Foaming in Separator Handling and Operation Issues

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PROCESS SOLUTIONS

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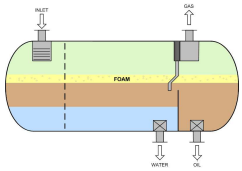
What is foam, how is it generated?

What is foam…?

- **Definition** - Foams are colloidal systems with a liquid continuous phase and a gaseous dispersed phase



How is it generated?

- Foam formation requires three factors liquid, gas and a foam-stabilizing agent (surfactant)
  - Remove or weaken any one and foam collapses
- The amount of foam produced depends upon
  - Nature and amount of the surfactant
  - Design of the existing process system
  - The level of gas release (pressure drop)
- Surfactants responsible for foaming stability in crude oils are similar to those that stabilize emulsions i.e. resins, asphaltenes.

1 Detecting foam in separators

- **White rag test** - A simple and widely used method to monitor foam problems and control measures
  - A white rage is place on the gas sample point of separators
  - This will collect oil mist that can be used as a qualitative check on the amount of oil being carried with the gas

How is it generated?

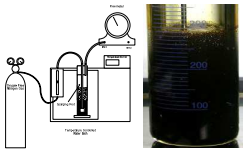
- Foams can be formed in two basic ways:
  1. **Condensation –** gas releases and agglomerates at the liquid surface to form large bubbles. This is analogous to a head forming on a beer.
  2. **Dispersion –** Gas is introduced into the liquid phase to become bubbles e.g. water injection gas deaerator or gas flotation for water treatment. Dispersed bubbles of gas rise to the surface of the liquid to form a foam.

Where is it generated?

- Where there is gas release
- Foam forms in processing equipment, pipework, chokes, control valves, separator inlet devices where poor design causes poor separation.
- Poor separation between gas and crude can result in foam formation

Determining the foaming stability of a crude

- No easy assessment unless representative sample is available
- Foaming risk can be predicted by using laboratory apparatus as described in IP 146
  - Gas is sparged through test crude at test temperature for set period and foam level is assessed
- This simple test can be used to test a crudes tendency to foam and to screen anti-foam treatment chemicals



IP146 Foam Test

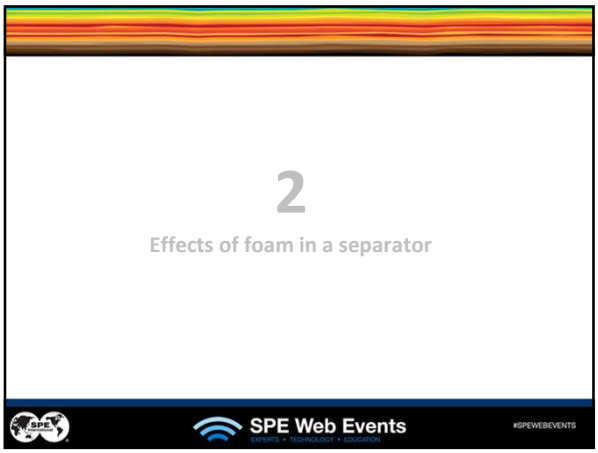
Foam Stabilization

Influenced by One or more mechanisms of stabilization of the interface must be present:

- **Film Elasticity**
- **Viscosity –**
- **Bulk Viscosity**
- **Temperature**
- **Electrical Double Layer Repulsion**
- **Gas Diffusion**

Detecting foam in separators

- A white rage is place on the gas sample point of separators (may not be feasible in some systems due to safety)
- Instrumentation irregularity
- Liquid Carry over in the vessels downstream'
- Vessel Scan / Process diagnostics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Effects of foam in a separator
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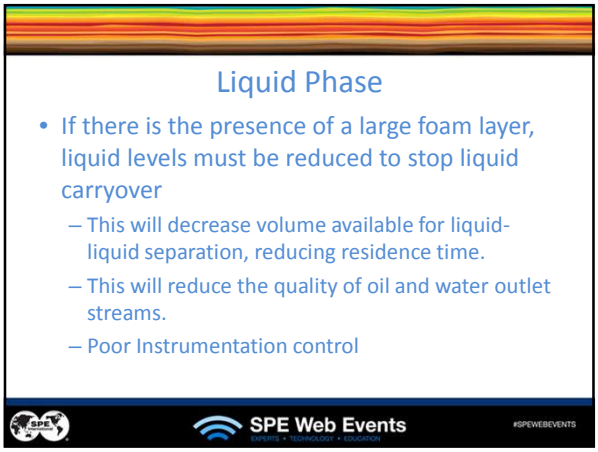
Liquid Phase
• If there is the presence of a large foam layer, liquid levels must be reduced to stop liquid carryover
– This will decrease volume available for liquid-liquid separation, reducing residence time.
– This will reduce the quality of oil and water outlet streams.
– Poor Instrumentation control
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Level Control Instruments
• Presence of a foam layer will result in false readings from traditional instrumentation.
• Generally a false high reading will be given due to the foam layer.
• This can result in levels being too low and resulting in gas carry-under or poor oil and water quality.
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2 Impact on Production

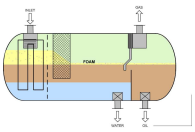
Problem	Processing Area
Reducing unit capacity, which limits the throughput to below design capacity	Deaerators, gas scrubbers, effluent systems, glycol regenerators, crude treatment vessels (2- or 3-phase separators), gas compressors
Interrupting operation of units, which impacts cost	Gas compressors, glycol regenerators
Contaminating separated gases or liquids, with associated loss of desired product.	Crude treatment vessels (2- or 3-phase separators), gas scrubbers, gas compressors
Causing downstream problems due to entrained contaminants	Effluent systems, refinery
Causing safety hazards, fire, pollution, and spillage	Gas compressors, glycol regenerators
Reducing the life of process equipment	Glycol regenerators, gas scrubbers, gas compressors

3

Designing for foamy crudes in a new horizontal separator

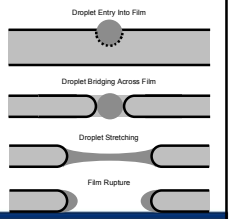
Designing to Control by Mechanical Means

- Cyclonic inlet device collapses foam if designed correctly (poor design can exacerbate the foam)
- Foam breaker pack reduced residual foam (poor operation can worsen the problem)
- Demister drain pipe height includes allowance for foam



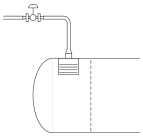
Chemical Treatments

- Two types of treatment chemicals may be added to the crude oil:
  - Anti-foams - prevent or reduce the amount of foam that forms
  - Defoamers - dosed into an existing foam to break it down
- There is little difference as the same active ingredients are used
  - Defoamers may also contain a low-level of surfactant for dispersal
  - Difference is usually down to how the chemical is used
- Anti-foams work by spread of droplets from the centre of a foam film which drags along underlying bulk liquid
  - The foam film thins and ruptures



Inlet Pipework

- Foam can be caused by:
  - Control valves too close to separator inlet
  - Undersized feed pipework
  - Sharp Bends close to pipework
  - Reducers too close to inlet
  - Badly designed inlet devices



Separator Size

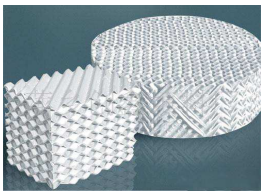
- Foam accumulation is an equilibrium condition between generation and decay, foam volume is not arbitrary.
- Foam can thus be treated as a separate phase.
- Foam has to be accommodated between LA(H) and LZA(HH).
- If foam volume is not accounted for, it will overflow as liquid carryover.

Inlet Device

- Cyclonic inlet devices can collapse foams through centrifugal action if correctly designed.
- Poor design can cause gas carry-under leading to foam generation.
- Effective:
  - Correctly sized units have been demonstrated to reduce foam breaker chemical consumption

Foam Breaker Packs

- Made from structured packing (also used in contactor towers) which provides torturous path for foam to pass through
- Mounted after inlet device and extends across gas phase
- Promotes break-down of foam as it passes through pack
- Stainless steel has serrated finish which promotes foam degredation.

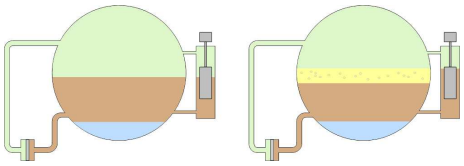


Demisters

- Foam can affect liquid drainage causing liquid siphoning leading to severe liquid carryover in gas stream.
- Low pressure drop devices such as vane packs (as shown) preferred to axial-flow cyclones (relatively high pressure drops)

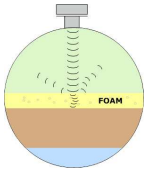
Level Instruments

- Foam will cause traditional level instrumentation to give false high level readings (differential pressure and displacer instruments are shown).

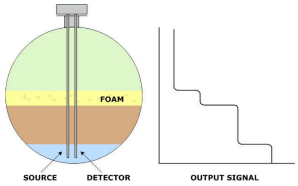


Level Instruments

- Radar instruments not suitable for foam application as foam will scatter return signal



- Nucleonic density profilers can detect foam layers.



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Examples of overcoming a foam problem

Examples of Foaming Issues

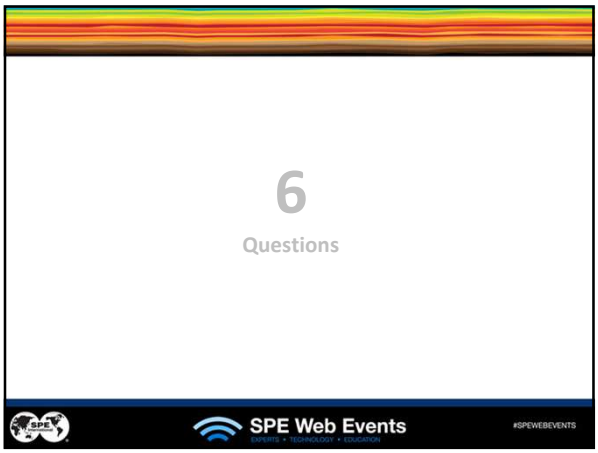
1. Foam can impact gas dehydration system downstream
2. Regular tripping of the production system
3. Reduce production capacity
4. Compressor fouling
5. Impact Separation efficiency and poor oil quality

5

Conclusions

Conclusions

- Foaming is a natural phenomenon in crude oil production
  - Can be exacerbated by process design and chemical management
- Can cause liquid carry-over and gas carry-under
- Will cause level instrumentation to give false readings
- Anti-foam and foam breaker can reduce foaming or breakup pre-existing foams
- Correct initial design can reduce foaming tendencies:
  - Inlet pipework
  - Inlet device
  - Separator sizing
  - Foam breaker packs
  - Demisters
  - Correct level instrumentation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Questions
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