Floating LNG: How CFD Studies Improve Technip’s Project Development

Cédric LEBER – CFD/Process Engineer
Knowledge Management Department, Process Division, 16th of March 2015
Technip Today

- With engineering, technologies and project management, on land and at sea, we safely and successfully deliver the best solutions for our clients in the energy business
  - Worldwide presence with 38,000 people in 48 countries
  - Industrial assets on all continents, a fleet of 27 vessels (6 of which under construction)
  - 2014 revenue: €10.7 billion

Energy is at the core of Technip
Two Business Segments, One Technip

Subsea

- Design, manufacture and supply of deepwater flexible and rigid pipelines, umbilicals and riser systems
  - Subsea construction, pipeline installation services and Heavy Lift
- Seven state-of-the-art flexible pipe and/or umbilical manufacturing plants
- Five spoolbases for reeled pipeline assembly as well as four logistic bases
  - A constantly evolving fleet strategically deployed in the world's major offshore markets

Onshore/Offshore

- Gas treatment and liquefaction (LNG), Gas-to-Liquids (GTL)
- Oil refining (refining, hydrogen and sulphur units)
  - Onshore pipelines
- Petrochemicals (ethylene, aromatics, olefins, polymers, fertilizers)
- Process technologies (proprietary or through alliances)
- Biofuel and renewable energies
- Non-oil activities (principally in life sciences, metals & mining)

The best solutions across the value chain

- Engineering and fabrication of fixed platforms for shallow waters (TPG 500, Unideck®)
- Engineering and fabrication of floating platforms for deep waters (Spar, semi-submersible platforms, FPSO)
- Leadership in floatover technology
- Floating Liquefied Natural Gas (FLNG)
  - Construction yard

CONFIDENTIAL - Not to disclose without authorization.
Technip France – Process & Technologies Division

- **Business Areas**
  - Onshore/Offshore Oil & Gas Production
  - Gas Treatment & Syn. Gas (Proprietary Technologies « Cryomax »)
  - LNG/ Floating LNG
  - Oil Refining
  - Ethylene (Proprietary Technologies : Ethane & Naphta Crackers)
  - Poly-olefins (Polyethylene, Polypropylene)
  - Chemicals (Proprietary Technologies : Ethanol)
  - Energy (Power Plants)
  - Metals & Mining (Bauxite, Nickel, Uranium)
  - Life Sciences and others

- **Knowledge Management Department**
  - Support activities to projects : Process Dynamic Simulation, Depressurization study, CFD study
  - Dedicated CFD ressources including Compute Cluster

CONFIDENTIAL-Not to disclose without authorization
CFD activities in Process Division KM Department

**Activities**
- Offshore/Onshore Oil & Gas Production
- Oil Refining
- Gas Treatment & Syn. Gas
- LNG & Floating LNG
- Ethylene

**Studies**
- Atmospheric Pollutant Dispersion : FLNG / Offshore
- Liquid Pool spreading and vaporization : FLNG
- Hot Air recirculation : Offshore/Onshore (LNG & Gas Treatment)
- Hydrodynamic in vessels & columns
- Sloshing in vessels : FLNG/FPSO
- Technology development for Aircoolers and enhanced Shell&Tubes Exchanger (Wieland) : LNG chilling trains, Ethylene
CFD activities in Process Division KM Department

### Activities
- Offshore/Onshore Oil & Gas Production
- Oil Refining
- Gas Treatment & Syn. Gas
- LNG & Floating LNG
- Ethylene

### Studies
- **Atmospheric Pollutant Dispersion : FLNG / Offshore**
- Liquid Pool spreading and vaporization : FLNG
- Hot Air recirculation : Offshore/Onshore (LNG & Gas Treatment)
- Hydrodynamic in vessels & columns
- Sloshing in vessels : FLNG/FPSO
- Technology development for Aircoolers and enhanced Shell&Tubes Exchanger (Wieland) : LNG chilling trains, Ethylene
Floating LNG Solutions

A unique combination of technologies and know-how from our 3 business activities

CONFIDENTIAL-Not to disclose without authorization
Atmospheric Pollutant Dispersion for Technip FLNG

- **Objectives**
  - Calculate pollutant (NOx, SOx, Benzene) concentration on Working Areas and at Living Quarter
  - Operators Health
  - Position of Living Quarter Air Intakes

- **Basis of study**
  - FLNG typical dimensions: 300 m length, 50 m width
  - Very congested areas: around 10 modules, Living Quarter, Turret, Flare
  - Very weighty CAD files from 3D Model
  - Geometry simplification: some pipes and secondary structures neglected
Using STAR-CCM+® for FLNG Atmospheric Pollutant Dispersion

- Geometry preparation
  - 3D Model from Technip’s dedicated service: .dgn, .rvm, .nwd
  - 3D Model sorting
  - Conversion into .stl (tesselated surfaces)
Using STAR-CCM+ for FLNG Atmospheric Pollutant Dispersion

▪ **Geometry preparation**
  - 3D Model from Technip’s dedicated service: .dgn, .rvm, .nwd
  - 3D Model sorting
  - Conversion into .stl (tessellated surfaces)

▪ **Methodology**
  - Import .stl into STAR-CCM+
  - Separate faces: Air Intakes, Exhaust
  - Define atmosphere and sea level around FLNG
  - Repare some minor issues on the surface: big holes
  - Set mesh sizes
  - Wrap, remesh the surfaces and generate trimmed volumic mesh: 30 M cells

**Input file : STL**

**Wrap result**

**Remesh result**
Geometry import and meshing workflow

Input file: STL

Wrap result

Remesh result

Volumic mesh

CONFIDENTIAL - Not to disclose without authorization
Overview of the meshed geometry (video)
CFD study for FLNG Atmospheric Pollutant Dispersion

- **Pollutant dispersion objectives**
  - Nox, Sox and Benzene molar concentration at Living Quarter Air Intake → Driving Air Intake design: position, size
  - Nox, Sox and Benzene molar concentration on modules walls
  - Nox, Sox and Benzene plume over modules and working zones → Driving exhaust stack design: position, size

- **Streamlines colored by pollutant concentration**
Results for FLNG Atmospheric Pollutant Dispersion

- Flow pattern around the FLNG
  - Velocity contours on a vertical plane

Recirculation zone
Results for FLNG Atmospheric Pollutant Dispersion

- Pollutant isosurfaces and contours
Conclusion

Benefits using STAR-CCM+
- Case set-up eased by graphical interface
- CFD study better integrated in projects: 3D model update flexibility
- Effort spent by the engineer: automatic geometry and meshing
- Time saving: ~1 month saved out of 3 months
- Able to handle very large model
- High fidelity model: no rough simplification to be performed
- Detail level more representative of the flow congestion and ventilation
- Improved deliverable credibility

Conclusion
- Atmospheric Pollutant Dispersion has been achieved with complex geometry
- Methodology has been set-up and validated to prepare and mesh geometry

Perspectives
- Add more geometry: small pipes
- Using STAR-CCM+ to perform other studies: Helideck Availability Study, Flare Flame Out study
- Refine mesh size to get even more reliable results
Thank you