RESERVOIR ENGINEERING FUNDUMENTALS

(L-T-P: 3-1-0)

Objectives:

The students should learn the basic theories and their applications of Reservoir Engineering. By opting the above course students will learn the applications of Physics in understanding the mechanics of hydrocarbon production from the reservoir. They should develop an understanding to maximize the hydrocarbon recovery without damaging the reservoir with the help of various Reservoir Engineering tools used in the industry. This will also be useful for students who want to pursue their career in Petroleum industry in future.

Syllabus:

Petroleum Reservoir: Origin (Generation, Migration and Entrapment of Hydrocarbons) and Classification of Reservoirs based on Reservoir Fluids.

Reservoir rock and fluid properties:

Rock Properties: Porosity, Permeability, Wettability, Fluid Saturation, Formation Compressibility, Total and Effective Isothermal Compressibility, Hydrostatic and Overburden Pressure and Capillary Pressure.

Fluid Properties: Gas Properties. Pseudocritical Properties, Pseudoreduced Properties, Gas Deviation Factor, Gas Formation Volume Factor, Gas Viscosity, Gas Isothermal Compressibility, Gas Properties from Gas Composition, Gas Density and Wellstream Gravity.

Oil Properties: Specific Gravity of Oil, Bubble Point Pressure, Oil Viscosity, Oil Formation Volume Factor, Oil Density Determination, Dissolved Gas/Oil Ratio.

Water Properties: Solubility of Gas in Water, Water Formation Volume Factor, Water Isothermal Compressibility and Water Viscosity.

Fluid Flow through Porous Medium: Darcy's Law, Absolute, Effective and Linear Permeability, Single and Multiphase flow, Relative Permeability Measurements, Linear and Radial Systems for Parallel and Series Layers. Frontal Drive Equations.

Hydrocarbon Phase Behavior: Single and Multiphase Systems; Single Phase Das Reservoir, Single Phase Oil Reservoir, Condensate Reservoirs, Saturated and Undersaturated Reservoirs, Retrograde Condensation.

PVT Analysis for Reservoir Fluids. Reservoir Fluid Sampling. Sampling Wet Gas and Gas Condensate Systems, Recombination of the Surface Gas Oil and Gas Samples, Applications of PVT Data.

Reserve Estimation: *Volumetric:* Original Oil in Place and Recoverable Oil, Original Gas in Place and Recoverable Gas, Original Oil and Gas in Place in a Field.

Material Balance Equation: Oil Reservoirs. General Form of the Material Balance Equation, OOIP in Solution Gas Drive Reservoirs, OOIP in Gas Cap Drive Reservoirs, OOIP in Natural Water Drive Reservoirs, Combination Drive Reservoirs.

Material Balance Equation: Gas Reservoirs. OIGP in Depletion Type Reservoir, OGIP in Water Drive Reservoir, Effect of Water and Pore Compressibility, OGIP in Abnormally High Pressured Gas Reservoirs, Calculation of Reservoir Pressure from p/z.

Decline Curve methods: Constant Percentage Decline, Hyperbolic Decline and Harmonic Decline.

Reservoir Drive Mechanism: Classification of Reservoirs Based on Drive Mechanisms.

Solution Gas Drive Reservoirs: Behavior of the Produced Gas/Oil Ratio, the Schilthuis Method, the Tarner Method, the Tracy Method, the Muskat and Taylor Method, Real Time Forecast from Material Balance.

Water Drive Reservoirs: Cumulative Water Influx in Edgewater Drive Reservoirs and in Bottomwater Drive Reservoirs, Simultaneous Evaluation of OOIP and Water Influx. Predicting the Amount of Water Influx.

Gas Cap Drive Reservoirs, Compaction Drive Reservoirs, Gravity Drainage and Combination Drive Reservoirs.

Gas, Gas-Condensate and Oil Reservoirs.

Single Phase Gas Reservoirs: Calculation of Gas in Place by Volumetric Method, Unit Recovery from Volumetric Gas Reservoirs, Unit Recovery from Gas Reservoirs under Water Drive. The Gas Equivalent of Produced Condensate and Water. Abnormally High Pressured Gas Reservoirs.

Gas-Condensate Reservoirs: Calculation of Initial Gas and Oil in Place by Volumetric method, gas equivalent of produced condensate and water. Performance of Volumetric Reservoirs. Material Balance Equation Applied to Gas-Condensate Reservoirs.

Oil Reservoirs: Undersaturated Oil Reservoirs; Calculation of Initial Oil in Place by Volumetric Method and Estimation of Oil Recoveries, Material Balance in Undersaturated Reservoirs. *Saturated Oil Reservoirs:* Material Balance in Saturated Reservoirs, Material Balance as a Straight Line. Performance Prediction for Depletion Drive Reservoirs.

Water and gas coning: Vertical Well Critical Rate Correlations for Gas Coning, Water Coning and Combined Gas and Water Coning.

Pre-requisite: Thermodynamics, Fluid Mechanics and Basic Geology.

Books:

1. Fundamentals of Reservoir Engineering : L. P. Dake
2. Applied Petroleum Reservoir Engineering: B. C. Craft & M.F. Hawkins
3. Petroleum Reservoir Engineering: Physical Principles: J. W. Amyx, D.M. Bass & R.L. Whiting.
4. Oil Reservoir Engineering: S. J. Pirson.