COLLEGE OF ENGINEERING AND COMPUTER SCIENCE
FLORIDA ATLANTIC UNIVERSITY

Announces the Ph.D. Dissertation Defense of

Mazen Hafez

for the degree of Doctor of Philosophy (Ph.D.)

"UNDERSTANDING GRAVITY-DRIVEN PARTICLE SETTLING AND DISTRIBUTION IN FRACTURES"

November 8, 2022, 1:00 pm
Ph.D. Dissertation
WebEx
Meeting number: 2623 054 7858
Password: UMd63ZcggK4

DEPARTMENT:
Ocean and Mechanical Engineering

ADVISOR:
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ABSTRACT OF DISSERTATION
The elevated energy demand and high dependency on fossil fuels have directed researchers' attention to promoting and advancing hydraulic fracturing (H.F) operations for a sustainable energy future. Previous studies have demonstrated that particle suspension and positioning in slick water play a vital role during the injection and shut-in stages of the H.F operations. A significant challenge for H.F is the premature particle settling and uneven particle distribution in a formation. Even though various research was conducted on particle transport, there still exist gaps in the fundamental particle-particle interaction mechanisms. This dissertation utilizes experimental and numerical approaches to advance state of the art in particle-particle interactions in various test conditions. Experimentally, the study utilizes high-speed imaging coupled with particle tracking velocimetry (PTV) and particle image velocimetry (PIV) to provide a 2D space and time-resolved investigation of both two-particle and multi-particle interactions during gravitational settling, respectively. Dual-particle experiments uncovered an unstable regime of interactions characterized by chaos. On the hand, quantification and mathematical modeling of lateral forces acting upon dual particles was completed in the stable regime. Three-dimensional numerical investigations of fluid flow over dual particles were conducted at various separation distances and Re. Special attention was given to close proximity conditions. The results demonstrate unique unreported flow patterns and new information on the flow blockage phenomenon. Transient simulations highlight the coupled relationship between vortex shedding, Re, and separation distance. A multi-perspective experimental study on the coupled effect of viscosity and multi-particle mix ratio on slurry velocity was conducted. PIV analysis highlights unique agglomeration and particle interactive patterns. The results demonstrate the existence of a reduced velocity condition at a given viscosity and particle mix ratio. Lastly, a PIV analysis was conducted on particle interactions in an impulse injection condition, inclusive and exclusive of gravitational effects. The study targeted uncovering the coupled effect of fracture angle and solution viscosity on fracture filling patterns, vortex formations, and final proppant deposition.

BIOGRAPHICAL SKETCH
Born in Cairo, Egypt
B.S., Florida Atlantic University, Boca Raton, FL, 2019
M.S., Florida Atlantic University, Boca Raton, FL, 2020
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CONCERNING PERIOD OF PREPARATION
& QUALIFYING EXAMINATION

Time in Preparation: 2019-2022

Qualifying Examination Passed: Semester Fall 2019

Published Papers:

Mazen Hafez, Abhishek P Ratanpara, Yoan Martiniere, Maxime Dagois, Mahyar Ghazvini, Mohammadhassan Kavosi, Philippe Mandin, Myeongsub Kim, "CO2-monoethanolamine-induced oil swelling and viscosity reduction for enhanced oil recovery", Journal of Petroleum Science and Engineering, 2021.

Mahyar Ghazvini, Mazen Hafez, Abhishek Ratanpara, Myeongsub Kim, "A review on correlations of bubble growth mechanisms and bubble dynamics parameters in nucleate boiling", Journal of Thermal Analysis and Calorimetry, 2021.

Seokju Seo, Mohammad Mastiani, Mazen Hafez, Genevieve Kunkel, Christian Ghattas Asfour, Kevin Ivan Garcia-Ocampo, Natalia Linares, Cesar Saldana, Kwangsoo Yang, Myeongsub Kim, "Injection of in-situ generated CO2 microbubbles into deep saline aquifers for enhanced carbon sequestration", International Journal of Greenhouse Gas Control, 2019.

Mazen Hafez, Mahyar Ghazvini, Myeongsub Kim, "Mechanisms of Particle Distribution in a Cavity", International Journal of Multiphase Flow. (Under Review).

Mazen Hafez, Mahyar Ghazvini, Myeongsub Kim, "Investigation of Particle Settling Characteristics under Gravity using Particle Image Velocimetry (PIV)", Physics of Fluid. (Under Review).

Mazen Hafez, Mahyar Ghazvini, Myeongsub Kim, "Numerical Investigation of Three-Dimensional Flow Over Dual Particles During Settling", Powder Technology, 2022. (Under Review).

Mazen Hafez, Mahyar Ghazvini, Myeongsub Kim, "On the Stability of Particle-Particle Interaction During Gravitational Settling", Energies, 2022. (Under Review).

Mahyar Ghazvini, Mazen Hafez, Philippe Mandin, Myeongsub Kim, "Experimental Study of Pool Boiling Heat Transfer on Novel Pin-Finned Surfaces", International Journal of Heat and Mass Transfer, 2022. (Under Review).

Mazen Hafez, Thi-Han Nge, Mahyar Ghazvini, Abischek Ratanpara, Myeongsub Kim, "Understanding Particle-Particle Interaction during Settling under Gravity", American Physical Society Division of Fluid Dynamics, 2021.

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Mahyar Ghazvini, Roosvelt Delius, Shilei Richards, Abisheck Ratanpara, Mazen Hafez, Myeongsub Kim, "Experimental Study of Pool Boiling Heat Transfer on Novel Pin-Finned Surfaces", American Physical Society Division of Fluid Dynamics, 2021.

Abhishek Ratanpara, Mazen Hafez, Mahyar Ghazvini, Myeongsub Kim, "Green CO2 Capture using Waste Concrete and Natural Seawater", American Physical Society Division of Fluid Dynamics, 2021.