reconstruction process.

Student presentation contest

Not Interested

Journal Submission

Consider for Journal Submission

Student Poster Contest

Not Interested

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Presenter: Dr SHAMS, Reza (Sharif University of Technology)

Track Classification: Geotechnique/Soil Mechanics

Contribution ID: **39** Type: **Oral Presentation**

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Wednesday, 25 September 2024 10:00 (15 minutes)

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Student presentation contest

Opt in

Journal Submission

Consider for Journal Submission

Student Poster Contest

Opt In

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Presenter: VALIPOUR, Mehdi (Master of Science Student, Sharif University of Technology)

Session Classification: Parallel Session 6

Track Classification: New Energies / Underground Gas Storage

Contribution ID: **40** Type: **Oral Presentation**

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Wednesday, 25 September 2024 11:15 (15 minutes)

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Student presentation contest

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Student Poster Contest

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Session Classification: Parallel Session 8

Track Classification: Digital Rocks / Machine Learning

Contribution ID: **41** Type: **Poster Presentation**

[illegible]

[illegible] TPMS [illegible] TPMS [illegible]

Student presentation contest

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Student Poster Contest

Opt In

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Track Classification: Digital Rocks / Machine Learning

Contribution ID: **43** Type: **Oral Presentation**

[illegible]

Wednesday, 25 September 2024 10:15 (15 minutes)

[illegible]

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Student Poster Contest

Opt In

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Session Classification: Parallel Session 6

Track Classification: New Energies / Underground Gas Storage

Contribution ID: **44** Type: **Oral Presentation**

Investigation of the effect of ultrasonic waves on the deposition of asphaltenes in porous media

Wednesday, 25 September 2024 09:45 (15 minutes)

Improving oil recovery from reservoirs is an important challenge in the oil industry. In recent years, the use of ultrasonic waves to stimulate oil wells (reducing formation damage) and change the rheological properties of crude oil has received more attention. From the economic, environmental and operational safety perspectives, ultrasonic wave radiation has significant advantages over other conventional methods of improving oil recovery, such as acid injection and hydraulic fracturing. In this regard, the irradiation of ultrasonic waves to crude oil leads to a decrease in oil viscosity and an improvement in the relative permeability of oil in the porous media of rock. The phenomenon of cavitation and vibration created in crude oil are the main factors in changing the properties of crude oil with ultrasonic wave radiation. In this research, the effect of ultrasonic waves on the amount of asphaltene deposition in a transparent porous media micromodel has been investigated. According to the obtained results, irradiation of ultrasonic waves to crude oil has led to a decrease in the amount of asphaltenes deposition in the porous media, and as a result, reduced the blockage of the rock pores. The analysis of the images taken from the micromodel shows that the irradiation of ultrasonic waves to crude oil by breaking the asphaltene clusters in the crude oil prevents their deposition in the rock pores especially near the fracture. The results of this research are used in the improved oil recovery operation from reservoirs with the problem of asphaltene deposition.

Student presentation contest

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Student Poster Contest

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Session Classification: Parallel Session 5

Track Classification: Hydrocarbon Recovery / Flow in Porous Media

Contribution ID: **45** Type: **Oral Presentation**

[illegible]

Wednesday, 25 September 2024 11:00 (15 minutes)

[illegible]

Student presentation contest

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Student Poster Contest

Opt In

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Session Classification: Parallel Session 10

Track Classification: New Energies / Underground Gas Storage

Contribution ID: **46** Type: **Oral Presentation**

Simulation of Single-Well Chemical Tracer Test (SWCTT) to Measure Residual Oil Saturation

Wednesday, 25 September 2024 10:00 (15 minutes)

Determining residual oil saturation (Sor) in hydrocarbon reservoirs is crucial for reservoir evaluation and designing an enhanced oil recovery (EOR) method. Single-well chemical tracer test (SWCTT) is an efficient, economical, and accurate method for estimating Sor within approximately 20 to 30 meters around the well, providing valuable data for production optimization decisions. This technique utilizes the time difference between the production of ester and hydrolyzed alcohol, resulting from the chromatographic separation of the secondary tracer from the partitioning tracer. This study aims to simulate SWCTT for Sor measurement using the University of Texas Chemical Flooding Simulator (UTCHEM) in a glass bead pack flood system. Initially, SWCTT was conducted in this laboratory system by injecting ethyl acetate. Subsequently, an attempt was made to simulate the tracer behavior and experimental results using UTCHEM, a multi-dimensional, multi-phase, and multi-component flooding simulator capable of modeling a separable reactive tracer. The results demonstrated that Simulations by UTCHEM for SWCTT closely match the experimental data from glass bead flooding experiments for Sor estimation. Additionally, sensitivity analyses conducted on key parameters such as diffusion coefficient, injection rate, and tracer concentration revealed that simulation results are sensitive to these parameters. These findings highlight the capability of the SWCTT technique and UTCHEM simulator in accurately evaluating the oil-saturated zone around the well, providing valuable information for reservoir management decisions, including selecting the appropriate EOR fluid and process.

Student presentation contest

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Student Poster Contest

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Session Classification: Parallel Session 5

Track Classification: Hydrocarbon Recovery / Flow in Porous Media

Contribution ID: **47** Type: **Poster Presentation**

Pore-scale modeling of non-equilibrium gas injection process in fractured reservoirs

Many carbonate reservoirs of Iran's Bangestan Group have a tight and fractured matrix. Some of these reservoirs, despite having the conditions for the formation of a gas cap, do not benefit from the gravity drainage mechanism well due to the shortness of the matrices and high capillary pressure. Some of these reservoirs are very undersaturated, and their capillary pressure is usually higher than the oil saturation pressure.

In such reservoirs, the main production mechanism is rock and fluid expansion, which leads to small oil recovery. Despite the high production potential, these reservoirs have more optimal production requirements due to the low recovery factor.

Non-equilibrium gas injection by activating a molecular diffusion mechanism can be an efficient solution to this problem. This study uses the pore-network approach with the aim of accurately modeling this process. In this method, the molecular diffusion process is simulated in a matrix block surrounded by fractures. The developed model also considers the micro-mechanisms of the porous medium drying process.

The main advantage of this model is to pay attention to the microscopic distribution of liquid and gas phases and the arrangement of pores and throats. These features lead to a deeper understanding of the molecular diffusion process and provide a more accurate model for predicting additional production from fractured reservoirs.

This model can be used in choosing the appropriate injection gas, estimating additional production potential, optimizing gas injection flow rate and other parameters related to the molecular diffusion process in fractured reservoirs.

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Track Classification: Geotechnique/Soil Mechanics

Contribution ID: **48** Type: **Poster Presentation**

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[illegible]

Student presentation contest

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Journal Submission

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Student Poster Contest

Not Interested

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Presenter: YAZDA, Farshad

Track Classification: Geotechnique/Soil Mechanics

Contribution ID: **49** Type: **Oral Presentation**

Study the effect of fracture roughness on the relative permeability of a fractured porous medium using pore-scale simulations

Wednesday, 25 September 2024 10:15 (15 minutes)

Modeling of flow properties in fractured porous media is important due to the existence of a significant contrast in the storage properties and flow conductivity in the matrix and fracture parts. In the case of two-phase flow, one of the flow properties, which can be affected by fluid flow mechanisms at the pore scale are relative permeability, curves. However, the existence of fracture and the roughness of fracture walls are among the factors that affect these curves. In this research, the micro CT image of a two-dimensional section of rock was used as a basic porous media, and then by adding a horizontal fracture, simulation of a two-phase flow of water and oil was investigated, and two-phase relative permeability curves were extracted by extended JBN method. The simulation of two-phase flow is done using the equations of the phase field method and in the COMSOL software and the effects of parameters such as the width of the fracture and the roughness of the fracture wall on the relative permeability curves of the phases are investigated. The simulation results showed that the presence of a fracture causes a delay in the relative permeability curves. With the increase of the fracture width, the relative permeability values of the phases increase significantly, especially for the wet phase. In addition, the presence of roughness on the fracture surface reduces the relative permeability values of the phases. With the help of the obtained results, a more complete understanding of the flow in the fractured porous media can be obtained.

Student presentation contest

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Journal Submission

Not Interested

Student Poster Contest

Not Interested

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Session Classification: Parallel Session 5

Track Classification: Hydrocarbon Recovery / Flow in Porous Media

Contribution ID: **50** Type: **Poster Presentation**

Modeling the Damage Caused by Air Penetration During Air Drilling by Using the Lattice Boltzmann Method

Multiphase flows in porous media are crucial in both industrial processes and natural phenomena, impacting hydrocarbon recovery, groundwater flow, catalysts, and fuel cells. Numerous experimental methods have been developed to study these issues, allowing for large-scale observation of dynamic interface behavior. However, accurately describing fluid flow at the pore scale remains challenging. Laboratory micromodel studies can predict fingering patterns and their initial growth but do not provide insights into their later-stage evolution.

Numerical simulators are valuable for complementing theoretical and experimental studies, examining the effects of flow and physical parameters in complex three-dimensional porous environments. However, continuum-based numerical methods fall short in investigating the impact of pore-scale parameters on bulk properties, failing to detail pore-scale flow patterns. The Lattice Boltzmann Method (LBM) is recognized for its ability to simulate multiphase flows at the pore scale, offering advantages over traditional computational fluid dynamics (CFD) methods due to its parallel computational capability and ease of handling complex geometric boundaries.

In this study, LBM with a phase-field approach was used to investigate formation damage during air drilling, considering high density and viscosity differences. A two-phase simulator core was developed in C++ due to the lack of commercial simulators for this approach. Simulation results were initially validated against theoretical solutions for single-phase and two-phase cases, showing acceptable errors. Further simulations in capillary tubes and synthetic porous media examined flow patterns and the effect of density ratio on these patterns.

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Track Classification: Geotechnique/Soil Mechanics

Contribution ID: **51** Type: **Poster Presentation**

A Review of the Methods for Enhancing Oil Well Production Efficiency

Abstract:
In a world where crude oil resources are dwindling and the demand for energy is continuously rising, enhanced oil recovery (EOR) technologies have become critically important. while traditional production methods can only recover 30 to 40 percent of the oil present in reservoirs, advanced EOR technologies provide access to substantial amounts of the remaining oil. These technologies, which include a variety of methods such as chemical flooding, water injection, gas injection, steam injection, combustion, and ultrasonic stimulation, significantly improve oil displacement efficiency. This review paper examines these innovative techniques and analyzes their impact on reducing interfacial tension, controlling fluid mobility, and enhancing the efficiency of njected fluids. It also explores miscible and immiscible gas flooding processes as well as steam and combustion injection techniques, each of which, offers different approaches to increasing oil recovery.

Keywords: Enhanced oil recovery; Reducing interfacial tension; Chemical injection; Steam injection; Biological injection; Nano material injection

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Student Poster Contest

Opt In

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Track Classification: Geotechnique/Soil Mechanics

Contribution ID: **52** Type: **Poster Presentation**

Biological soil improvement

The concept of using biological process in soil improvement, which is known as bio-mediated soil improvement, has shown more potential in geotechnical engineering applications in terms of performance and environmental sustainability. This article provides an overview of the soil microorganisms responsible for this process and the factors that affect their metabolic activities and compatibility with the soil, as well as the mechanism of biomineralization. Environmental and other factors that may occur in situ during microbially induced calcite precipitation (MICP) and their effects on the process were identified and presented. Improvements in soil engineering properties such as strength, stiffness and permeability have been investigated as evaluated in some studies.

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Track Classification: Geotechnique/Soil Mechanics

Contribution ID: **53** Type: **Oral Presentation**

Application of statistical analysis of CBCT images in evaluation of rock heterogeneity of hydrocarbon reservoirs and reservoir studies

Wednesday, 25 September 2024 11:30 (15 minutes)

Investigating changes in the reservoir rock's pore system during multiphase flow studies in porous media is crucial, especially for processes like enhanced oil recovery, underground carbon dioxide storage, and wastewater disposal. Ignoring core heterogeneity in laboratory studies can significantly impact the results and their potential for upscaling to the reservoir.
In this study, 31 limestone samples with varying porosity and permeability from the Ilam Formation were scanned using a dental Cone-Beam Computed Tomography (CBCT) scanner. To assess heterogeneity, 9 or 12 cross-sections were selected from each sample. Histograms were plotted for each image based on the CT number of all voxels using image processing software. The standard deviation of each histogram was then calculated. This approach quantified the heterogeneity and classified the samples into five zones based on data dispersion: homogeneous (blue zone), relatively homogeneous (green zone), relatively heterogeneous (yellow zone), heterogeneous (orange zone), and damaged (red zone).
The results showed that out of the 31 samples studied, 14 samples were within the blue zone, 11 in the green zone, 3 in the yellow zone, 1 in the orange zone, and 2 in the red zone. It is recommended to prioritize these samples in that order (1st to 5th) for reservoir rock laboratory studies.

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Student Poster Contest

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Session Classification: Parallel Session 8

Track Classification: Digital Rocks / Machine Learning

Contribution ID: **54** Type: **Poster Presentation**

Analytical Investigation of Soil Settlement and Pore Pressure in Poroelastic Systems

Abstract

This study addresses the analytical solutions for one-dimensional consolidation problems, focusing on classical problems fundamental to geomechanics. Two key problems are examined: Terzaghi' s consolidation problem and the loading by fluid pressure in a poroelastic medium. The analysis begins with revisiting Terzaghi's consolidation theory under poroelastic conditions, deriving solutions for pore pressure and settlement. Specifically, the governing equations are transformed into a homogeneous diffusion equation under certain conditions, yielding explicit solutions for both pore pressure and displacement. Subsequently, the impact of an applied fluid pressure on the surface of a soil stratum is explored. Solutions are derived by superposing two loading modes, resulting in comprehensive expressions for pressure and displacement profiles over time. The results elucidate the settlement characteristics and the dissipative nature of energy in these processes. The analytical solutions show that the initial pore pressure distribution is proportional to the applied load and decays over time, while the settlement progresses from an initial value to a final steady state. For the fluid pressure loading case, the surface settlement initially increases and then rebounds, illustrating the complex interaction between pore fluid pressure and soil deformation. This analytical framework not only reinforces the classical consolidation theory but also provides a robust basis for validating numerical models in poroelastic media.

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Student Poster Contest

Not Interested

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Track Classification: Geotechnique/Soil Mechanics

Contribution ID: **55** Type: **Oral Presentation**

Numerical study of the effect of spatial distribution of artificial rainfall on unsaturated flow in a finite soil slope

Wednesday, 25 September 2024 11:00 (15 minutes)

Shallow landslides cause significant financial and human losses annually. Most previous studies have focused on large-scale mountainous slopes, investigating landslides in small-scale urban slopes requires analyzing two-phase flow under rainfall. Therefore, the aim of this study is investigating the effect of local artificial rainfall distribution due to irrigation on unsaturated flow in small-scale soil slopes in different rainfall scenarios. To achieve this goal, a numerical model of a soil slope was created using the multiphase COMSOL software, and artificial rainfall with different spatial distributions was applied in four scenarios. Specifically, rainfall was simulated at the top of the slope, the middle of the slope, the bottom of the slope and the entire boundary. The results showed that the least variation in pore water pressure at the toe of the slope occurs when rainfall is distributed at the upper boundary, and the most critical condition occurs when rainfall is applied to the entire model boundary. These results highlight the role of rainfall spatial distribution in slope stability, especially in agricultural lands and recreational parks where artificial irrigation is common.

Student presentation contest

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Student Poster Contest

Not Interested

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Session Classification: Parallel Session 9

Contribution ID: **56** Type: **Poster Presentation**

Leveraging Large Language Models and Generative AI in Pore-Scale Modeling for Enhanced Hydrogen and Carbon Storage

The transition to sustainable energy sources necessitates advanced technologies for efficient hydrogen and carbon storage. Pore-scale modeling plays a crucial role in understanding the intricate mechanisms within geological formations. This study explores the transformative potential of Large Language Models (LLMs) and Generative Artificial Intelligence (AI) in enhancing pore-scale modeling. A comprehensive overview of traditional pore-scale modeling methods is provided, followed by an examination of recent advancements driven by AI. The capabilities of LLMs and generative AI are highlighted, emphasizing their potential to improve the accuracy of pore-scale simulations, reduce computational costs, and enhance predictive capabilities while reducing the need for extensive physical imaging.

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Student Poster Contest

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Track Classification: Hydrocarbon Recovery / Flow in Porous Media

Contribution ID: **57** Type: **Oral Presentation**

Effect of solvent on porosity, crystallinity and thermal stability of ZIF-8 metal-organic framework

This study investigated the effect of three different solvents including water, methanol, and ethanol on the structural properties and stability of metal-organic frameworks (MOFs) of ZIF-8 type. The synthesis of ZIF-8 was done using zinc nitrate and 2-methylimidazole in the mentioned solvents, and the characteristics of the synthesized materials were analyzed and compared by XRD, BET, FTIR, and TG analyses. The results show that different solvents significantly affect the percentage of crystallinity, crystal structure, specific surface area, porosity, and thermal stability of ZIF-8. In particular, ZIF-8 synthesized with methanol and ethanol has higher crystallinity and thermal stability than the sample synthesized in the presence of water. The present research findings show that adjusting the synthesis conditions makes it possible to achieve suitable structural, crystalline, and morphological properties of the ZIF-8 metal-organic framework for adsorption and catalyst applications.

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Student Poster Contest

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Track Classification: Digital Rocks / Machine Learning

Contribution ID: **58** Type: **Poster Presentation**

A Review Study on Lithium Extraction from Geothermal Brine Reservoirs

Alkali metal lithium is recognized as one of the most important and highly valuable metals, utilized extensively in energy production and industry. Among the various sources for lithium extraction, such as seawater, hydrothermal clays, and pegmatites, geothermal brine reservoirs hold significant potential for lithium recovery. However, several challenges impede the development of lithium extraction methods from geothermal reservoirs. These challenges include sustainable production over time, environmental concerns, cost, and appropriate separation techniques. This study briefly addresses the economic challenges of lithium production from geothermal wells, highlighting its potential for long-term, environmentally friendly co-production of geothermal energy and lithium. The findings indicate that at lithium concentrations above 1 gr/L, the extraction efficiency from geothermal brine exceeds 90%. Moreover, lithium extraction using adsorbents demonstrates high efficiency and environmental compatibility.

Student presentation contest

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Journal Submission

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Track Classification: Hydrocarbon Recovery / Flow in Porous Media

Contribution ID: **60** Type: **Oral Presentation**

[illegible]

Wednesday, 25 September 2024 11:15 (15 minutes)

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Student presentation contest

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Journal Submission

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Student Poster Contest

Not Interested

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Session Classification: Parallel Session 9

Track Classification: Geotechnique/Soil Mechanics

Contribution ID: **61** Type: **Oral Presentation**

Predicting the amount and mechanism of carbon dioxide storage in underground reservoirs using artificial intelligence

Wednesday, 25 September 2024 11:15 (15 minutes)

Underground storage of carbon dioxide is one way to reduce the negative effects of greenhouse gas emissions on global climate change. This method was agreed upon as one of the basic solutions to limit global temperature rise to less than 2 degrees Celsius by the end of the 21st century at the UN Convention in December 2015. It is also a strategic method that, on the one hand, enables the continuation of the work of manufacturing plants and Clean Air Control, and on the other hand, helps to establish and maintain the international position of the oil industry and the continuation of oil production, particularly from low-yield reservoirs. Therefore, underground CO2 storage is not only justifiable but also requires development.

In this paper, the aim is to evaluate the mechanism of absorption and storage of carbon dioxide gas in underground saltwater reservoirs. This mechanism involves the injection of carbon dioxide gas into a reservoir with a saltwater reservoir in which the carbon dioxide gas is mixed with water and remains in the reservoir as a solvent or in an impregnated form. In this project, we simulated 900 different repositories using the Eclipse 300 simulator software, and using the data obtained from the simulation in this software, we trained the artificial intelligence network built using the algorithm (CNN). The network is built using 65,000 parameters for training with a learning rate of 0.1 and has an accuracy of R2=0.98. We designed the grid in such a way that 3 parameters—porosity, permeability, and location of the water production well in the reservoir—are predicted in the form of a gray photo, and the rate of injection of carbon dioxide gas and the rate of water production are input as numerical parameters to the grid, resulting in the final storage of carbon dioxide gas.

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Journal Submission

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Student Poster Contest

Opt In

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Presenter: AGHABEYG, SAEID

Session Classification: Parallel Session 10

Track Classification: New Energies / Underground Gas Storage

Contribution ID: **62** Type: **Oral Presentation**

Generating Images of Naturally Fractured Carbonate Reservoir Rocks Using Deep Learning Architecture

Wednesday, 25 September 2024 11:45 (15 minutes)

Carbonated reservoirs is one of the most usable and common reservoirs in throughout the world, especially in the middle east, and it is challenging to predict the fractures in these reservoirs. Generative adversarial networks (GAN) and Autoencoders can generate or create different purposes based on needs using images among different types of artificial intelligence algorithms. Powerful and useful GAN algorithm can generate images similar to the input images, while Autoencoder algorithm encode images into vectors and decode various images. In this study, we want to reconstruct the input 64*64 pixel resolution images using 2D Autoencoder algorithm and generate images similar to the inputs via GAN algorithm. This resolution speeds up the fracture identification and reduces changes during the training set. We can produce and generate a huge amount of naturally rock fractured carbonated reservoirs images via utilizing a deep GAN which is valuable for increasing and having more images of 2D grayscale images for further analysis in industry and research, including predicting the properties of naturally fractured reservoirs. The loss function of deep GAN algorithm ranges from 0.4 to 1.9 for the generator and from 0.2 to 1.8 for the discriminator. Autoencoder algorithm train and test are converged with the loss function of 0.0015. The images are generated and reconstructed which are convenient to evaluate even by a visual inspection.

Student presentation contest

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Journal Submission

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Student Poster Contest

Opt In

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Session Classification: Parallel Session 8

Track Classification: Digital Rocks / Machine Learning

Contribution ID: **63** Type: **Oral Presentation**

Numerical simulations and experimental study of saturated/superheated steam injection into unsaturated zone of soil

Wednesday, 25 September 2024 11:30 (15 minutes)

In this research, two- and three-dimensional simulation of saturated and supersaturated steam injection process in the unsaturated zone of soil is carried out using some simplified assumptions via DuMux Simulator. The simulator is developed in the Department of Hydromechanics and Modeling of Hydrosystems (LH2), Institute for Modeling Hydraulic and Environmental Systems (IWS), Stuttgart University, for Multi-{Phase, Component, Scale, Physics, …} flow and transport in porous media. The main objective of the study is observation and comparing the progress of the saturated temperature front and the supersaturated temperature front during the process of injecting saturated and supersaturated steam in the unsaturated zone of the soil. Moreover, some experiments are performed for supersaturated and saturated steam injection in the unsaturated zone of soil using the available sand box of Research Facility for Subsurface Remediation, VEGAS, Stuttgart University. Particular purpose of this part of study is evaluation of the heat-up efficiencies of supersaturated steam as opposed to saturated steam. Based on the experimental conditions, values of the local heat-up efficiency are calculated over time concerning the heat-up of defined points in the sandbox. The acquired values are 14.3% and 6.3% for mass based calculated local heat-up efficiency and energy based calculated local heat-up efficiency, respectively.

Student presentation contest

Opt in

Journal Submission

Consider for Journal Submission

Student Poster Contest

Opt In

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Presenter: JANFADA, Taraneh (Iran University of Science and Technology)

Session Classification: Parallel Session 9

Track Classification: Geotechnique/Soil Mechanics

Contribution ID: **64** Type: **Oral Presentation**

Comparison of the geotechnical properties of wind-blown sand from the Mesr desert of Iran with three other uniform sands for use in laboratory research.

Wednesday, 25 September 2024 11:45 (15 minutes)

In nature, sandy soils form the major part of alluvial sediments and wind-blown sands on the earth's surface. Examining the different behavioral and resistance characteristics of these types of soils is particularly important in geotechnical engineering. For this purpose, various static and dynamic tests are performed in laboratories using different devices and equipment. These tests can be divided into two groups element and physical model tests. To do both groups, sandy soil samples are needed. Today, natural and artificial sandy soils are used in laboratories worldwide. Several types of sand are used in Iran's current research, among which we can mention the natural and coastal sand of Babolsar and the artificial sand of Firouzkoh. In this article, a windblown sand called Mesr sand, which can be obtained from the Mesr desert of Iran, is introduced. The properties of this sand are compared with those of Babolsar and Firouzkoh, as well as the well-known Toyora sand of Japan, which is a well-known geotechnical sand.

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Primary author: Mr JAFARZADEH, Fardin (Associate Professor)

Co-authors: Mrs MOUSAVI, Zahra (Master of science); Mr KARIMZADEH, Ali Akbar (Post-doctoral fellow)

Presenter: Mr JAFARZADEH, Fardin (Associate Professor)

Session Classification: Parallel Session 9

Track Classification: Geotechnique/Soil Mechanics

Contribution ID: **65** Type: **Poster Presentation**

Bibliometric analysis in scientific research on unsaturated soils

In recent decades, the importance of addressing and understanding the behavior of unsaturated soils has increased due to the challenges of designing safe and cost-effective geotechnical structures based on the axioms of this scientific field. Therefore, this study conducts a bibliometric analysis of research conducted in the field of unsaturated soils in geotechnical engineering. For this purpose, the Vosviewer tool was used to analyze the content of relevant technical literature. The input information and data analysis comprised 2478 articles collected from the Web of Science database. The results show that the highest number of publications occurred in 2022 with 230 articles, accounting for 8.37% of the total dataset. Keyword analysis indicates that terms such as "unsaturated soils" and "model" have the highest frequency, highlighting the complexity of developing devices and testing methods in this area. This study demonstrates significant advancements in methodology and increased attention to unsaturated soil research.

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Primary author: MOLAABASI, Hossein (Visiting scholar professor, Sharif University of Technology)

Co-authors: Dr SADEGHI, Hamed (Sharif University of Technology); Dr SEIF, Mohammad Esmaeil (Islamic Azad University, Arak Branch)

Presenter: MOLAABASI, Hossein (Visiting scholar professor, Sharif University of Technology)

Track Classification: Geotechnique/Soil Mechanics

Contribution ID: **67** Type: **Oral Presentation**

ZIF-8

ZIF-8 pH

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Primary authors: SEIF ZADEH, Davood; Dr HOOR ABADI SABOR, Fahimeh; Mr ZAHEDI ASL, Saeed

Presenter: Dr HOOR ABADI SABOR, Fahimeh

Track Classification: Digital Rocks / Machine Learning

Contribution ID: **69** Type: **Poster Presentation**

[illegible]

[illegible]

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Student Poster Contest

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Primary authors: KHOEI, Amirreza; SAEEDMONIR, Saeed

Presenters: KHOEI, Amirreza; SAEEDMONIR, Saeed

Track Classification: Geotechnique/Soil Mechanics

Contribution ID: **70** Type: **Oral Presentation**

[illegible]

Wednesday, 25 September 2024 10:30 (15 minutes)

[illegible]

Student presentation contest

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Journal Submission

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Student Poster Contest

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Primary authors: MOKHTARI, Alireza; GATMIRI, Behrouz

Presenters: MOKHTARI, Alireza; GATMIRI, Behrouz

Session Classification: Parallel Session 7

Track Classification: Diverse Topics in Porous Media

Contribution ID: **71** Type: **Oral Presentation**

[illegible]

Wednesday, 25 September 2024 11:30 (15 minutes)

[illegible]

Student presentation contest

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Journal Submission

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Student Poster Contest

Opt In

Primary authors: EMAMI, Mohammad; NOROZI, Mohammad; SAJJADI, Mozhdeh (Assistant Professor)

Presenter: NOROZI, Mohammad

Session Classification: Parallel Session 10

Track Classification: New Energies / Underground Gas Storage

Contribution ID: **72** Type: **Oral Presentation**

Improving Oil Recovery: Combination Method of Nanohybrid, Low Salinity Water and Green Surfactant

Wednesday, 25 September 2024 10:15 (15 minutes)

In recent years, a combination of different methods or several materials is used to increase the effectiveness of enhanced oil recovery. When the combination of low salinity water, surfactants and nanoparticles are used simultaneously, it could move more trapped oil and improve the oil recovery factor. Gamma-alumina and silica metal oxide nanoparticles were used because of their high hydrophilic properties. Gum arabic was used as a nanoparticle stabilizer in the presence of salts in basefluids. Gum arabic is a natural and environmentally friendly surfactant and it can also help improve oil recovery by reducing interfacial tension. From distilled water and low salinity water with ppm concentrations (4171, 8142, 20400 and 41710) were considered as base fluids. Different combinations of mass ratio of nanoparticles, salt water and surfactant were investigated. Finally, after checking the stability of solutions, nanofluids with acceptable stability can be identified and selected. In micromodel flooding the highest oil recovery factor related to the gamma-alumina and silica nanohybrid with mass ratio of 10:90 was reported as 60.34%. However, the lowest interfacial tension for the nanohybrid with mass ratio of gamma-alumina and silica of 50:50 dispersed in brine 4171 ppm was reported.

Student presentation contest

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Journal Submission

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Student Poster Contest

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Primary authors: KHAJEH KULAKI, Azin; HOSSINI-NASAB, Seyed Mojtaba

Presenters: KHAJEH KULAKI, Azin; HOSSINI-NASAB, Seyed Mojtaba

Session Classification: Parallel Session 7

Track Classification: Diverse Topics in Porous Media

Contribution ID: **73** Type: **Oral Presentation**

[illegible]

[illegible] 0.3 [illegible] 5.5 % [illegible] 62.6% [illegible] 70.24% [illegible]

Student presentation contest

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Journal Submission

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Student Poster Contest

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Primary authors: MALEKI, Sahar; Dr HOSSEINI-NASAB, Seyed Mojtaba (School of Chemical, Oil and Gas Engineering)

Presenters: MALEKI, Sahar; Dr HOSSEINI-NASAB, Seyed Mojtaba (School of Chemical, Oil and Gas Engineering)

Track Classification: Geotechnique/Soil Mechanics

Contribution ID: **75** Type: **not specified**

Exploring the Potential of Energy Piles in Industrial Applications

Tuesday, 24 September 2024 15:00 (1 hour)

The impending depletion of fossil fuel resources and the environmental degradation caused by the pollutants generated from their utilization have necessitated the employment, development, and application of renewable energy sources. Geothermal energy, as one of the renewable energy sources, has played a significant role in the development of countries around the world, and in Iran, it is considered one of the most suitable renewable energy sources to potentially replace fossil fuels. Energy piles, a type of structural pile installed beneath the foundation of a structure, incorporate heat exchange pipes within their body, allowing for the absorption and transfer of the Earth's thermal energy by the fluid circulating within these pipes. Essentially, energy piles serve a dual purpose: they function as load-bearing structural members and as an intermediary for harnessing geothermal energy. By employing energy piles, in addition to conserving and stockpiling fossil fuels, their utilization for cooling and heating purposes in the industry can be realized, while simultaneously preventing the release of environmental pollutants that would otherwise result from the combustion of fossil fuels.
In this workshop, the focus will be on the practical usages of energy piles, with discussions on the following subjects:
1) An introduction to energy piles
2) Geotechnical, structural, and mechanical aspects in implementing energy piles
3) An introduction to the Geo-Energy Structures Laboratory at NRI
4) Industrial potentials for using energy piles

Student presentation contest

Journal Submission

Student Poster Contest

Presenter: Dr AKBARI GARAKANI, Amir

Session Classification: Workshop

Contribution ID: **76** Type: **not specified**

Embark on Your Funding Journey

Wednesday, 25 September 2024 14:00 (1h 15m)

"Persuasive Grant Writing" is your guide to using narrative tools that resonate with your funders. Elevate the quality of your grant applications, align your proposals with funder objectives, and apply narrative tools to make your applications more informative and persuasive.
Key Learning Points:
• Craft winning grant applications
• Create effective project budgets
• Design impactful projects
• Uncover the secrets of successful grant revisions

Who Should Attend:
Anyone eager to master the art of finding and applying for grants! Whether you're a student, a Ph.D. or postdoc, or an early-career researcher, this workshop is tailored just for you.

Student presentation contest

Journal Submission

Student Poster Contest

Presenter: SHOKRI, Nima (Hamburg University of Technology)

Session Classification: Workshop

Contribution ID: **77** Type: **not specified**

Patenting or Publishing

Tuesday, 24 September 2024 11:00 (1 hour)

Academic researchers often face a dilemma when deciding whether to publish their new research as patents or articles, as the choice between the two options is influenced by various factors that may not always be clear to those in academia. This workshop covers a range of topics, such as the reasons for publishing research papers, the definition and purpose of patents, the requirements for patent eligibility and patentability, the process of patent examination, the differences between authors and inventors, reviewers and examiners, as well as papers and patents. Additionally, the workshop explores the importance of the claim in patents, common reasons for patent rejections, current challenges in the field, provides two examples, and offers a list of 20 points to consider when making the decision between patenting and publishing.

Student presentation contest

Journal Submission

Student Poster Contest

Presenter: Dr MAHANI, Hojjat (Assistant Professor, Sharif University of Technology)

Session Classification: Workshop

Contribution ID: **78** Type: **not specified**

Rock 3D Digital Imaging, digital core analysis, and artificial intelligence applications at the pore scale

Section 1: Physics, instrumentations, and applications of Micro-CT scanners
This workshop introduces the basic physics, instrumentations and applications of Micro-CT scanners. Micro-CT provides micron-sized high-resolution 3D imaging information that cannot be obtained with other non-destructive technologies. This 3D reconstruction allows the user to see inside the object without destroying the structure and produces contrast between different material types depending upon their relative composition and density. This 3D imaging information are used to quantify material characteristics such as porosity, used as input for numerical models, or are simply being used to gain better understanding of the interior of a sample
Section 2: Imaging techniques to understand pore-scale processes
Dynamic processes such as fluid flow, reactive transport, mineral precipitation, mass transport, and biological activity interact within porous rocks, regulating their macroscopic behavior. These processes are significantly influenced by the rock's mineralogy, pore structure, and environmental conditions. A variety of imaging techniques, such as scanning electron microscopy, laser confocal microscopy, and X-ray computed tomography, have been used to investigate these dynamic pore-scale processes in porous geomaterials. These tools provide valuable insights into the mechanisms occurring within the pores. Understanding these processes through pore-scale imaging and modeling is crucial for accurately predicting the macroscopic behavior of materials. This course briefly introduces a selection of imaging techniques and their potential applications with examples from various experiments related to the visualization and characterization of dynamic pore-scale processes in porous media.
Section 3: Applications of machine learning in digital rock physics workflow
This workshop investigates into the synergy between machine learning techniques and digital rock physics (DRP) workflow, offering a comprehensive exploration of concepts and applications. The fusion of deep learning methodologies with DRP not only enhances the efficiency of estimating porous media properties but also accelerates the process significantly. The implementation of deep learning is showcased across various applications at the pore scale, encompassing image segmentation (e.g., two-phase (pore-solid) or multimineral segmentation), rock property estimation (regression of single or multiphase properties), image resolution enhancement, and porous media reconstruction. Participants in this course not only gain proficiency in the DRP workflow but also acquire a thorough understanding of the diverse applications of machine learning within this framework. The curriculum spans a broad spectrum, ranging from pore-scale imaging through μ-CT scanning to predicting pore-scale properties using DRP. The course explores the latest advancements in pore-scale studies driven by deep learning methods, providing participants with insights into cutting-edge developments in the field.

Student presentation contest

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Student Poster Contest

Presenters: Dr QAJAR, Jafar (Department of Petroleum Engineering, Shiraz University); Dr SADEGH-NEJAD, Saeid (Department of Petroleum Engineering, Faculty of Chemical Engineering, Tarbiat Modares University, Tehran, Iran); Dr GHADIRI, hossein (Tehran University of Medical Sciences)

Session Classification: Workshop

Contribution ID: **79** Type: **not specified**

Rock 3D Digital Imaging, digital core analysis, and artificial intelligence applications at the pore scale

Lab Tour

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Journal Submission

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Session Classification: Workshop

Contribution ID: **80** Type: **Oral Presentation**

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Wednesday, 25 September 2024 10:25 (20 minutes)

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Journal Submission

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Student Poster Contest

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Primary author: AGHAEIFAR, Zahra

Co-authors: STRAND, Skule; PUNTERVOLD, Tina

Presenter: AGHAEIFAR, Zahra

Session Classification: Parallel Session 6

Track Classification: Hydrocarbon Recovery / Flow in Porous Media