

Flow Assurance

1.1 Course Number: PE546

1.2 Contact Hours: 3- 0- 0 Credits: 9

1.3 Semester-offered: 4th Year-Odd

1.4 Prerequisite: Pipeline Engineering, Pumps & Compressors

1.5 Syllabus Committee Member: Dr. Tushar Sharma, Dr. Satish Kumar Sinha

2. **Objective:** This course enables the understanding of technical, safety and environmental risks associated with deposition problems in near-wellbore formations, production tubing, wellhead equipment, flowlines and processing facilities which are relevant in the oil and gas industry

3. **Course Content:**

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-topic	Lectures
1	Pipeline flow	Two-phase flow in pipelines, Convective mass transfer, Boundary layer theory, Particle mass transfer, Deposition models, pipeline and station design, compressor fundamentals, choice of pumps	8
2	Solubility principles and scaling issues	Natural gas hydrate: Trapped in cages, Water vapour in natural gas, Equilibrium lines, Non-hydrocarbon gases and water salinity, Prevention by antifreeze, Prevention by low-dosage chemicals, Prevention by cold flow. Inorganic scale: Main factors and issues, Solubility graphs, Equilibrium and activity, Chemical potential, Solubility of scaling minerals, Sulphate scale, Carbonate scale, Sulphide scale, Amorphous silica	12
3	Challenges in flow assurance	Naphthenate: Naphthenic acids, Tetracarboxylic acids, Composition of deposits, Deposition parameters, Interface processes, Size of bubbles and droplets. Identifying challenges in flow assurance: How, when, where?, Initial diagnosis and solution of flow assurance production problems in operations, rheology investigation, Hydraulic and thermal analysis, Flow restrictions and blockages in operations. Flow assurance deliverability issues : Flow assurance stability issues, Flow assurance integrity issues, Research methods in flow assurance, Flow assurance modeling, Risk analysis	10
4	Multiphase flow and modelling aspects in flow assurance problems	Transient Multiphase Flow in Pipes: Transient Flow Applications, Successive Steady-State Flows, Transient Modeling, Transient Multiphase Flow Commercial Software. Black oil model and compositional model for fluid simulation, Transient, multiphase fluid modeling to assess thermal and hydraulic transients during production rate changes, turndown, startup, shutdown, and blow-	10

		down; including flowline and riser slugging, cool-down, and warm-up. Use of modeling and/or laboratory analysis to predict and assess solid formation, deposition, bedding and/or blockage behavior for hydrates, sand, wax, scale, asphaltenes, and other solids.	
			Total
			42

4. Readings

4.1 Textbook:

- a) Flow Assurance Solids in Oil and Gas Production, Jon Gudmundsson, Taylor & Francis, 2017
- b) Handbook of Multiphase Flow Assurance, Taras Y. Makagon, Gulf Publishing, 2019.

4.2 Reference books:

- a) Natural Gas Hydrates in Flow Assurance, Carolyn Ann Koh and Sum, Gulf Publishing 2010.
- b) Petroleum Production Engineering, Boyun Guo et al. Gulf Professional Publishing, 2017.

5 Outcome of the Course:

The precipitation and deposition of solids are a major challenge in the production of oil and gas. Flow assurance solids are formed because of unavoidable changes in temperature, pressure and composition of the oil-gas-water flow stream, from reservoir conditions to processing conditions. The exploitation of heavy crudes has also made flow assurance issues dominant in ensuring efficient and safe exploitation of hydrocarbon assets.