The Development of Efficient Compact Separation Technology using CFD

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Main office in Arnhem, NL
Engineering hub for Process & Mechanical in KL, Malaysia
JV’s Malaysia, Brazil, Oman, Korea, Nigeria, partners in China, India, Mexico
High in-country value through
  • Process Design, Engineering
  • Fabrication
  • Technology development/R&D

ISO 9001:2008 certified, FPAL, ACHILLES registered
Prequalified and approved vendor with several OILCO and EPC companies
Technical solutions using high performance technologies with verified designs
  • Subsea processing
  • Newbuilt facilities
  • Mature fields rejuvenation
  • Heavy Oil solutions
A company by separation specialists
Dynamic and high level of customer drive
ASCOM proprietary technology and IP rights
Verified industry leading design rules
Lab testing
• Model fluids/crude
• Relatively fast

Performance simulations

Product Development

Dynamic simulations

Site testing
• Actual fluids
• Real proof for clients

CFD
• Insight in flow
• Fast geometry changes

Product development examples:
Desander
TwinLine Gas/Liquid separator
Hydrocyclone

July 10 2012
CFD Oil 2012
Testing partner Prolab, based in Arnhem, NL
Testing under realistic conditions and full-scale
Virtually any field conditions can be simulated
Verification of performance and design rules
Short track from prototype to real unit

• 1200 m² area – 11 meters high
• **Atmospheric (0.3 barg operating)** visualisation test loop
  • 3600 Am³/hr air and 80 m³/hr liquid (water & hydrocarbon)
• Dedicated desanding test loop operational

• **Medium Pressure (40 barg operating)** test loop
  (Accessible in cooperation with KEMA – Formerly Gasunie Laboratory)
  • Summer: 300 Am³/hr Natural gas, 2 m³/hr (hydrocarbon liquid OR water)
  • Winter: 800 Am³/hr Natural gas, 2 m³/hr (hydrocarbon liquid OR water)

• **High Pressure (85 barg operating)** test loop
  • Max. 2400 Am³/hr Natural gas, 150 m³/hr Oil AND 150 m³/hr Water (22,600 BWPD)
  • Liquid flow rate **6x as high** as currently existing in any other operational flowloops
ASCOM Inline Desanders

Compact Desanding Cyclone characteristics:

- Suitable for 2-phase and 3-phase flows
- Built according to pipe specification
- Low pressure drop, ideally 1 – 1.5 bar (or lower if required)
CFD Model Setup

Geometry
- Full 3D geometry

Model
- Steady
- Single phase: mixture of water and diesel
- RSM Turbulence Model
- Uncoupled particle tracking: sand
Flow and Swirl Design

Maximizing swirl generation
Pressure drop and shear

- Reduction of pressure drop
- Minimization of droplet breakup

Desander Pressure Drop

- Experiment
- Fit of Experiment
- CFD

Flow [m^3/h] vs. Pressure Drop [bar]

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Separation

Measurements

- 73% for fine sand

CFD

- Separation curve from particle tracking
- Weighted by size distribution
- Gives an efficiency of 87%

Sensitivities

- Size Distribution
- Particle Tracking Accuracy

Desander Efficiency

- Efficiency
- Size Distribution

Particle Diameter [micron]

Separation Efficiency [%]
1st stage swirl generation and liquid entrapment
Inlet up to 20% Liq. load
Stable conditions ~90% liquid removal

2nd stage swirl and liquid removal
Rest liquid separation

Overall Separation efficiency 98-99.x %
CFD Model Setup

Geometry

- First stage: Swirl to gas outlet
- 3D

Model

- Unsteady
- Euler lagrangian:
  - Coupled particle tracking
  - Wall film on outer walls
- Fluids:
  - Air and water
- SST:
  - No RSM for two-phase stability
Flow Results

Streamlines

Tangential velocity

Axial velocity

Streamlines

Tangential velocity

Axial velocity
Separation Results

Particle tracks
ASCOM Mixed Flow Hydrocyclone

Flow is guided through vanes
- Lower pressure drop
- Pre-separation in swirl

Multiple inlets
- Symmetric flow pattern
- Minimal reject core oscillation

Avoidance of preferential flow path
- No severe erosion

Removable swirl section
- Easy cleaning & inspection
CFD Model Setup

Geometry
- Full 3D

Model
- Steady
- Single Phase: Water
- RSM
- Uncoupled particle tracking: Oil
Flow Results

Streamlines: Strong swirl

Axial velocity: Flow reversal at reject outlet

Tangential velocity: Strong swirl
Separation Results

Hydrocyclone Efficiency

CFD underestimates separation. However, results can be used for design improvement.

Separation Efficiency [%]

Droplet Size

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Conclusions

CFD is used for

• Product development (examples in presentation)
• Equipment design

CFD Results

• Confirms our test results
• Conservative on performance
• Sensitive to relevant properties

Future

• CFD will reduce testing
• CFD cannot completely substitute testing
• More coupled multiphase simulations
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