

Lateef Kareem

Curriculum Vitae

Department of Mechanical and Aerospace Engineering
Benjamin Statler College of Engineering and Mineral Resources
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"blessed is he who studies to solve societal problems"

Teaching Interests

Teaching Mathematical Methods(Partial, Ordinary Differential Equations, Complex analysis and Numerical Methods), Physics(Mechanics, Heat and Electricity), Thermodynamics, Mechanics (Statics and Dynamics), Fluid Mechanics, Analysis of Statically Determinate Structures, Programming(Matlab, Mathematica, Python and Julia)

Teaching Experience

Mathematical Methods, Petroleum Engineering and Advanced Reservoir Simulation

Jan. 2019 – **Teaching Assistant**, Benjamin Statler College of Engineering and Mineral Resources, West Virginia University, 26505 Morgantown, WV, United States.

I held tutorials on Finite element analysis and uses of ANSYS with undergraduate students for MAE456

Oct. 2016 – **Visiting Lecturer**, Institute of Petroleum Studies, University of PortHarcourt and IFP France, PortHarcourt, Nigeria.

I taught MSc students (2016/2017 set) Numerical methods

Practical Projects:

- Estimation of compressibility factor using Starling Canahans Equation of State (Hall and Yarborough Correlation) using the Newton-Raphsons's method of root finding.
Role: I walked them through how to compute numerical differentiation of functions, development of newton-raphson algorithm, estimation of initial guess for the Hall and Yarborough equation and the estimation of Zfactor;
- Solution of the diffusivity equation for aquifer flow for the edge-drive dimensionless water influx .
Role: I walked the student through the derivation of diffusivity equation using the combination of continuity equation and darcy law, solved the equation for pressures and estimate the constants, derive the differentiation of Pressure with space at the inner boundary and evaluate the water flow rate across the boundary and then the water influx by integration of the flow rate over time(all in laplace space), then we performed the numerical inversion to obtain the result in time space;
- Assign a final project on Reserve estimation and aquifer parameter evaluation to the students

Oct. 2016– **Visiting Lecturer**, Petroleum and Gas Engineering Department, University of PortHarcourt, PortHarcourt, Nigeria.

I taught MSc students:

- (2017/2018 set) Statistics and Application of Monte Carlo Simulation in Uncertainty quantification in the oil and gas industry.
- (2016/2017 set) Laplace transform and its Application in Reservoir Engineering

Sep. 2012– **Teaching Assistant**, *Petroleum Engineering Department, King Fahd University of Petroleum and Minerals*, Dhahran, Eastern Provinces, Saudi Arabia.

Jan. 2013 I taught Application of Laplace transform to MSc student 2012/2013 set in Petroleum Engineering department, I also assisted the lecturer (Dr Abeeb Awotunde) in advanced reservoir simulation

Research Interests

Research Numerical Simulation of Reactive and Non-reactive Flow in Porous Medium, Numerical Simulation of Carbon Capture with Organo-Metallic Framework in Pre-Combustion Carbon Capture, Numerical Solution of Partial Differential Equation, Modeling and Optimization of Physical Systems.

Research Experience

Jan. 2019 – **PhD Candidate**, *Benjamin Statler College of Engineering and Mineral Resources, West Virginia University*, 26505 Morgantown, United States.

Theory of Combustion in Micro-Tubes.

Projects Involvement:

- Physics of Combustion in Micro-Tubes and Parallel Plates.

Role: A new approach to describe flame acceleration in micro tubes was developed. Starting with the Navier-stokes equation for an axial flow in a cylindrical tube, we set the pressure gradient to be proportional to the radial component of a velocity function and then absorbed the driving force into the temporal component of the resulting velocity differential equation. This leads to a model with two unknown parameters (coming from the temporal and radial component of the velocity function). Since the chemistry of the combustion is not considered in the model, these two parameters were computed by nonlinear fitting of the model to the experimental measurement showing good agreement between the model and the experiments.

Jan. 2016 – **Applied Mathematician/Petroleum Engineer**, *CypherCrescent Ltd (Software Development and Oil Servicing Company)*., PortHarcourt, Nigeria.

Applied Mathematics and Optimization.

Projects Involvement:

- Development of the Mathematics Library.

Role: Mathematics library on which most of our computation is based was built. The Mathematics library is a collection of classes such as the Matrix class (for linear algebra calculations- solution of linear system, eigen-system calculations), Solver class (for solution of linear and nonlinear equation, differential equations, numerical inversion of Laplace transforms), Integration class (for all kinds of numerical integration like trapezoidal method simpsons method, gauss-legendre, gauss-jacobi, gauss-laguerre and gauss-hermite), Optimizer class(for linear, nonlinear, constrained and unconstrained optimization), Complex class (for all complex arithmetic calculations), Valder class (for automatic differentiation), Statics class (for statistical model computation of probability and inversions), Special Function class(Bessel, Gamma, Laguerre, Legendre, Airy and Kelvins functions. as well as Fresnel Integrals, Exponential Integral and Elliptic Integral) ;

- Development of Water Influx estimation .

Role: I developed the solution to water influx problem for edge drive, bottom drive for both radial and rectangular geometry,

- Numerical computation of reservoir fluid properties using Equation of State(EOS).

Role: I performed the solution of the multi-component chemical equilibrium equations used in compositional gradient calculations, phase envelope calculations, and as well developed new criticality condition for multicomponent systems. I also developed a new power correlation for estimation of pure component vapour pressure.

Sept. 2013 – **Research Engineer**, *Center for Petroleum and Minerals, Research Institute, King Fahd University of Petroleum and Minerals*, Dhahran, Saudi Arabia.

Computational Fluid Dynamics Section with Focus on Reactive and Non Reactive Flow in Porous Medium.

Projects Involvement:

- Numerical Simulation of Carbon Capture With Organo-Metallic Framework (Masters degree Thesis Research of Bamidele Olufemi Mechanical Engineering King Fahd University of Petroleum and Minerals).

Role: I was responsible for validation of the mathematical model of the physical system, Nonlinear regression for estimation of the Langmuir Isotherm model parameters for the adsorption of carbon dioxide from experimental data and the numerical solution of the coupled system of ordinary and partial differential equations.;

- Improved Numerical Simulation of Wormhole propagation in Carbonate Core(Schlumberger Oil Services -project CPM (2298)).

Role: I processed CT scan images of the core and develop CT scan number porosity relationship and piece-wise permeability-porosity equation. I also built a simulator to solve coupled reactive transport differential equations. I performed simulation and carried out report and publication writing.

- Assessment of Impact of Micro fractures on Well productivity in Shale gas Reservoirs: Numerical Simulation Approach (Baker Hughes sponsored).

Role: I performed 6 half-cell permeability characterizations, and now I am solving transport differential equation.,

- Inflow Performance Relation of a Fully Penetrating Horizontal Well with Transverse Elliptic Fractures using Spheroidal Coordinate System.

Role: I solved diffusivity equation in spheroidal, radial and rectangular coordinate systems. I coupled the result to develop the overall pressure drop. Now, I am performing simulation to account for errors due to change from linear to radial and spheroidal flow pattern.

Publication

- **Kareem, LA**, Iwalewa, TM and Al-Marhoun, M. (2016). 'New explicit correlation for the compressibility factor of natural gas: Linearized z-factor isotherms.' *Journal of Petroleum Exploration and Production Technology*, p. 1-12
- **Kareem, LA**, Sultan, AS and Iwalewa, TM. (2015) 'Simplified Semi-analytical Productivity Index for an Eccentric Horizontal Well in a Box Model Reservoir.' *Journal of Energy Exploitation and Exploration*. 33, pp. 785-808.
- **Kareem, LA**, Sultan, AS. 'New Understanding in Numerical Simulation of Wormhole Propagation in Carbonate Core Acidizing.' *Journal of Transport in Porous Media*., Decision: revise and resubmit (2015).
- **Kareem, LA**, Iwalewa, TM and Omeke, JE. (2014). 'Isobaric specific heat capacity of natural gas as a function of specific gravity, pressure and temperature.' *Journal of Natural Gas Science and Engineering*. 19, pp. 74–83.

Conference Presentation

- **Kareem, LA**, 'A New Analytical Model of Flame Propagation in Micro Tubes With One End Closed' (2019). *94th Annual meeting of West Virginia Academy of Science*, West Liberty University, WV, United States, March, 2019.
- **Kareem, LA**, 'Determination of Petroleum Fluid Composition From Separator Information' (2018). *40th Nigerian Annual International Conference and Exhibition*, Lagos, Nigeria, August, 2018.

- **Kareem, LA**, 'Z factor: Implicit correlation, convergence problem and pseudo-reduced compressibility' (2014). *36th Nigerian Annual International Conference and Exhibition*, Abuja, Nigeria, August, 2014.
- **Kareem, LA**, Explicit Half Range Cosine Fourier Series Expansion For Z Factor (2013). *35th Nigerian Annual International Conference and Exhibition*, Lagos, Nigeria, August, 2013.
- **Kareem, LA**, Characteristic Equation and Determinant of a Null Matrix. *Southeastern Meeting American Mathematical Society*, Tulane University, New Orleans, Louisiana, United States, October 13-14, 2012.
- **Kareem, LA**, Omeke, JE, Furui's IPR Model Correction and its Application in Horizontal Well Cresting Control & Inflow Control Device Installation (2012). *34th Nigerian Annual International Conference and Exhibition*, Lagos, Nigeria, August, 2012.
- **Kareem, LA**, Omeke, JE, Specific Heat Capacity of Natural Gas; Expressed as a Function of Its Specific gravity and Temperature (2011). *33th Nigerian Annual International Conference and Exhibition*, Abuja, Nigeria, August, 2011.
- **Kareem, LA**, Omeke, JE, Achumba, GA, A New Approach for Recovery Factor Estimation; Using the Mechanics of Fluid Flow through Reservoir and Production Tubing and Expansion of formation and Reservoir Fluids (2010). *32th Nigerian Annual International Conference and Exhibition*, Calabar, Cross Rivers, Nigeria, August, 2010.

Scholarship and Award

- 2019–2021 **PhD Graduate Research Assistant**, *Computational Fluid Dynamics and Applied Multi-Physics Center*, Department of Mechanical and Aerospace Engineering, West Virginia University, Morgantown, WV, United States.
- 2017–2020 **PhD Physics, University of Warsaw Scholarship**, Warsaw, Poland, .
- 2018–2020 **PhD Deanship of Graduate Studies Scholarship**, *King Fahd University of Petroleum and Minerals (KFUPM)*, Dhahran, Saudi Arabia, .
- 2015–2018 **PhD Engineering, University of Cambridge**, *Cambridge Trust, IDB Cambridge International Scholarship*, Sydney Street, Cambridge, United Kingdom, .
- 2014–2015 **PhD Energy, University of Cambridge**, *Islamic Development Bank (IDB) Scholarship*, Jeddah, Saudi Arabia, .
- 2011–2013 **MSc Deanship of Graduate Studies Scholarship**, *King Fahd University of Petroleum and Minerals (KFUPM)*, Dhahran, Saudi Arabia, .

Education

- 2011–2013 **MSc in Petroleum Engineering**, *King Fahd University of Petroleum and Minerals (KFUPM)*, Dhahran, Saudi Arabia, 3.86.
Distinction
- 2002–2007 **B-Eng in Petroleum Engineering**, *Federal University of Technology (FUTO)*, Owerri, Nigeria, .

Master's thesis

Title *Improved Numerical Simulation of Wormhole Propagation in Carbonate Acidizing*
Supervisors Dr. Abdullah Sultan, Dr. Abee Awotunde and Dr. Rajai Alassar

Description Numerical simulation of wormhole propagation is the solution of systems of equations that describes the wormhole phenomenon as close to the reality as possible. This solution provides access to lots of data that are not available in experimental studies. Knowledge of pressure, concentration, porosity and permeability at every location in the core and time during the simulation provide a better understanding of the stimulation process. In this work, strongly coupled and stiff system of differential equation describing the phenomenon was solved using Implicit Pressure Explicit Concentration Implicit Mineral Volume Implicit Porosity method (IPECIMVIP). Using 141,647 grid cells ($51 \times 51 \times 81$) for a 1.5inch diameter, 2.4inch thick carbonate core, we performed numerical simulation of wormhole propagation, discuss the stability criteria for time step selection and present new understandings of the wormhole phenomenon: 1). The use of mean core acid concentration as an indication of the efficiency of the phenomenon, 2). The presence of 2 breakthroughs- Acid and wormhole breakthrough, 3). The shifting effect of local mass transfer coefficient and molecular diffusivity on the acidization curve, 4). The impact of initial permeability of the core on the pore volume injection to breakthrough, 5) The joint impact of Péclet and Damköhler number and 6). Pore volume injection to concentration breakthrough at high injection rates.

Membership of Professional Bodies

Oct. Society of Petroleum Engineers, Nigeria, Board of Technical Review Committee since 2014
2002–Present

Feb. Society of Petroleum Engineers, Saudi Arabia
2011–Present

Nov. Society of Petroleum Engineers, London
2015–Present

Board of Reviewers for Journal

May, Journal of Natural Gas Science and Engineering
2014–Present

June, Journal of Petroleum Science and Engineering
2016–Present

Research Profile Pages

- o Google Scholar, Academia, Researchgate, and Matlab file Exchange

Computer skills

Computational Matlab, Fortran, Mathematica, Julia, C++, C# and Python

Modelling Eclipse, CMG, SNAP, Sapphire
Software

Visualization Matlab and Paraview

High IBM HPC Platform Version 4
Performance
Computing

Word MSWord and Latex
Processor

Presentation MS PowerPoint and Latex
Operating Windows and Linux
System

Certifications

Matlab Matlab Onramp Certificate
Matlab Deep Learning Onramp Certificate
MITx Certificate for Circuits and Electronics
MITx Certificate for Dynamics
MITx Certification in Computer Programming with Python
BUx Introduction to Differential Equations
DartmouthX Certificate for The Engineering of Structures Around Us
Mathematica Certified Wolfram Technology Associate
Joint Basic User Certification for Microscopy with Xradia Versa XRM 500
KFUPM-
ZEISS

Languages

Yoruba **Native User**
English **Expert User**

IELTS Score 7.5/9.0

Volunteering

- Matlab File Exchange Contributor. I have contributed 8 file getting over 170 downloads per month
- Drone Flight AutoPilot
- Brick Games for MatLab

References

ThankGod Technical Director, Cyphercrescent Ltd
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