Knowledge of Real Fluid Behaviour – the Key to Successful Gas Processing Systems

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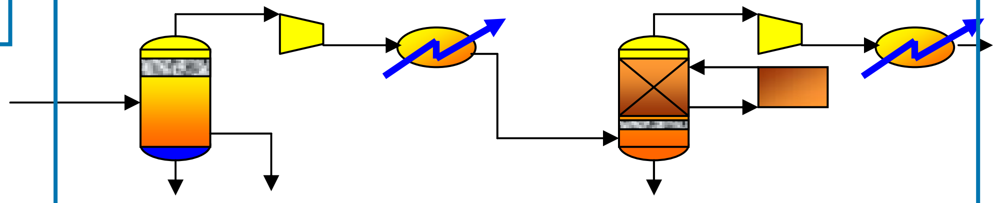
Outline

- Definition Gas Processing
- Some Challenges Gas Processing
- Gas-Liquid Separation
- Solubility challenges
    - Glycol Solubility in Gas
    - Salt Solubility in Glycol

Gas Processing - elements

- Gas-liquid separation
- Dehydration
- Gas sweetening (CO_2 and H_2S removal)
- Trace component removal and handling
- Glycol reclaiming and regeneration
- Heat exchange
- Compression/expansion



2 phase flow or Multiphase flow

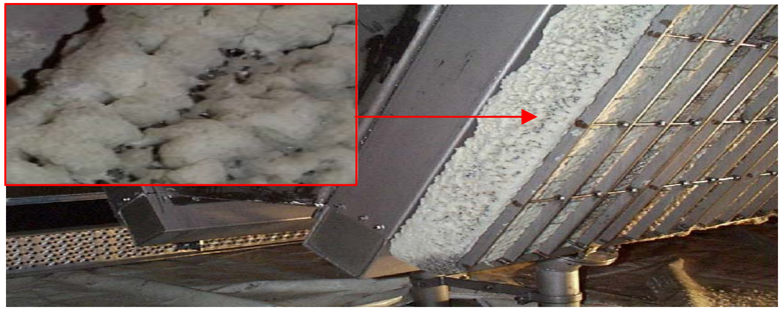
Sales gas
Pipeline transportation

LNG production

Gas conversion

Some Challenges

Gas-liquid separation
•Compressor breakdown
•Upsets in contactors and absorbers
•Low efficiency/malfunction of adsorbers and absorbers
•Off-spec gas product



Absorption processes
•Absorbent capacity and kinetics
•Foaming
•Emulsions due to additives
•Loss of absorbent

Solubility of trace components
•Changes with process parameters
•Accumulates and deposits

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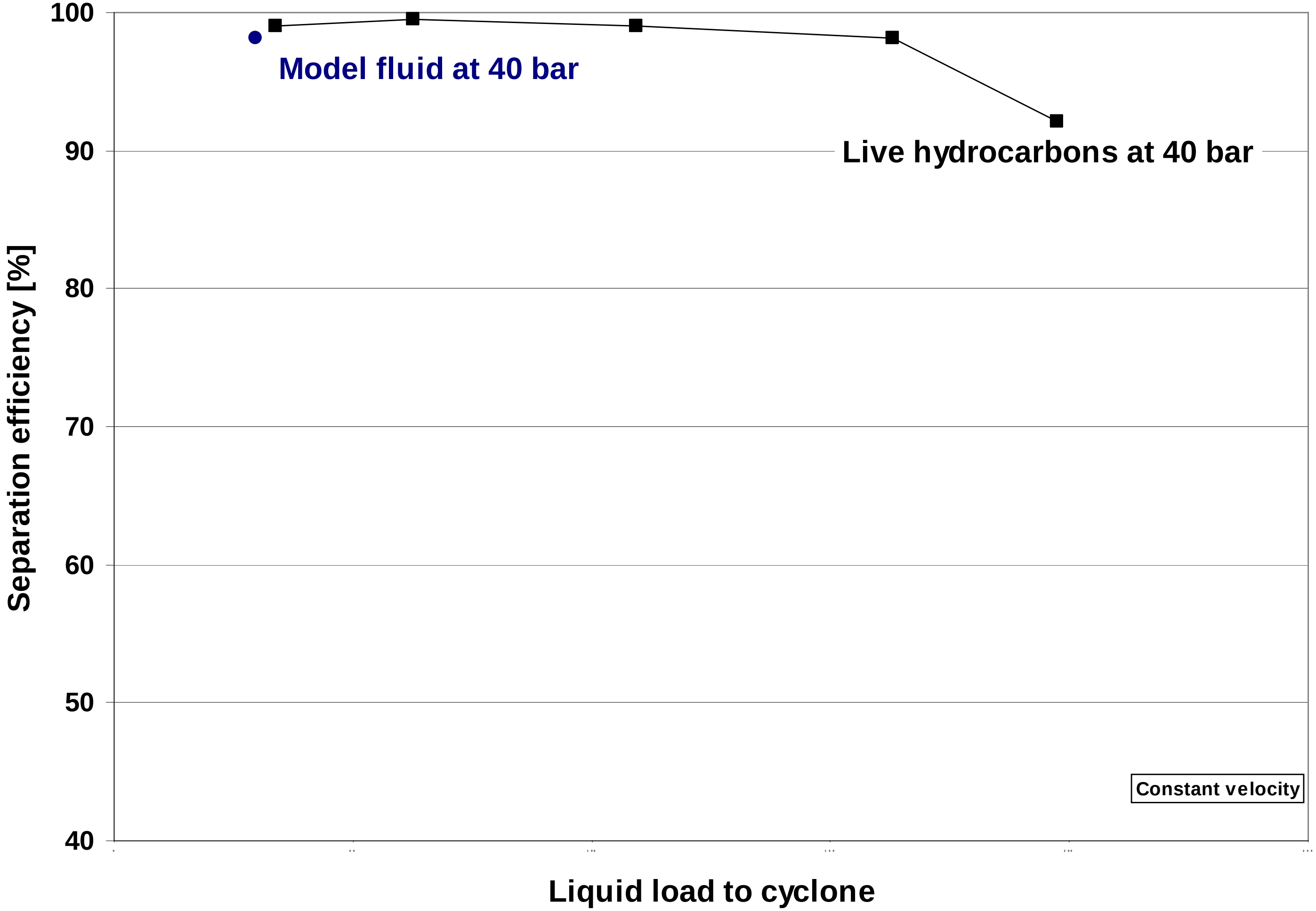
DEMISTING CYCLONES –
Impact of Fluid and Pressure



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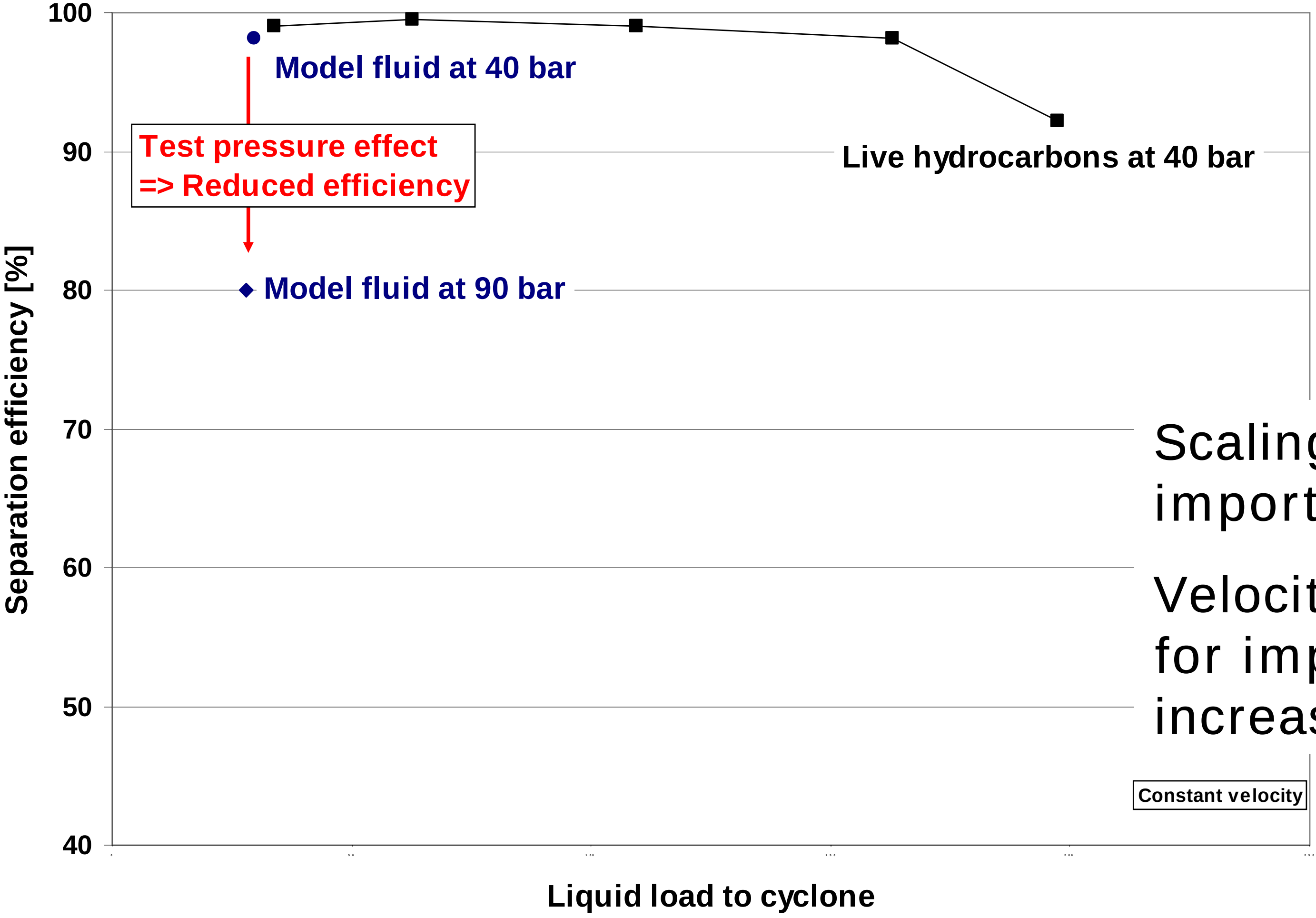
DEMISTING CYCLONES – Impact of Fluid and Pressure



Scaling rule important

Velocity not proper for impact of increased pressure

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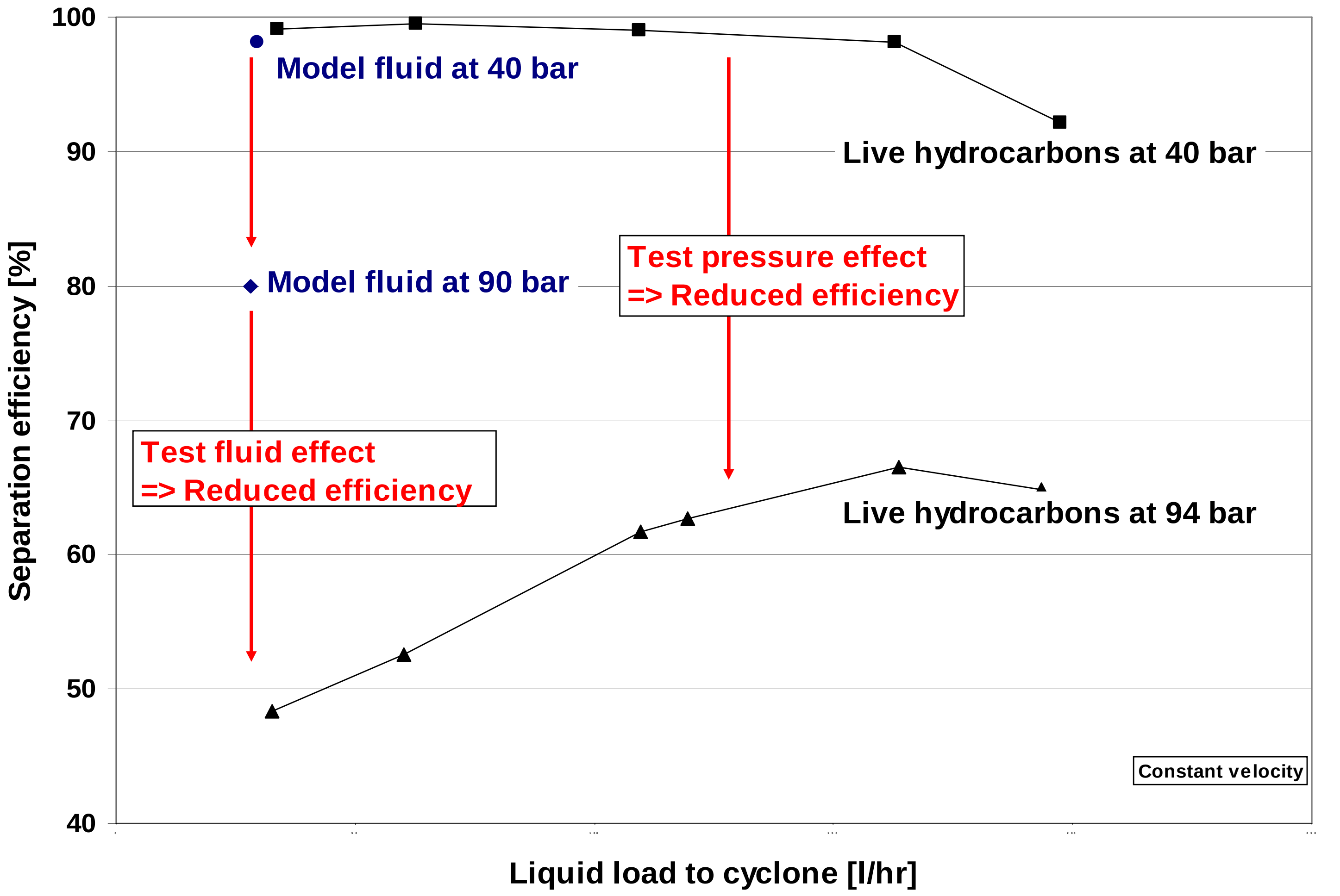
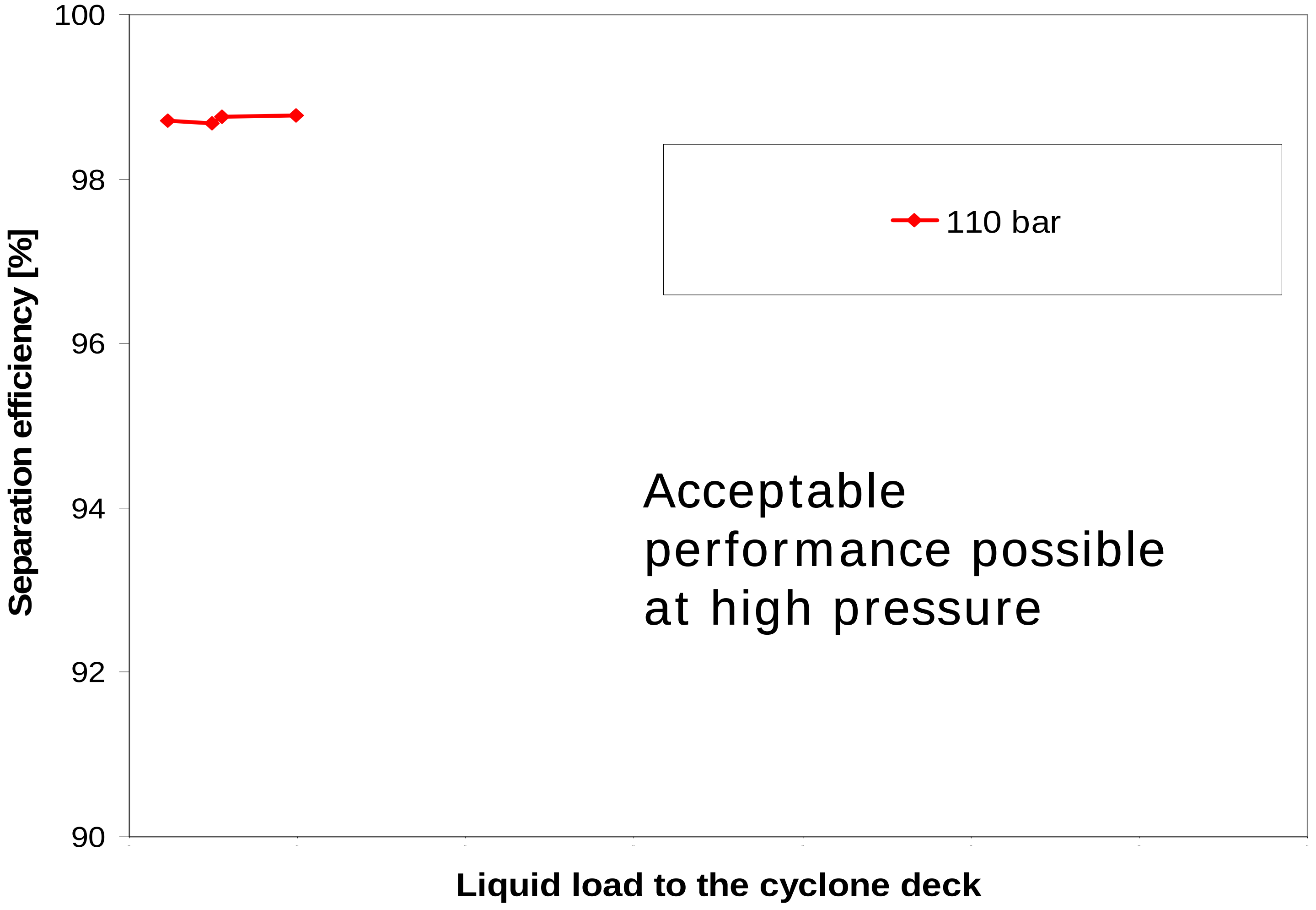
DEMISTING CYCLONES – Impact of Fluid and Pressure



DEMISTING CYCLONES – Impact of Velocity



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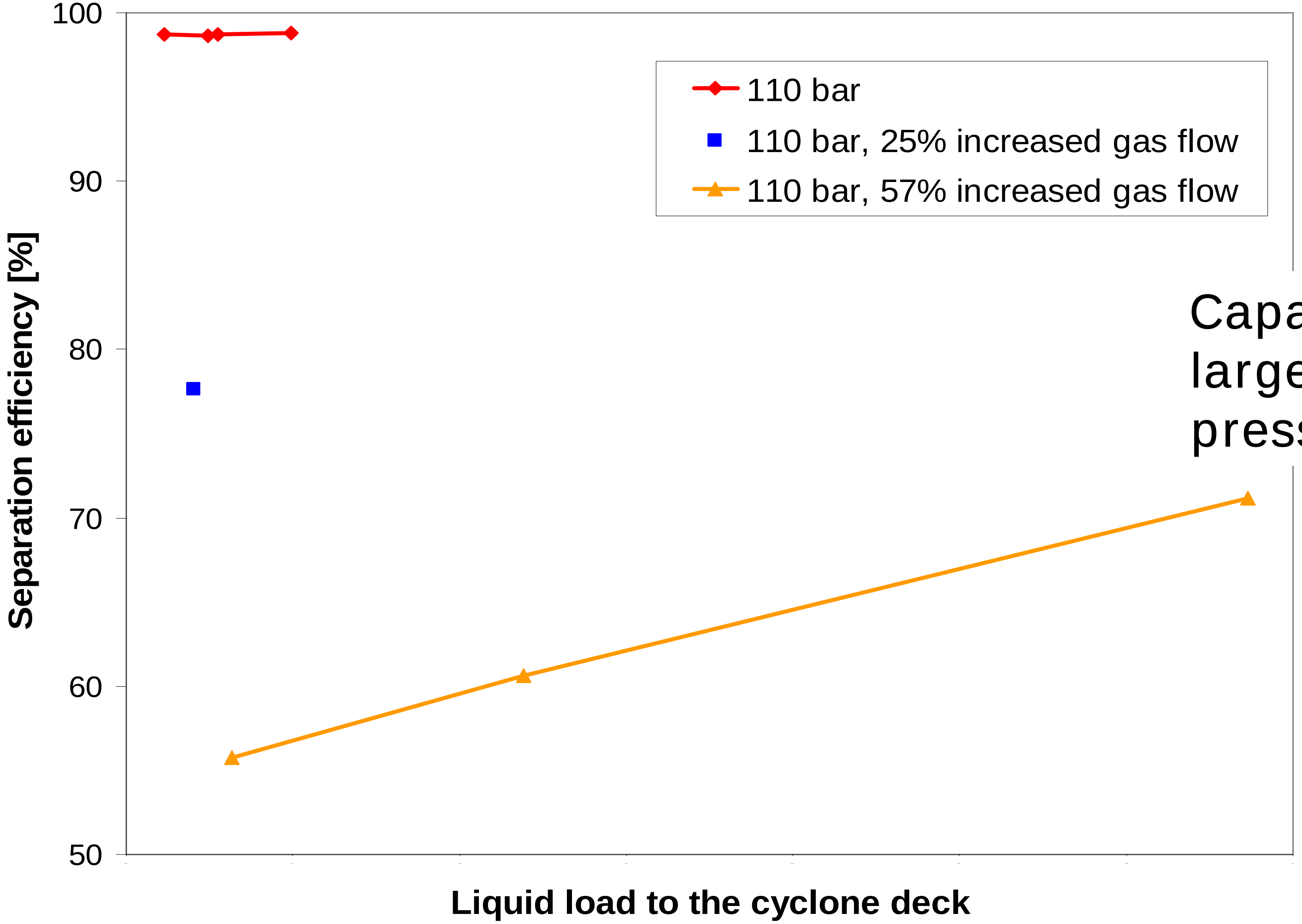
DEMISTING CYCLONES – Impact of Velocity



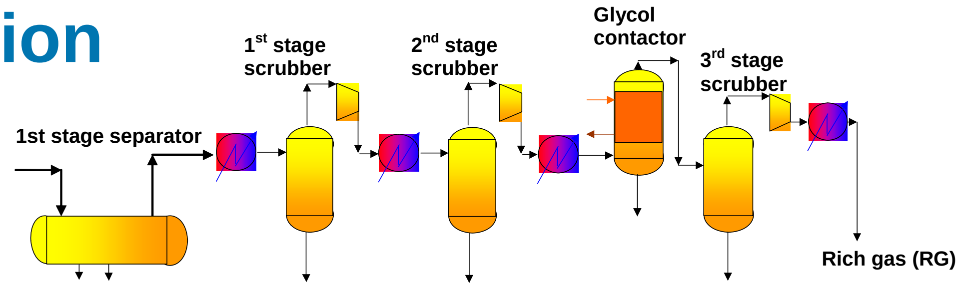
Capacity deviate largely from low pressure testing

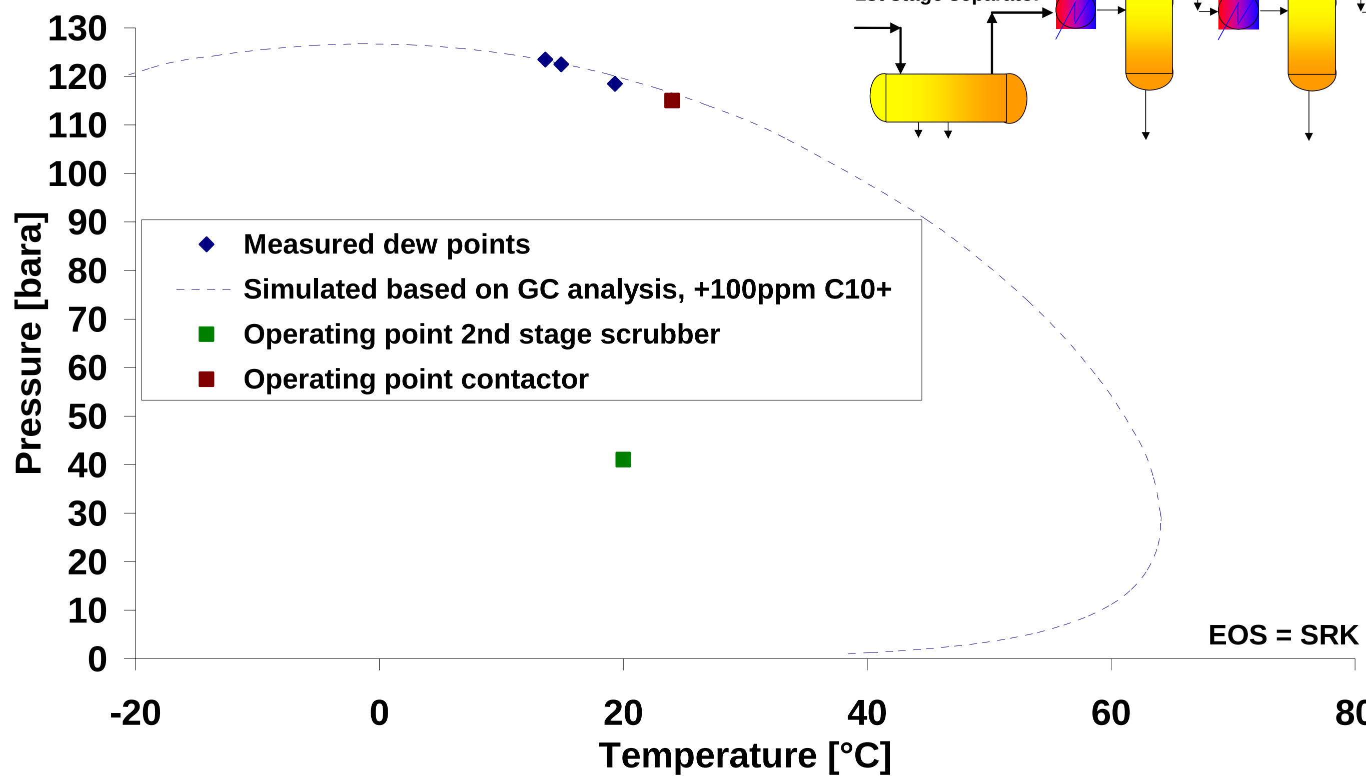
Fluid Behaviour – Gas–Liquid Separation

- **Fluid impact**
  - Water not representative for hydrocarbon systems
  - Large impact of fluid properties such as surface tension
- **High pressure separation**
  - Large impact of pressure
- **Scrubber elements**
  - Large variation in characteristics

Testing: basis for fundamental understanding and establishment of proper scaling rules

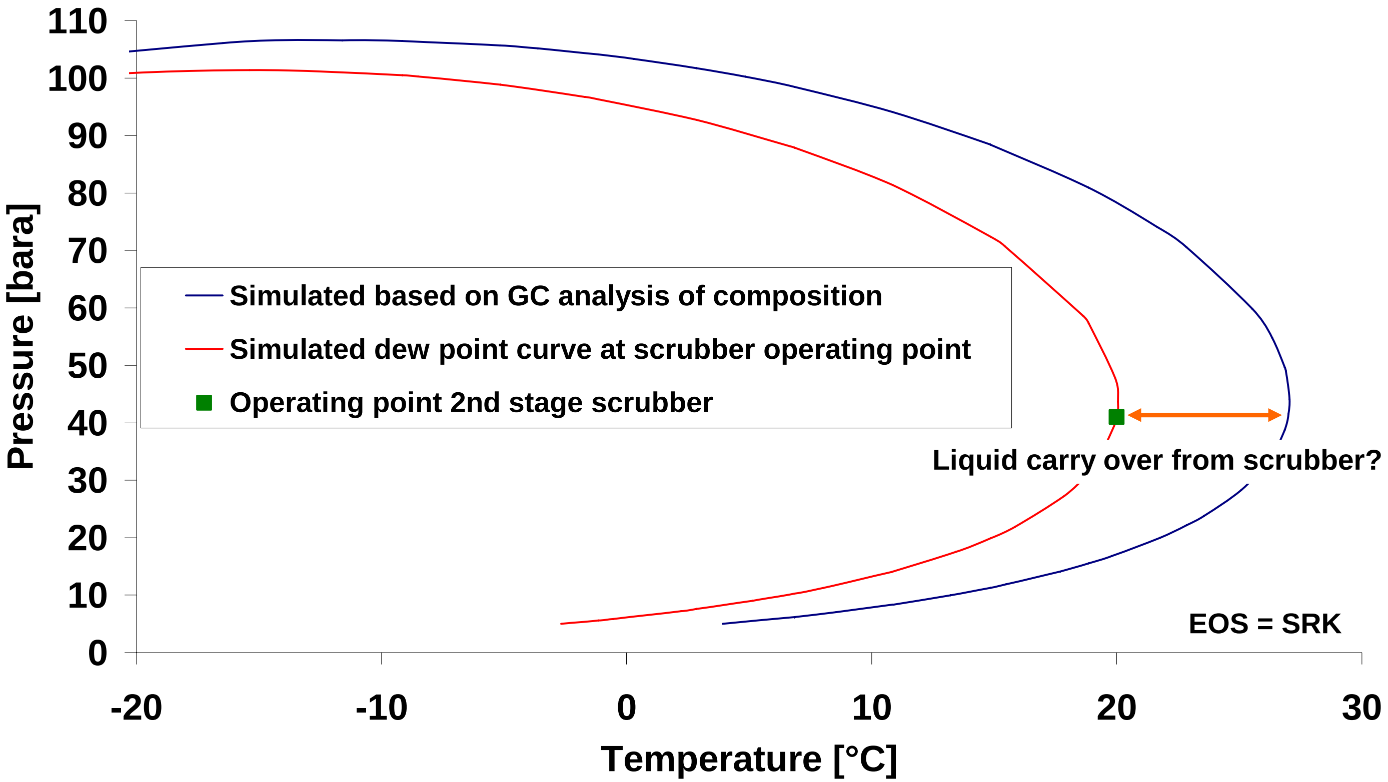
Challenge - Gas specification





- High cricondenbar, 127 barg. Contactor determines cricondenbar
- Liquid entrainment from 2nd stage scrubber.

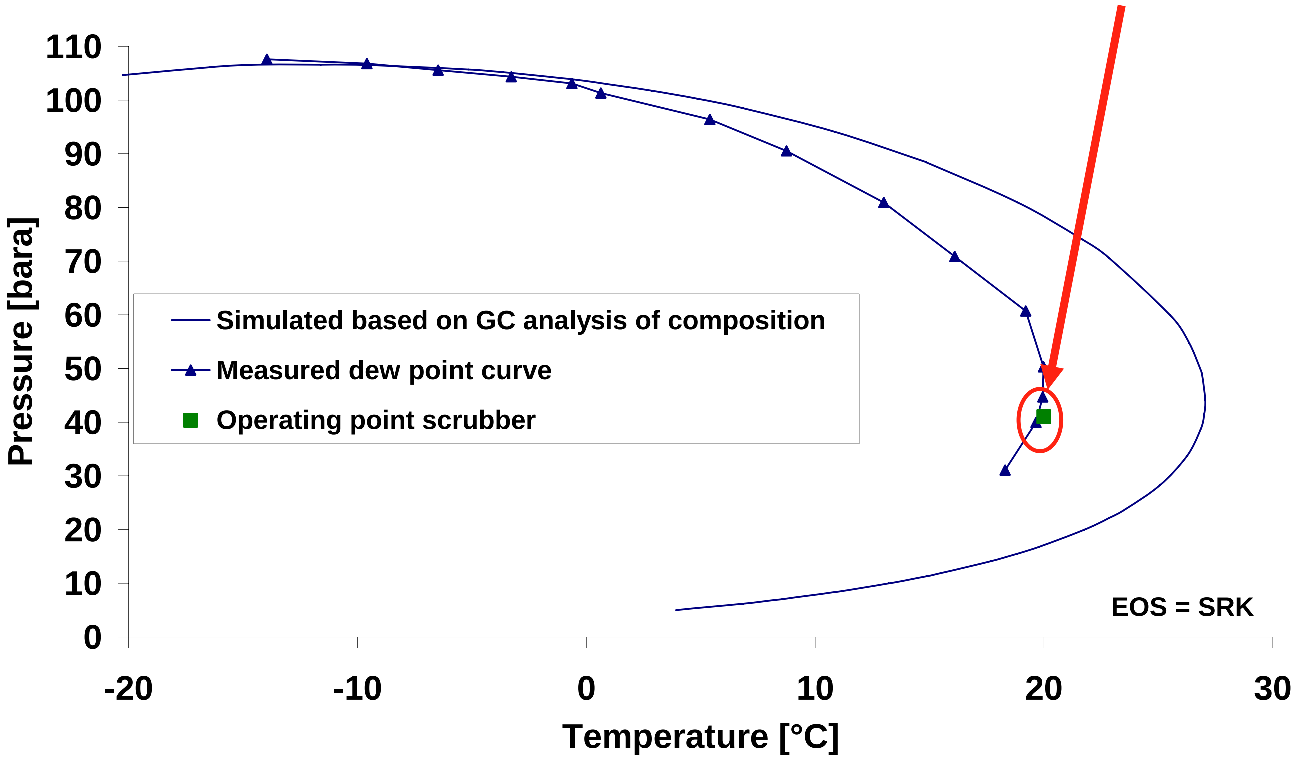
After modification of scrubbers



- Simulated dew point curve at higher temperature than scrubber operating temperature indicates liquid carry over from scrubber
- Need for dew point measurements offshore or representative gas samples taken in single phase flow for dew point measurements in laboratory

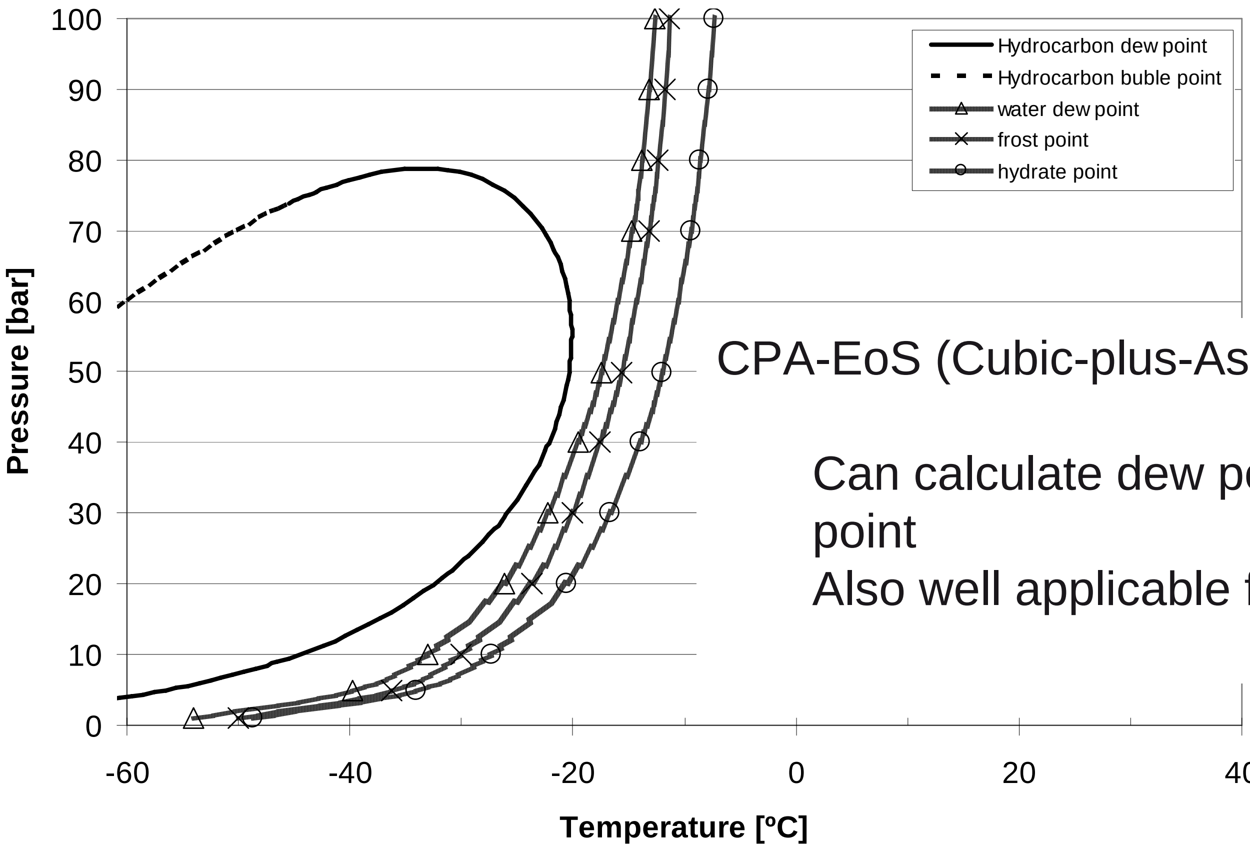
Problem Solution

Modelling uncertainties. Not a scrubber problem!



- Experimental dew point measurements needed to find correct conclusions
- True dew point curve steeper than simulated as also found for the synthetic gases

Phase behaviour



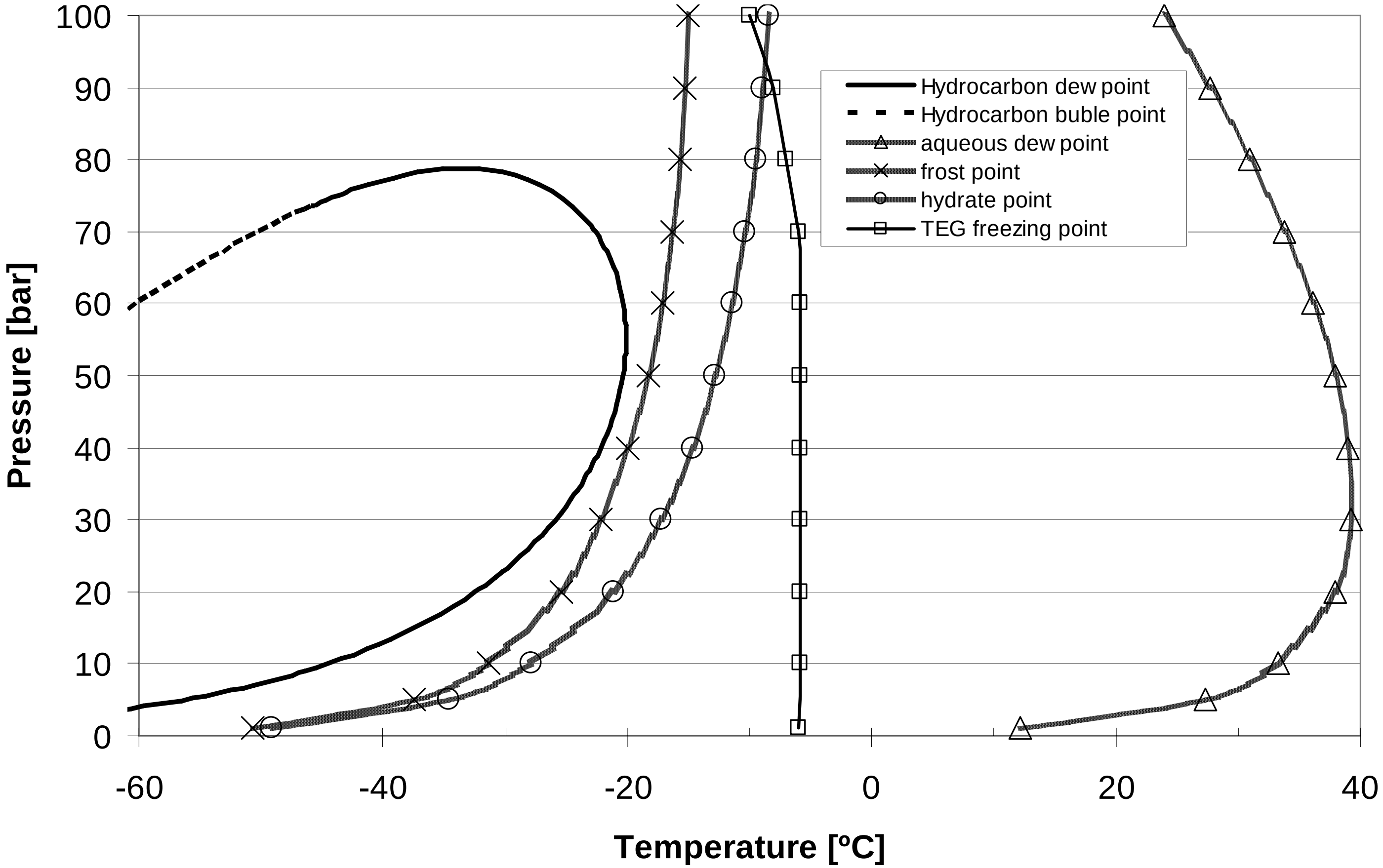
CPA-EoS (Cubic-plus-Association equation of state)

Can calculate dew point, frost point and hydrate point
Also well applicable for aqueous dew point

Phase behaviour of natural gas with traces of water (40 ppm(mole)),

NG composition (mole): 85 % C1, 10 % C2, 4 % C3, 0.5 % nC4, 0.5 % iC4

Phase behaviour – glycol solubility



Phase behaviour of natural gas with traces of water (40 ppm(mole)) and TEG (0.5 ppm(mole)),

NG composition (mole): 85 % C1, 10 % C2, 4 % C3, 0.5 % nC4, 0.5 % iC4

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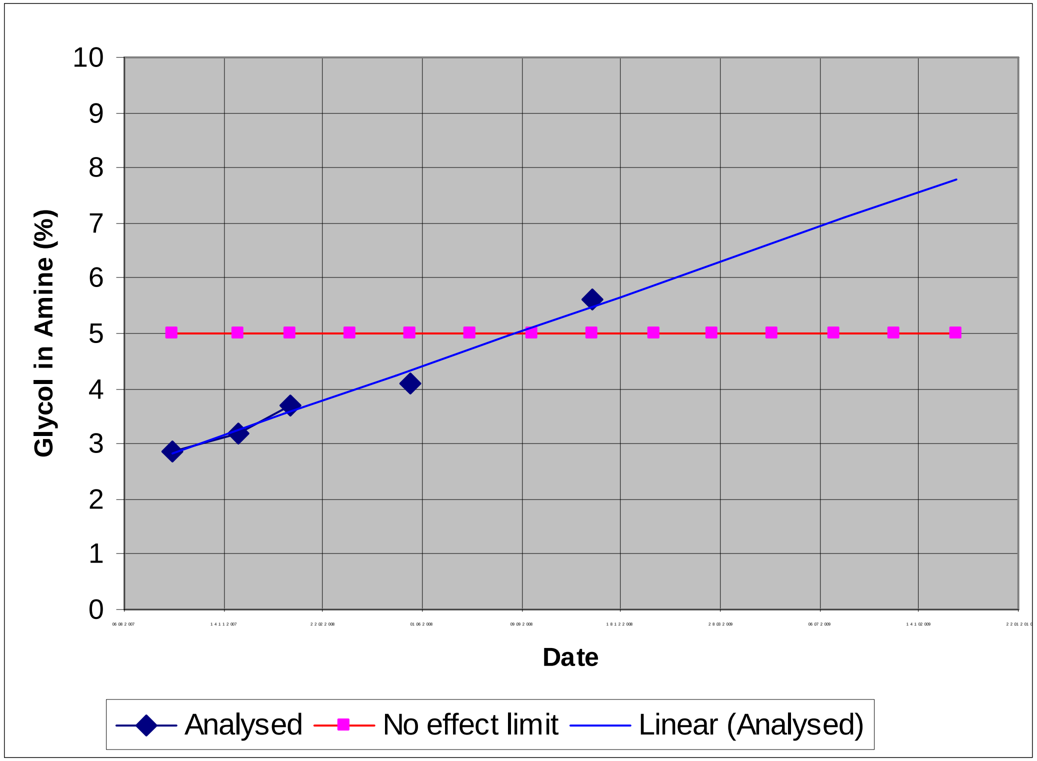
Challenge – Contamination of absorbent

Glycol dehydration unit in upstream process

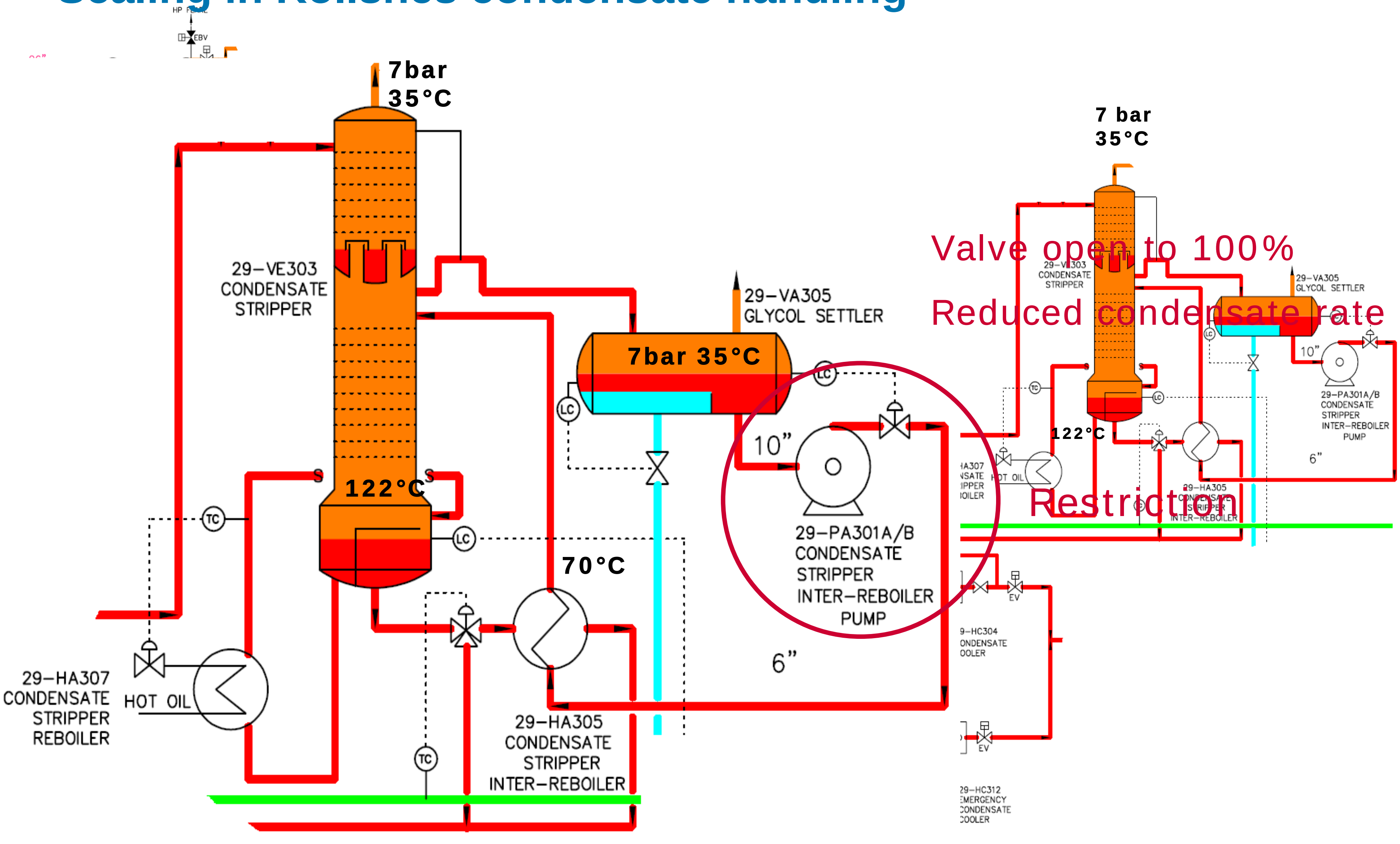
Glycol soluble in gas

Accumulates in Amine

Amine capacity affected



Scaling in Kollsnes condensate handling



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Questions to task force

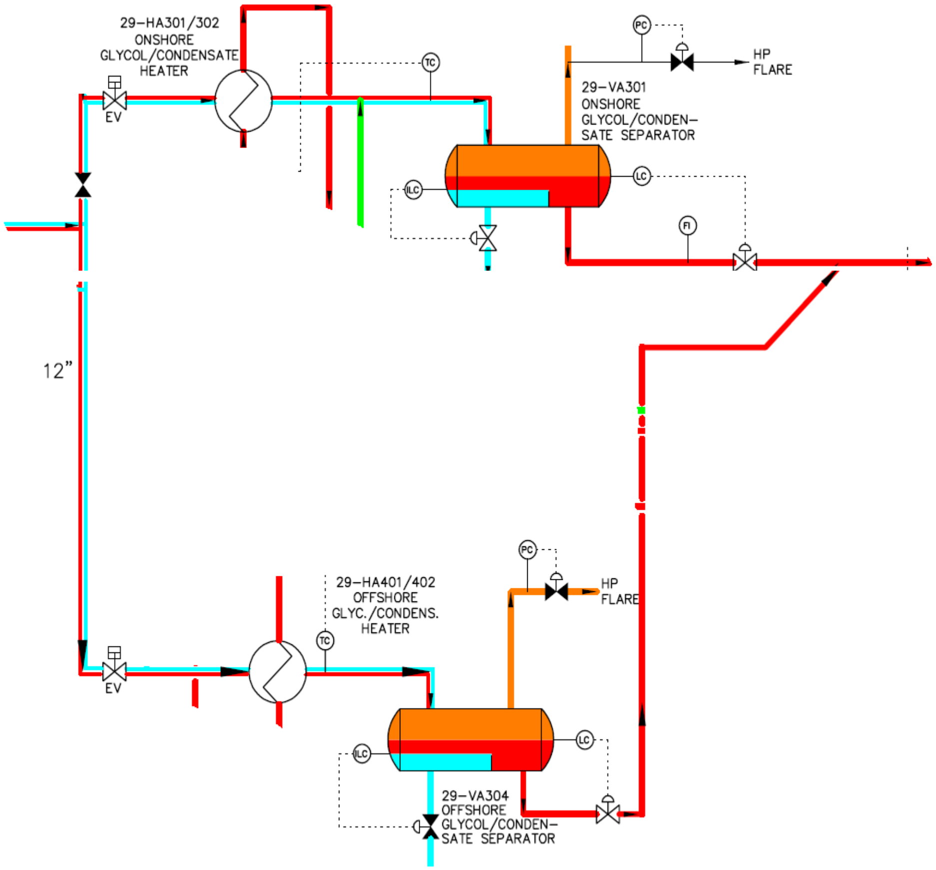
- Why scale in a condensate system?
- Why now after several years of operation?
- Why $NaHCO_3$ – a salt with high solubility?
- How to remove it without shutting down the production?
  - A wash/replace will require 8-12 hours -> loss of 50-70 MSm^3 gas
- Which chemicals can we use that will not contaminate the condensate?

And please hurry!

The valve is about to get plugged once more!

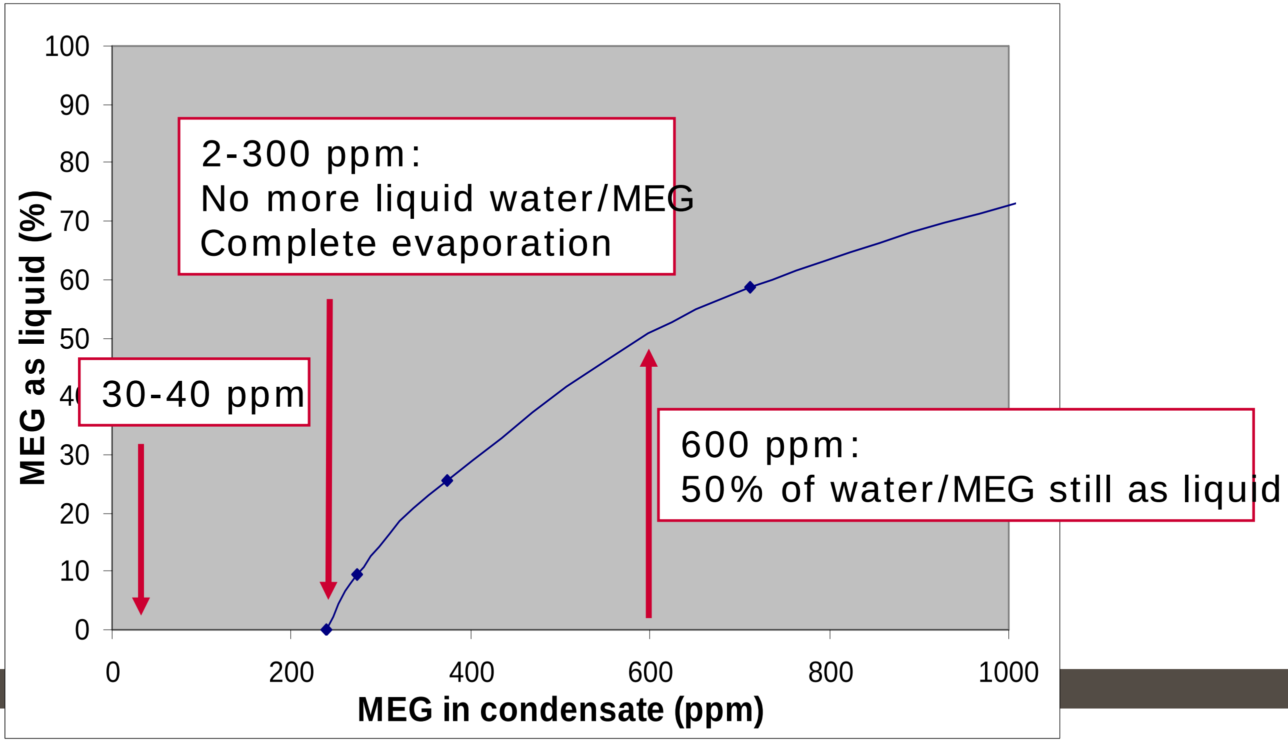
Process analysis

- Only one condensate MEG separator
  - MEG in condensate: 600 ppm
- Start of second cond-MEG separator
  - MEG in condensate: 30-40 ppm
- Improved separation, why problem?
  - Less MEG should give less salt and less precipitation?



MEG evaporation in stripper column

- MEG is depressurised to 7 bar and heated to 35°C
  - Solubility of MEG and water in gas increases
- What happens when MEG in condensate is reduced from 600 to 30-40 ppm?

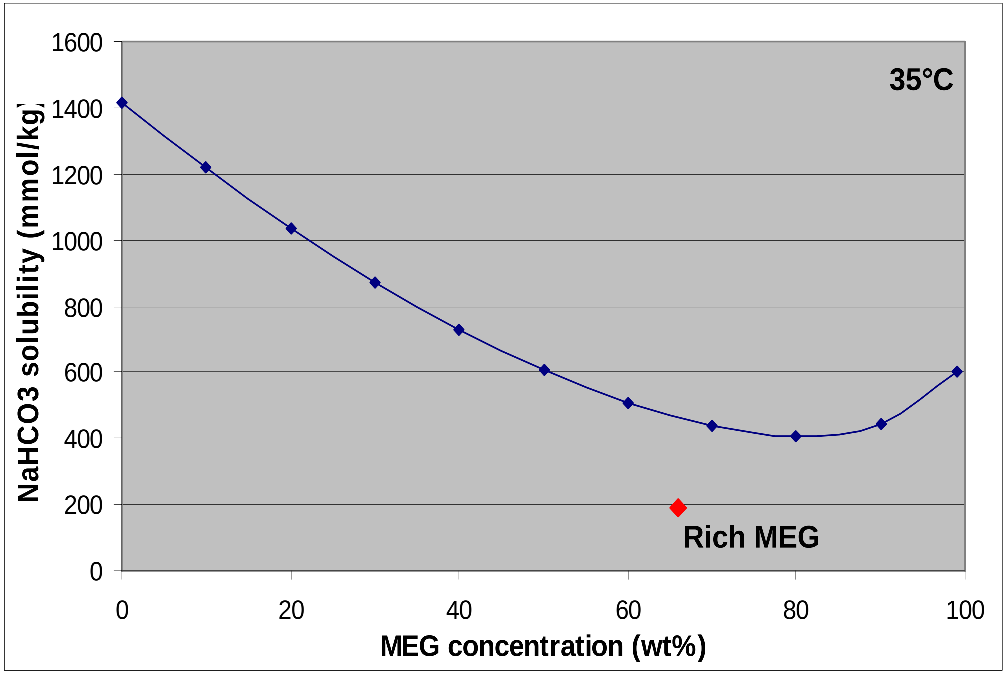


Scale removal options

- Open/replace valve
  - Require shutdown, loss of 50-70 MSm^3 gas
- Carbonate salt -> Use an acid (suggested by a service company)
  - Require shutdown as acid would contaminate condensate
- Water – $NaHCO_3$ is highly soluble
  - Possible, but will increase water content in condensate
  - May cause hydrate formation in condensate transfer line
- What about using MEG?

Use of MEG to dissolve scale

- $NaHCO_3$ is soluble in MEG
- Advantages with MEG
  - Already present and will not contaminate the condensate
  - MEG is available
  - No use of other chemicals
  - Spent MEG can be treated in MEG regeneration



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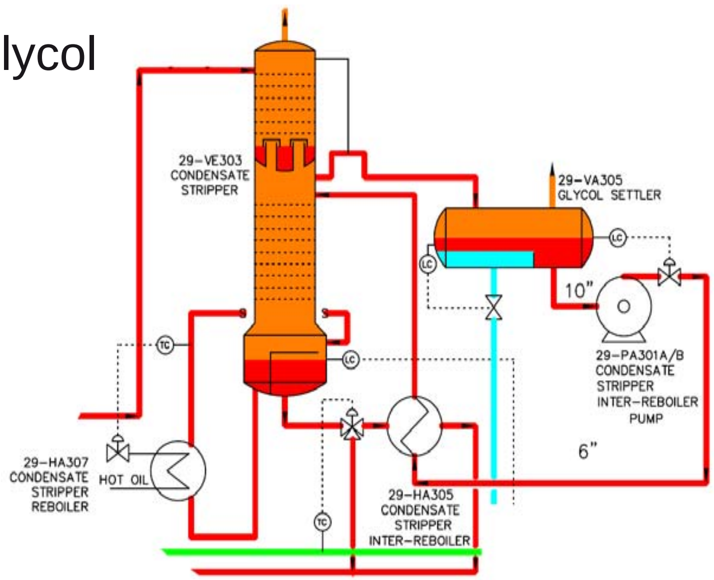
Treatment – MEG injection

- MEG injected into condensate upstream stripper
- Injection rate: 40 litre/hour
  - Rate adjusted to get accumulation in glycol settler
- Treatment duration: 24 hours
  - Total MEG consumption is about 1 m^3
- MEG collected in glycol settler and sent to MEG regeneration



Summary – key to success

- Experimental evaluations
  - Evaluations have to be carried out with real fluid systems – model systems will deviate from real systems
  - Large impact of pressure; high pressure processing is a challenge
  - Establish fundamental data and knowledge of mechanisms
  - Developing improved design and solutions

- Modelling
  - Experimental data and experiences need to be incorporated into models
  - Models to be used in combination with best practices

- Operational experience and problem definition
  - Important to identify where data/knowledge is needed
  - Combination with experimental experience proven to be successful