

Dr. Mohamed Mahmoud — Research Impact, Scientific Contributions, and Leadership

Over the past two decades, I have built an internationally recognized career in petroleum and energy engineering, distinguished by a prolific publication record, pioneering research innovations, and transformative leadership in sustainable energy technology. My work has fundamentally advanced the understanding of fluid–rock interactions, CO₂ sequestration and mineralization, hydrogen generation and storage, enhanced oil and gas recovery (EOR/EGR), and thermochemical energy systems, contributing directly to the global transition toward carbon neutrality.

Impact of Published Work

I have authored/co-authored over 500 peer-reviewed journal papers, more than 300 conference papers, and holds over 90 issued U.S. patents, placing me among the top 2% of scientists worldwide according to the Elsevier–Stanford Global Ranking (2020–2025). My Google Scholar H-index of 63 and Scopus H-index of 54 testify to the deep and sustained impact of my research on the global scientific community.

My work is widely cited in *Energy & Fuels*, *ACS Omega*, *Fuel*, the *Journal of Petroleum Science and Engineering*, *Applied Surface Science*, and the *Journal of Energy Resources Technology*—journals at the forefront of energy innovation. Across these publications, I have advanced the conceptual and practical frameworks that underpin eco-friendly stimulation fluids, thermochemical systems for heavy oil recovery, and integrated CO₂-management technologies.

Among my most influential contributions is the development of environmentally friendly chelating agents for formation-damage removal and high-temperature stimulation. This innovation replaced hazardous acids traditionally used in well stimulation, marking a paradigm shift toward green chemistry in petroleum operations. The methodology has since been adopted by research teams and companies across the world.

My later publications extended this eco-conscious philosophy into CO₂ storage and mineralization, nano-bubble CO₂ for enhanced recovery, and thermochemical hydrogen production in subsurface reservoirs—concepts that merge carbon management and clean-energy generation within a single subsurface system. His studies on enforced CO₂ mineralization in reservoir rocks, transforming injected CO₂ into stable carbonate minerals, have influenced industrial practices for permanent geological carbon storage in the Middle East and beyond.

Collectively, my publications demonstrate an exceptional ability to bridge fundamental science, engineering design, and field application. Several of my papers, including those published in *Energy & Fuels* and *SPE Journal*, have redefined conventional thermal EOR approaches by integrating renewable principles into petroleum processes. My research on machine-learning-based reservoir characterization and NMR-driven petrophysical modeling has further advanced digital subsurface analysis, fostering data-driven sustainability in oil and gas fields.

Scientific Contributions to Publications

Beyond volume, my research stands out for its originality and translational significance. My scientific contributions fall within several interconnected themes that collectively form a sustainable energy research ecosystem.

- 1. Pioneering Thermochemical Systems:** I have introduced thermochemical fluids capable of generating hydrogen and steam in situ within depleted oil and gas reservoirs, while simultaneously trapping CO₂. This dual-benefit innovation represents a world-first integration of hydrogen production and carbon sequestration, a concept now being explored internationally as a potential pathway to carbon-neutral energy systems.
- 2. CO₂ Capture and Mineralization:** My studies on CO₂–brine–rock interactions and mineral transformation kinetics have established the scientific basis for long-term CO₂ storage. I have developed predictive geochemical models that describe the interplay of dissolution, precipitation, and sorption in subsurface formations. These findings underpin multiple Aramco-funded carbon-management projects aimed at achieving Saudi Arabia’s Net-Zero Vision 2060.
- 3. Hydrogen Storage and Energy Transition:** As Principal Investigator of the landmark project “Enabling Underground Hydrogen Storage to Meet Net-Zero Targets in Saudi Arabia” (RDIA, budget SAR 6.5 million), I am leading the national development of safe and economically viable hydrogen storage systems. My laboratory is currently validating hydrogen-rock interaction mechanisms to ensure reservoir integrity, placing me at the forefront of global hydrogen subsurface research.
- 4. Green Stimulation and Enhanced Recovery Fluids:** I have designed biodegradable, seawater-based, non-damaging fluids that enhance productivity while minimizing freshwater consumption—a major environmental challenge in oilfield operations. Five of these formulations are already commercialized and field-applied in collaboration with Saudi Aramco and local partners, exemplifying impactful university–industry translation.
- 5. Advanced Petrophysics and Machine Learning:** I have redefined petrophysical characterization through AI-assisted modeling, NMR analysis, and multi-scale integration of log, core, and image data. My methods have been incorporated into corporate workflows at Saudi Aramco and referenced in numerous peer studies, reinforcing my status as a scientific innovator at the digital–physical interface of reservoir engineering.

6. Technology Commercialization and Patents: Several my patented processes—such as barite-scale removal, filter-cake dissolution, and thermochemical stimulation—have been licensed by companies including Halliburton, Saudi Multi-Chem, and Saudi Petrogestix, reflecting the industrial scalability and economic relevance of his research outputs. My work on thermochemical stimulation is currently the practice in Saudi Aramco with more than 50 field deployments annually with a cost reduction of 60% compared to the conventional stimulation solutions.

Research Leadership

My impact extends far beyond publications. As Professor of Petroleum Engineering at KFUPM, I have become a leader in sustainable energy research and education.

- I have directed multiple laboratories, including the Thermochemical Applications Laboratory, Enhanced Gas Recovery Laboratory, and Stimulation Research Laboratory, each serving as a regional hub for innovation in decarbonized subsurface systems.
- I led an international collaboration with the University of Western Australia that culminated in the establishment of a state-of-the-art NMR facility at KFUPM. This initiative secured five funded research projects from Saudi Aramco and DTV companies. Under my supervision, several students successfully completed their graduate studies, gaining exceptional hands-on training in advanced NMR research. Our laboratory has since become a regional hub for NMR innovation, providing specialized training to professionals from Saudi Aramco and KAUST.
- I have secured over USD 10 million in competitive research funding, leading/co-leading more than 40 funded projects, 30 of which were directly supported by Saudi Aramco. My research teams frequently pioneer cross-disciplinary collaborations that combine chemical engineering, geoscience, and data analytics.
- As a mentor, I have supervised over 50 master's theses and 20 doctoral dissertations, and participated in more than 100 graduate committees. Many of my mentees now serve as engineers and researchers at major energy organizations including Saudi Aramco, Halliburton, and Schlumberger. My mentorship emphasizes independent scientific inquiry and sustainability-driven problem solving, ensuring that his influence propagates through future generations of energy researchers.

My leadership also manifests through his editorial and professional service. Following are examples of my editorial/advisory roles in different journal/societies:

- Editor of ACS Omega (starting 2026 will serve as senior editor)
- Editor of the Arabian Journal for Science and Engineering
- Advisory Board Member for Energy & Fuels Journal
- Advisory Board Member of unconventional resources journal
- Board Member of the Society of Petrophysicists and Well Log Analysts (SPWLA)
- Appointed as a member of the International Advisory Board for the SPE Production and Facilities Committee, which guides international research priorities and scholarly discourse on energy and sustainability
- Founding member of the Saudi Arabia Chapter of the Society of Petrophysicists and Well Log Analysts (SPWLA), which was recognized as the Best Global Chapter in 2018.

My excellence has been recognized through numerous awards, including:

- 2024 SPE Sustainability and Stewardship in the Oil and Gas Industry Award (By Society of Petroleum Engineers)
- 2024 University Distinguished Professorship Award, KFUPM
- 2023 ACS Energy & Fuels Star Award (By American Chemical Society)
- 2022 University Best Applied Research Award
- 2022 SPE Distinguished Achievement Award for Petroleum Engineering Faculty (By Society of Petroleum Engineers)
- 2021 SPE Production and Operations Award (By Society of Petroleum Engineers)
- 2018-2022 SPE Outstanding Technical Editor Award for SPE Journal ((By Society of Petroleum Engineers))
- 2021 KFUPM Excellence in Advising Award
- 2020 KFUPM Excellence in Teaching Award
- 2016 KFUPM Excellence in Research Award