

Introduction to Nanotechnology for Petroleum Engineers

Technical Course for Petroleum Engineers

Novel nanoscale-structured materials, in the form of functional nanoparticles, solid composites and complex fluids, are bringing major technological advances in many industries. The upstream oil industry is now vigorously catching up to adapt those technologies to develop its own unique applications. Participants will learn the nanotechnology fundamentals, be introduced to important NT products and applications from other industries, and learn about the current state of various NT applications development in the upstream oil industry.

Target Audience

Any upstream oil & gas technical staff and managers who want a well-organized and concise introduction to nanotechnology with oilfield applications perspective, so that they can utilize and/or help develop innovative nanotechnology applications for improved oilfield operations and oil production.

Skills Learned in Course

Participants in the course will:

- Become familiar with the basics of nanotechnology
- Become familiar with synthesis and surface coating
- Understand the applications to oil and gas

Course Description

This two-day course will begin with an introduction to the very basics of nanoscience and nanotechnology, with description of some easily recognizable examples of their application, so that the participants appreciate their tremendous potential for upstream oil & gas industry. Methods of synthesizing the nano materials, and applying design surface coating to them (or imbedding them to form nano-composites) so that they have desired functionalities, are described. The participants will learn that, while tremendous advances have been made on synthesis and manipulation of nano materials in other industries, their oilfield applications require innovative specific adaptation for them to work under harsh downhole and/or reservoir conditions; and also learn how to go about fulfilling those requirements.

After participants become familiar with the nanotechnology fundamentals, the current state of development of various oilfield applications will be introduced. This will include the use of engineered nanoparticles for (i) improved drilling fluid and fracturing fluid formulations; (ii) stabilization of foams/emulsions for improved mobility control and conformance control for EOR; (iii) wettability alteration for EOR; (iv) produced water treatment; (v) enhanced reservoir sensing; and (vi) heavy oil upgrading. Throughout the course, participants will be encouraged to bring their specific oilfield needs to the instructor's and UEOR experts' attention, so that maximum benefit could be attained from their fresh exposure to the highly advanced (but new to oil industry) nanotechnology. The ultimate objective is for students not only to gain a well-rounded understanding of the vast range of the nanotechnology developments, but also to develop an ability to identify those applications that have potential to satisfy their specific needs and to assess what steps are needed to bring those applications for practical use and tangible benefit. Course material can be customized to a limited extent to suit client's needs.

Course Content

Nanotechnology Fundamentals

- Basic Properties of Nano Materials and Their Characterization Methods
- Nanoparticle Synthesis and Surface Coating
 - Nanoparticle synthesis and surface coating methods
 - Development of nanoparticles with desired, specific functionalities
- Nanoparticles in Fluids and at Fluid Interfaces
 - Dispersion stability of nanoparticles in fluids; Their transport in porous media
 - Adsorption of nanoparticles at a fluid interface
 - Nanoparticle-stabilized foams and emulsions; Their transport in porous media
- Nanomagnetism
 - Magnetic nanoparticles and their remote control/detection with external magnetic field
 - Ferrofluids; Ferrohydrodynamics
- Nano Composites
 - Polymer composites; Metal composites
- Nano Coatings
 - Abrasion-resistant, corrosion-resistant, self-healing coatings
 - Super non-wetting or wetting coatings
- Nano Catalysts
- Environments and Nanotechnology

Nanotechnology Applications in Upstream Oil Industry

- Drilling and Completions
 - Drilling fluids and fracturing fluids with improved rheology and well integrity
 - Improved hardware materials and their use
- Production Operations and Flow Assurance
 - Emulsion and colloidal particulate removal from produced fluids
 - Inhibition of scale/organic particulate deposition at near-wellbore and downhole zones
 - Flow assurance for oil/gas pipelines and surface facilities
- Reservoir Sensing
 - Enhanced reservoir imaging; Intelligent tracers
 - Downhole monitoring
- Enhanced Oil Recovery
 - Wettability alteration and imbibition enhancement
 - CO₂ foams and emulsions for improved reservoir sweep
 - Improved conformance control
- Heavy Oil Recovery
 - Nano catalysts for in-situ or near-wellbore oil upgrading