

E-504

### ▲ Who should attend?

Junior and more experienced engineers involved in the **operation and/or design** of Oil & Gas field processing facilities.

### ▲ Duration

5 days

### ▲ Dates & Location

February 16-20, 2009  
Rueil-Malmaison (Paris)

September 21-25, 2009  
Rueil-Malmaison (Paris)

October 05-09, 2009  
Rueil-Malmaison (Paris)

### ▲ Registration

Fees: € 2,060

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### ▲ Course Coordinator

Mohamed SKHIRI

Ref. PROD / ADV1

# THERMODYNAMICS APPLIED TO WELL EFFLUENT PROCESSING

## OBJECTIVES

To provide knowledge of the fundamentals of thermodynamics required in order to understand the operation and/or design of the Oil & Gas field processing facilities.

On completion of the course, participants:

- know the composition, the properties and the characterization parameters of Oil & Gas well effluents,
- know the ideal gas law and the real fluid behavior and characterization methods,
- understand the principle of liquid-vapor equilibrium of pure substances and mixtures,
- know the operating principle and performances for mixture separation processes,
- know the fundamentals of friction losses as well as gas compression and expansion,
- have a first experience in thermodynamic simulation and know the fundamentals of Equations Of State, their use and selection.

## COURSE CONTENT

### WELL EFFLUENT

0.5 day

Constitution and physical states of matter

Constituents of production **well effluents**: hydrocarbons, impurities, Water, sediments...

Different types of effluents (black oil, light oil, volatile oil, condensate or wet gas, dry gas) –

Main characterization parameters: GOR, CGR, BSW, WOR, Water Cut, Bo, Bg, B'g...

**Hydrates**: different types, formation conditions

*Examples of compositions of crude oil and natural gas effluent*

### IDEAL GAS AND REAL FLUID BEHAVIOR

0.5 day

Ideal gas behavior

Behavior of real fluids: compressibility factor, Amagat's law, law of corresponding state with two and three parameters

**Equations Of State (EOS)**: conception, uses, examples, selection

### GAS COMPRESSION AND EXPANSION

1 day

Isentropic and polytropic compression and expansion of ideal gases – Case of real gases

Practical gas compression and expansion laws

**Exercise**: Compression of propane

**Proll simulation**: Propane compressor

### LIQUID-VAPOR EQUILIBRIUM OF PURE SUBSTANCES

1 day

Vapor pressure curves: saturated and subcooled liquids, saturated and superheated gases, critical point, vapor pressure, boiling point... – Volatility classification

Overall phase diagram of a pure substance (three dimensions: T, P and V)

Enthalpy diagrams of pure substances

**Exercises**: Vapor pressure and boiling points of pure components

Vapor pressure and boiling point – Case of a column

**Proll simulation**: Propane Cryogenic Loop

### LIQUID-VAPOR EQUILIBRIUM OF MIXTURES - MIXTURE SEPARATION

1 day

Analysis and characterization of petroleum cuts - Pseudo-components (NBP, Specific gravity, MW...)

Phase envelopes: saturated and subcooled liquids, saturated and superheated gases, critical point, bubble curve, dew curve, cricondenbar, cricondentherm... – Retrograde condensation phenomena

Well effluents behavior from pay zone to surface processing facilities: Case of dry gases, condensate (or wet) gases, retrograde gases, light (or volatile) oils and heavy (or black) oils

**Exercises**: Equilibrium coefficients (K values) and relative volatility

Vapor pressure of a mixture of hydrocarbons

LPG recovery by physical absorption

**Proll simulation**: Mixture Separation by distillation – LPG splitter

### FUNDAMENTALS OF FRICTION LOSS THROUGH PIPES AND FITTINGS

1 day

**Single-phase** flow regimes (laminar and turbulent)

Friction losses calculation through pipes and fittings – Exercises