Course Description:	**Multiphase Flow Modelling of Crude Pipeline Networks**
Course Location	Hydrafact Limited, Edinburgh
Course Description	This course focuses on the fundamentals and modelling of multiphase flow in pipelines and wellbores, including: definition of variables in multiphase flow, a detailed examination of the procedure of pressure and temperature profile calculations, fluid physical properties including gas, oil, water and liquid phases physical properties determination in compositional and non-compositional (black-oil) models, VLE calculations and equations of state. In this course, flow regime determination, liquid hold-up and pressure drop prediction empirical and mechanistic models in horizontal, vertical and inclined flow conditions and some other special cases, e.g., downward vertical flow, flow in annulus and flow in riser pipes will be discussed in details. Furthermore, operational problems in multiphase flow pipelines like corrosion, pigging and slug flow will be reviewed. Design of separation facilities such as slug captures will be another part of the course.
Audience	Petroleum, Production, and Process Engineers
Prerequisites	Previous basic knowledge of fluid mechanics is necessary. Operational experience in production or process engineering would be useful.
Course Length	5 days
Course Materials	Copies of the slides The participants will be given a certificate indicating their participation in the course
Course Contacts	Please email us at info@hydrafact.com
Course Contents and Daily Programme	Please let us know if you wish to add anything to the course contents.

Course Content / Daily Programme	

Chapter 1: Principles of Multiphase Flow

1-1- Introduction

1-2- Definitions of Variables used in Multiphase Flow

1-2-1- Slippage

1-2-2- Liquid Holdup

- No Slip Liquid Holdup and Degree of Slippage

1-2-3- Velocity

- Superficial Velocity
- Actual Velocity
- Multiphase Velocity
- Slip Velocity
- Slip Ratio

1-2-4- Density

- Slip Density and No Slip Density

1-2-5- Viscosity

- Slip Viscosity and No Slip Viscosity

1-2-6- Flow Patterns

- Horizontal Flow Pipelines (Beggs-Brill Flow Patterns)
- Vertical Flow Pipelines
- Inclined Flow Pipelines

1-3- The General Energy Equation

1-3-1- Evaluation of Friction Losses- The Friction Factor

1-3-2- Modification of Pressure Gradient Equation for

1-4- Calculation of Pressure & Temperature Profile

1-4-1- Heat Transfer Coefficient

Chapter 2: Fluid Physical Property

2-1- Introduction

2-2- Black Oil Model (Non-Compositional Fluid)

2-2-1- Gas Phase

- Gas Density
- Gas Formation Volume Factor
- Gas Compressibility Factor (Standing-Katz Method)
- Gas Viscosity (Carr et al. Correlation and Lee et al.)

2-2-2- Oil Phase

- Solution Gas-Oil Ratio (Lasater, Standing and Vazquez)
- Production Gas-Oil Ratio
- Oil Formation Volume Factor (Lasater and Vazquez)
- Oil Density
- Specific Gravity of Free and Dissolved Gas
- Oil Compressibility
- Oil Viscosity (Beggs-Robinson and Chew-Connally)
- Surface Tension (Baker-Swerdloff Correlation

Course Content / Daily Programme	2-2-3- Water Phase Solubility of Natural Gas in Water McCain Correlation Water Formation Volume Factor McCain Correlation Water Density Water Viscosity McCain Correlation Surface Tension Katz et al. Correlation 2-2-4- Liquid Phase Liquid Density Volumetric Method Liquid Viscosity Volumetric Method API Procedure Liquid Surface Tension Volumetric Method **2-3- Compositional Model** 2-3-1- VLE Calculations Bubble and Dew Point Curves Equation of States Soave-Redlich-Kwong (SRK) Peng-Robinson (PR) Equilibrium Ratios Wilson Correlation **Chapter 3: Horizontal Flow** 3-1- Introduction 3-2- Horizontal Pressure Loss Prediction Methods Lockhart and Martinelli Correlation Beggs and Brill Constant Dukler et al. Correlation Eaton et al. Correlation Guzhov et al. Correlation Yocum Correlation Oliemans Correlation 3-3- Other Liquid Holdup Correlation Hughmark and Pressburg Correlation and Hughmark Correlation 3-4- Evaluation of Friction Factor and Pressure Loss Correlations 3-5- Evaluation of Liquid Holdup Correlations 3-6- Taitel-Dukler Flow regime Determination 3-7- Use of Panhandle Equations in Multiphase Flow

Course Content / Daily Programme	

Chapter 4: Vertical Flow

4-1- Introduction
4-2- Classification of Correlations
4-3- No Slip, No Flow Regime Consideration Correlations
- Poettmann and Carpenter
- Baxendell and Thomas
- Fancher and Brown

4-4- Slip Considered, No Flow Regime Consideration Correlations
- Hagedorn and Brown

4-5- Slip Considered, Flow Regime Considered
- Duns and Ros
- Orkiszewski
- Beggs-Brill
- Aziz, Govier and Fogarasi
- Chierici, Ciucci and Sclocehi

4-6- Evaluation of Pressure Loss Prediction Methods
4-7- Downward Vertical Multiphase Flow
4-8- Flow in Annulus
4-9- Coupling Wellbore Hydraulics to Reservoir Behavior
4-10- Temperature Prediction
4-11- Flow in Riser Pipes

Chapter 5: Inclined Flow

5-1- Introduction
5-2- Equation for Inclined Flow
5-3- Directional Wells
- Use of Vertical Correlations
- Beggs and Brill Correlations
- Griffith, Lau, Hon and Pearson Correlation

5-4- Pipelines
- Flanigan Correlation
- Guzhov, Mamayev and /odishariya Correlation
- Beggs and Brill Correlation
- Gregory, Mandhane and Aziz Method

5-5- Downhill Flow
- Bonnecaze, Erskine and Greskovich Correlation
- Gallyamov and Goldzberg Correlation
- Greskovich Method and Other Methods

5-6- Evaluation of Inclined Flow Correlations (Hilly Terrain Pipelines)

Chapter 6: Pipeline Design Problems

6-1- Pigging
6-2- Slug Catcher Design
6-3- Prediction of Slug Characteristics
6-4- Prediction of Internal Corrosion in Multiphase Flow Pipelines