



Welcome!

The program will begin soon.
You will not hear audio until we begin.



Multiphase Flow Conditioning: when you should care about it and why

Carlos Avila, PhD
Avila Multiphase Flow Consulting, LLC
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Multiphase Flow Conditioning (MFC)

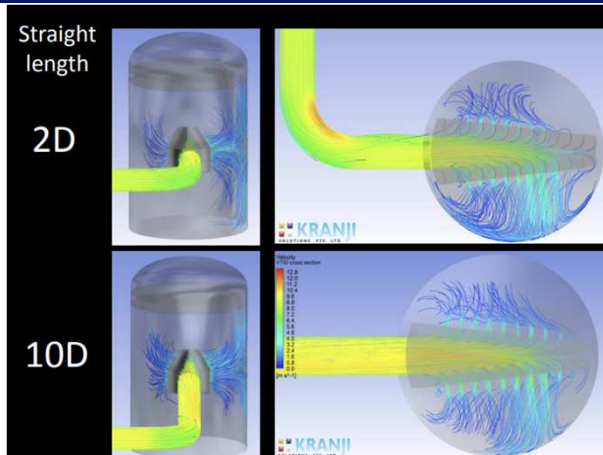


- Avila, 2015: “MFC typically exists at the intersection of pipeline flow assurance and 1st stage processing and addresses a multitude of issues that are often not considered by Flow Assurance & Process expertise. We can disable a separator by wrongly designing its upstream piping!”
- Deferred production may occur if MFC is ignored



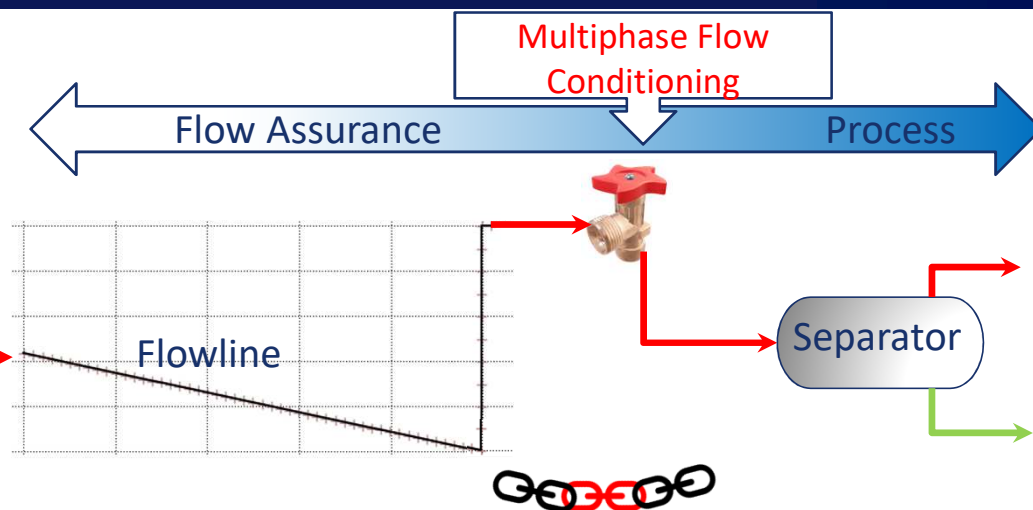
Slug flow simulations. Mohammadikharkeshi (2018)

Multiphase Flow Conditioning example

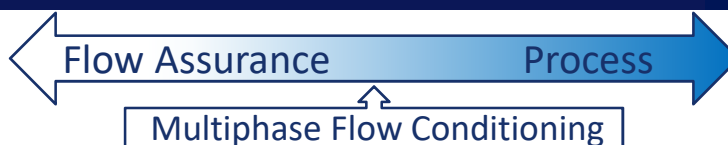


Cris Heijckers, "Flow Conditioning Impact on Separations", 2012

Where does Multiphase Flow Conditioning reside?



Where does Multiphase Flow Conditioning reside?



Multiphase Flow Conditioning Studies

- Multiphase Flow Characterization
 - Slug Characterization
 - Droplet phase predictions
- Effect of chokes and valves on fluids
- Severe Slugging mitigation
- Multiphase Flow Splitting



Purpose

- Separator's inlet piping optimization
- Screen separator's inlet piping FIV and piping support design
- Challenge Separator's BoD (improved design, internals selection)
- Troubleshooting Separators
- Slug management, Well sequencing
- Parallel processing train's efficiency

Situations where Multiphase Flow Conditioning is more critical



1. Subsea processing
2. Topsides production facilities, FPSOs
3. Compact Separation
4. Multiple Processing trains
5. It can also happen in onshore facilities! (Avila, 2015)



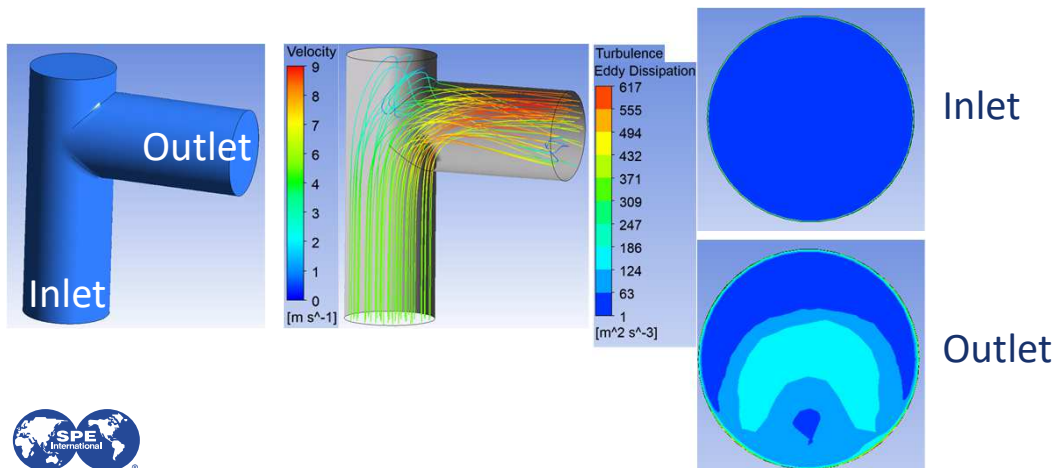
Flow Characterization



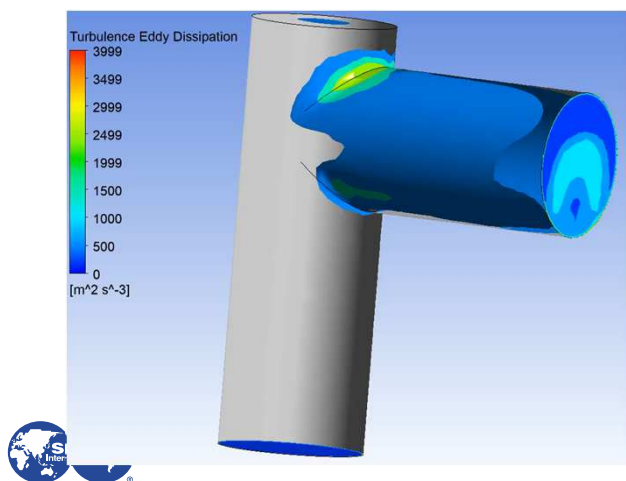
- Oil droplets dispersed in Water flowing at 5 m/s
- Piping components 0.15 m diameter
- ANSYS 2020 R2 / Fluent
- Comparison:
 1. Blind Tee
 2. Long radius elbow
 3. Impacting Tee



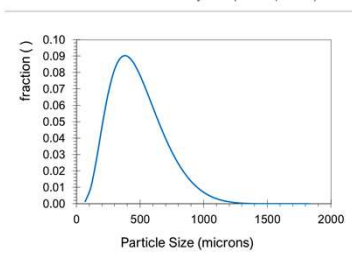
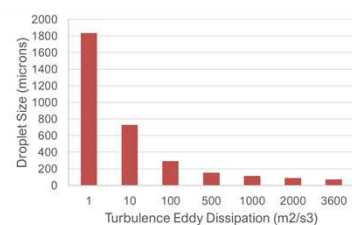
Flow Characterization: Blind Tee



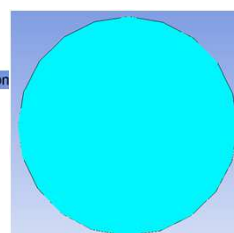
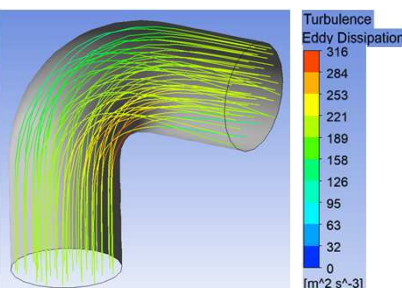
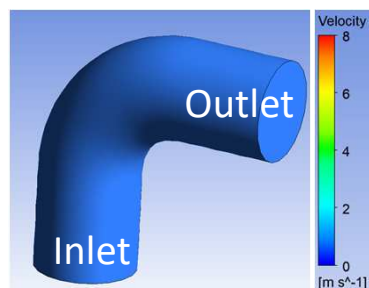
Flow Characterization: Blind Tee



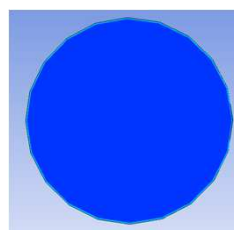
Hinze
(1955)



Flow Characterization: Long radius elbow



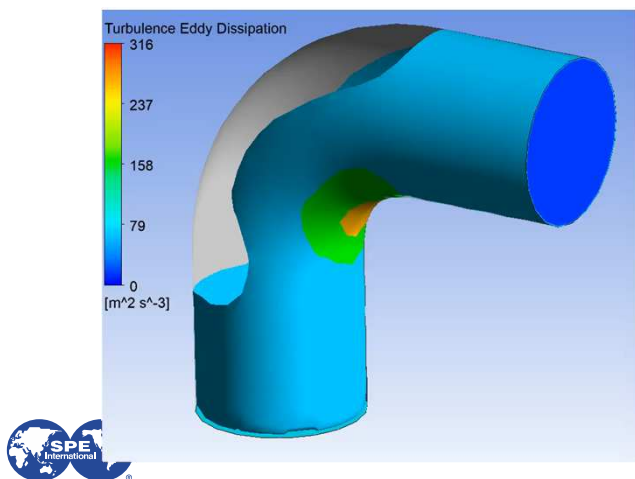
Inlet



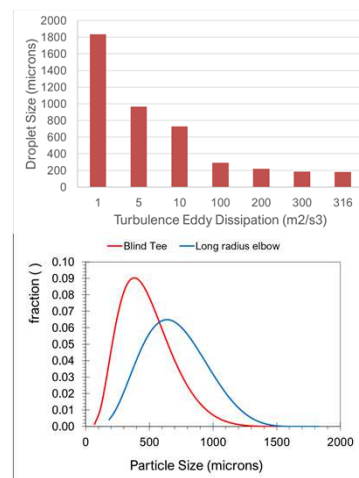
Outlet



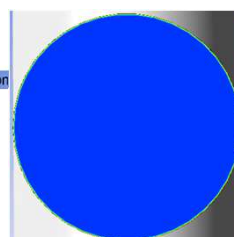
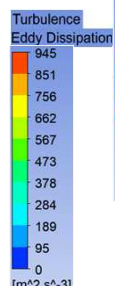
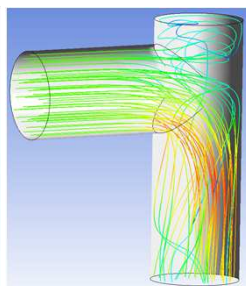
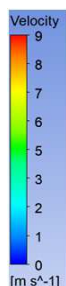
Flow Characterization: Long radius elbow



Hinze
(1955)



Flow Characterization: Impacting Tee



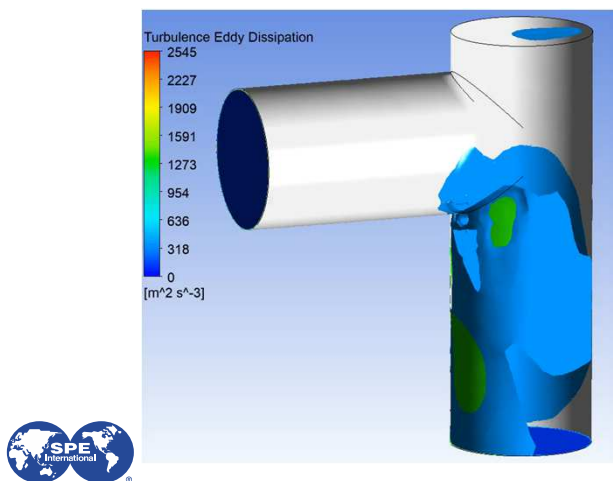
Inlet



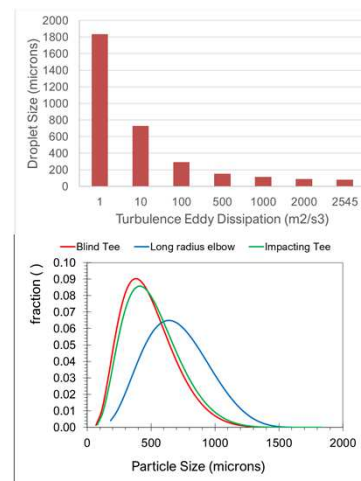
Outlet



Flow Characterization: Impacting Tee



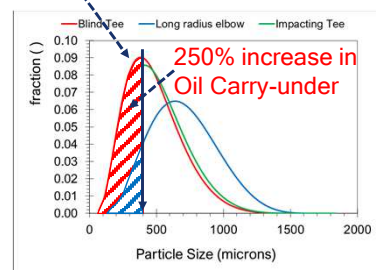
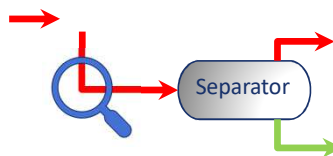
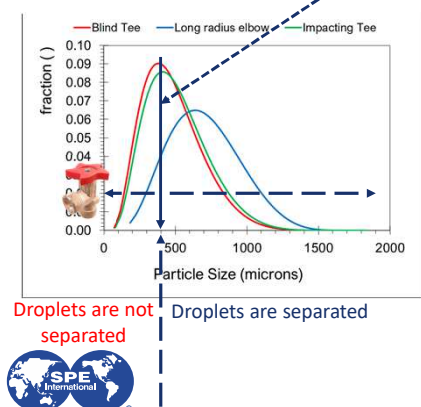
Hinze
(1955)



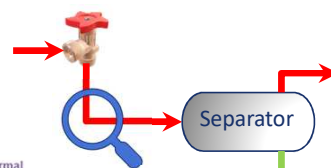
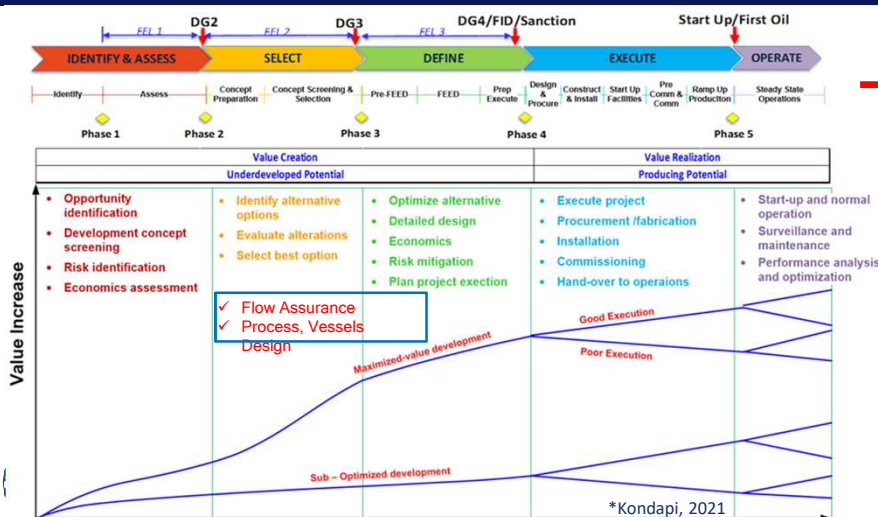
Flow Characterization: impact on separation



Separator droplet cut size

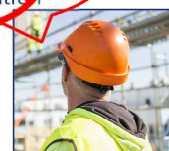


When should you care about Multiphase Flow Conditioning?

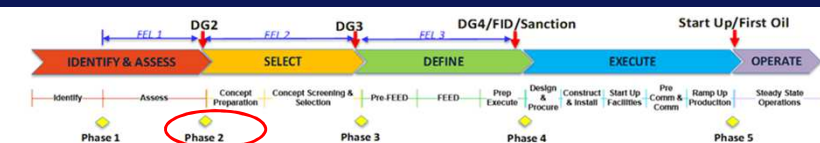


Hey! I think we have a bimodal droplet size distribution

- ✓ Measure
- ✓ See
- ✓ Feel



When should you care about Multiphase Flow Conditioning?

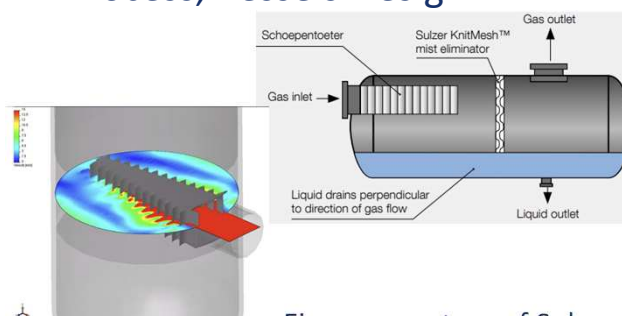


Flow Assurance studies



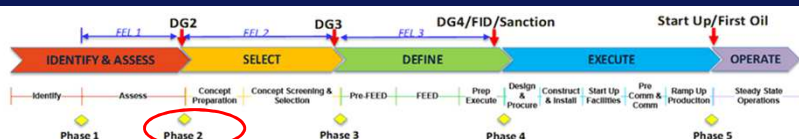
Pictures courtesy of AFS

Process, Vessels Design



Figures courtesy of Sulzer

When should you care about Multiphase Flow Conditioning?



Flow Assurance studies

- ✓ Wax
- ✓ Hydrates
- ✓ Hydraulics, slugs
- ✓ Asphaltenes
- ✓ Scale
- ✓ Emulsions

Process, Vessels Design

- ✓ Technology selection
- ✓ Technology qualification
- ✓ Vessel sizing
- ✓ Internals selection
- ✓ Instrumentation, Control
- ✓ Vessel performance

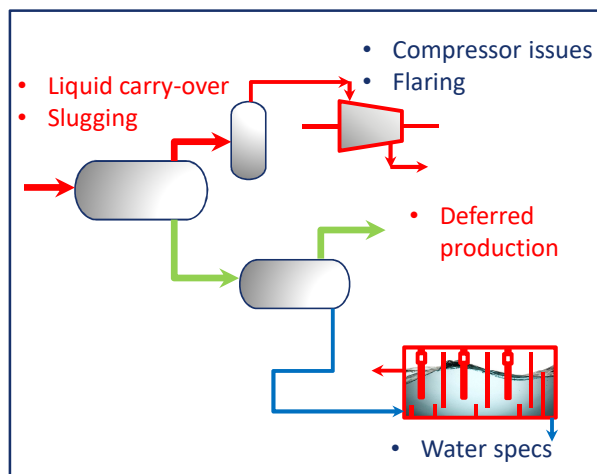


BoD Integration, MFC, BoD verification

Why should you care about Multiphase Flow Conditioning?



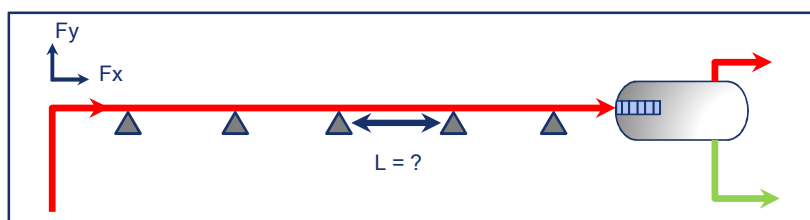
1. Because discovering that your separator was not properly designed the first day of production is already too late and to avoid:
 - a) unnecessary shut-downs to replace separator internals and unscheduled equipment modifications (especially in remote or challenging locations)
 - b) shut-downs due to equipment downstream of a separator failing due to the separator's poor performance
 - c) additional hassle on operators



Why should you care about Multiphase Flow Conditioning?



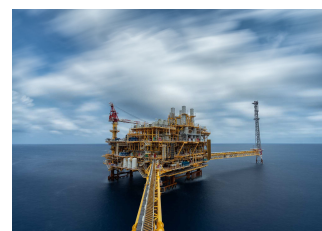
2. Because properly supported separator's inlet piping mitigates Flow Induced Vibrations due to Multiphase Flow forces
3. And because Flow Induced Vibrations mitigation involves pretty simple modifications to the separator inlet piping



Why is Multiphase Flow Conditioning overlooked?



- Flow Assurance studies are concerned about long flowlines but not the short pipes interconnecting Processing Equipment
- Process Engineers are busy sizing and qualifying each individual process unit sometimes overlooking interactions with other process equipment and their interconnecting pipes and fittings
- There is a “prize” for the piping engineer to save space in expensive environments such as an offshore platform where footprint/weight are prime
- Projects either are in a hurry to move on to the next phase or piping design arrives too late in projects development for review and make proper modifications



How to tackle Multiphase Flow Conditioning?



- Engineering tools based on Multiphase Flow mechanistic models
 - In house prediction tools
 - Custom made prediction tools
- Commercially available tools:
 - 1D Multiphase Flow simulators (steady and transient)
 - Computational Fluid Dynamics (CFD) software
- Engagements from Projects to Field troubleshooting
 - Recommendations for projects during Selection of Alternatives phase
 - Follow up with projects execution
 - Support and troubleshooting of operations
- Experts
 - SMEs, vendors, service companies, software companies, universities and research institutes

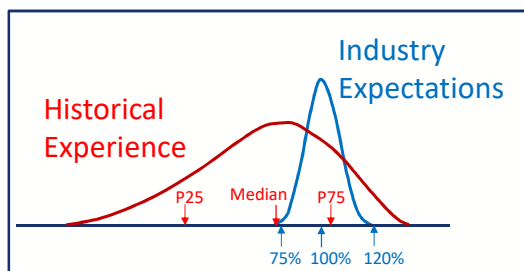


We can fix this!

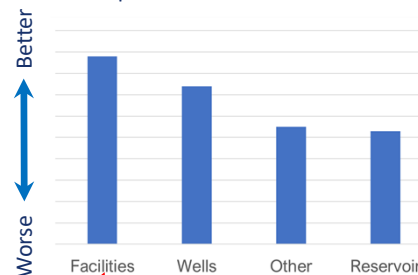


Failure to Produce: An Investigation of Deficiencies in Production Attainment,
N. Nandurdikar, L. Wallace. SPE 145437, 2011.

- Industry Production Attainment



- Functional Impact on Production Attainment



Multiphase Flow Conditioning



Conclusions



1. We can correct Multiphase Flow Conditioning (MFC) issues with relatively simple solutions
2. Consequences of overlooking MFC issues may be expensive
3. It is easier to correct MFC issues in the Value Creation phase of a project



Conclusions



4. Properly conditioned flow upstream of the separator enables the separator to operate at it's best (and isn't that the point?)



"a chain is no stronger than its weakest link"



Thank you!



Carlos Avila, PhD
Avila Multiphase Flow Consulting, LLC
carlos@avilamultiphaseflowconsulting.com
avilamultiphaseflowconsulting.com
[linkedin.com/company/avila-multiphase-flow-consulting](https://www.linkedin.com/company/avila-multiphase-flow-consulting)

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