The Application of a Digital Twin Aggregate for an LNG Liquefaction Process

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Outline

• Overview of a surveillance digital twin
• Discuss how an enhanced digitalization strategy can improve process efficiency within a liquefaction process
• Present a framework to apply the concept of digital twins to create a virtual representation of the physical process
• Illustrate how equipment can be virtually simulated in a manner that creates an overarching digital representation:
  o Process – operating efficiency
  o Reliability – mechanical integrity
  o Safety – consequence analysis
Objectives

• Identify process bottlenecks and strategies to
  o Maximize production
  o Minimize downtime
  o Optimize process efficiency

• Illustrate how an enhanced digitalization strategy facilitates real-time process optimization.

• Present a digital twin framework to enhance process efficiency and reduce risk
Improving Process Efficiency

Options to improve process efficiency include:

- Process – predictive surveillance
- Maintenance – predictive analytics
- Hardware – new/modified equipment
- Controls – APC algorithms
- Instrumentation – smart sensors
- Training to compliment modifications
The Digital Twin

• A virtual model of a producing asset
• The digital twin’s goals are to improve operating efficiencies, prevent downtime, & create a lower risk operating environment
• The twin uses field data in a virtual representation of processes to communicate real-time performance
• By continuous monitoring of performance data the twin can identify trends & quickly apply past learnings to models that can predict future performance
Enhanced Decision Making

- The twin creates linkages between data & models perpetuating enhanced surveillance & predictive analytics
- The twin seamlessly links process data to virtual models to provide real-time analysis
- The twin provides foresight relative to future operating conditions allowing improved decision making
- The twin can be made up a collaborating family (an aggregate) of separate twins
Liquefaction Plant System

- Constitutes equipment networks within a set of subsystems
- Each of these subsystems are made of individual components
- Each component needs to function with the highest integrity and efficiency to optimize production
Feed Quality - Illustration

Poor feed quality can be detrimental to operations:

• Reduces process efficiency
• Increases risk of downtime

An enhanced digital strategy applied to flow assurance risks can complement traditional tactics:

• Real-time dynamic process model
• Analysis relative to operating limits/constraints
• Early warning of transient events
• Predict impact on future production
Mixed Refrigerant - Illustration

MR composition is key to efficient liquefaction operations/rates

An enhanced digital strategy applied to evaluating MR composition relative to operating conditions can provide key insight:

• Enhance decision making wrt changing MR components
• Predict impact of changes in composition
• Evaluate impact of changes within operating limits/constraints
Digital Twin Aggregate

• Each individual twin can reside within a larger family of twins (an aggregate of twins)

• The agglomeration of twins permits sharing of data and modelling results

• This cross-functional relationship of interdependencies strengthens the ability of each individual twin to represent reality

• Through a shared residence in a virtual environment, a family of twins is a comprehensive ecosystem providing a holistic representation of the material world
Conclusions

• Optimizing liquefaction systems requires a holistic perspective that leverages a cross functional team to evaluate opportunities to improve processing efficiencies and mitigate downtime
• Enhanced digitalization can help overcome liquefaction processing challenges that negatively impact efficiency
• Useful digital solutions incorporate the conversion of data into meaningful information, providing value-added insight
• Digital twin(s) create a learning environment where subsequent human action is more effective
• The digital twin creates value by a) optimizing production, b) mitigating unplanned shutdowns, and c) improving process efficiency