



### «MODERN EOR TECHNICS», 5 days

#### COURSE OBJECTIVE:

improvement of professional competencies in sphere of:

- EOR technics;
- Physical and chemical, reservoir and gas EOR technics application;
- Application of flow deviation technologies in terms of infected water filtration pathway and flooding mechanism.

#### ACQUIRED ABILITIES:

- Plan, implement and analyze results of physical-chemical and gas EOR technics;
- Consider flooding mechanism and apply technologies of waterproofing sealant design;
- Apply modern gas EOR technics according to design and modeling requirements;
- Analyze results of gas technics implementation;
- Estimate technical-and-economic efficiency of EOR technics.

#### COURSE CONTENT:

Module Name	Content
Overview of EOR in Russia and the world	Modern classification of EOR technics and oil reserves. EOR – past, present, future. Application of EOR in Russia, CIS countries, USA, Canada and China. Development trends, leading scientific centers for EOR development.
Polymer waterflooding	Polymer waterflooding evolution: from classical to ASP. ASP waterflooding as the most efficient method of physical-chemical effect. World practice. Geological and technological criteria of polymer waterflooding (PW) applicability. Lab control and monitoring of polymer mixture injection. Hall method. Fixed and mobile PW equipment. Foreign case studies. Periodic and continuous units for treatment and injection of polymer mixtures. Offshore polymer waterflooding. Example of PW application for high-viscosity oil field.
Water-soluble polymer and its cross-linked forms for formation EOR	Applied polymers, leading polymer producers. Acrylamides polymer. Flow characteristics dependence on molecular property and water salinity. Mechanical, thermal and chemical destruction of polymer macromolecule in water solutions. Hydrogels on the basis of acrylamides polymer. Waterproofing properties of different

	hydrogels. Examples of injected amount calculation for conformance control. Modern polymer technologies (Bright Water, etc.)
Physics of conformance control under the influence on formation through injection wells	Flow deviation technologies (FDT) as a modern analogue of conformance control. FDT application with respect to waterflooding mechanism. Injected water filtration patterns, targeted design of hydrogel location. Engineering design algorithms. Matrix of hydrogels application depending on waterflooding pattern. Methods of waterflooding mechanisms identification. Tracer analysis. Realization examples with assessment of operational benefit for each filtration pattern.
Potential of low-capacity physical-chemical EOR technics while development of unhomogeneity terrigenous rock	Dependence of FDT efficiency on level of reservoir depletion. Analysis of systematic FDT application results by mathematic modeling. The impact of reservoir depletion level on physical-chemical exposure parameters. Classification of reserves in view of EOR. Including of various reserves categories in production depending on depletion level. The advance of production liquid waterflooding over reservoir depletion dynamic as EOR application criteria. Identification of highest expectable FD EOR efficiency period. Regular change of technological and economical parameters of FDT application at different stages of field development.
Selection and verification of affected objects and areas for EOR technics application	Prompt systems analysis of geological structure features and current level of depletion. Identification of zones for EOR application on the basis of map analysis matching (maps algebra). Priorities in selection of physical-chemical affected areas. Geological and technological criteria for areas selection. Step by step development of wellwork and EOR program on the basis of operational analysis. Post-event analysis of EOR application. Example of complex wellwork and EOR program application.
Selection and verification of affection technics	Classification of waterproofing technologies and compound depending on material formation, chemistry and strength properties of backfill composition. Expert review of optimum application conditions of various compositions. Step-by-step selection of base technology and composition for EOR application in design documentation. Practice of Russian petroleum companies. Particular cases of method, basic technology and its modification selection for conformance control and EDT based on the geological-physical profile of development object.
Hydrodynamic EOR technics	Physics of the methodology. Injectivity criteria. Non-stationary and cyclic waterflooding. World and Russian experience. Recommended reading.
Gas EOR technics	Injectivity criteria, results, modern Gas EOR (G-EOR) variations. Associated gas challenges and utilization ways. Temporary utilization of associated gas at oilfield gas-holders. Physics of EOR technics by hydrocarbon gases, CO <sub>2</sub> , nitrogen and combustion gases injection. Injection technics depending on reservoir geological features. Different hydrocarbon gas injection technics: water-alternated-gas (WAG), cyclic and alternate water and gas injection. G-EOR dependence on injected gas composition and technics. The matrix of injection technics applicability. G-EOR trends in Russia

	and the whole world. Injection modeling, evolution of modeling from simple three-phase to compositional simulation. Compositional modeling issues. Case study of WAG modeling. Well construction requirements. Compressor technics and production well operation requirements. Case study, feasibility study.
Modeling of Physical-chemical EOR technics	Problems of low-capacity EOR simulation. Models hierarchy: engineering design of low-capacity EOR, quasioone-dimensional model, 3D model (polymer waterflooding, G-EOR). Modeling concepts, technological parameters and target cost-performance ratio optimization. Updating of data while modeling.
Algorithm for assessment of technological and economic efficiency of EOR and wellwork	Technical approaches of EOR technical-economic efficiency assessment. Definition of base and analyzed periods, desaturation characteristic, production decline curve. Principles for selection of desaturation characteristics or production decline curves. Software for technological efficiency of EOR and wellwork. Principles of EOR economic efficiency assessment, uncertain part of oil production cost. Discounts application while EOR economic efficiency calculation.