



REFORMER CARE A COMPLETE ASSET INTEGRITY SOLUTION

- LOTIS® Laser-based Internal Inspection Technology
- MANTIS™ External Crawler Inspection Technology
- LifeQuest™ Reformer Remaining Life Assessment
- Integrated Solution Set for Steam Reformers

QuestIntegrity.com

CHALLENGE CONVENTION

LOTIS[®] & MANTIS[™] INSPECTION TECHNOLOGIES

Reformer Care Solution Includes:

- Inspection and Data Analysis
- Remaining Life Assessment
- Advanced Engineering

BENEFITS

Reduced Operational Risk

- Minimizes risk of unplanned shutdown due to premature tube failure
- Allows plant engineers to manage and often extend tube life beyond 100,000 operating hours
- Allows operators to improve reformer output and operate within an integrity window, providing a holistic approach to the operational needs
- Baseline inspections at tube manufacturing facility to ensure tubes meet your specifications prior to shipment

Cost-effectiveness

- Provides large quantity of diagnostic information
- Minimizes unplanned outage potential – typical outage cost is \$250K USD per day; average down time 7-10 days often costs operators = \$1.7M USD in lost production
- Enables cost management and financial planning for future tube replacement

Time Efficiency

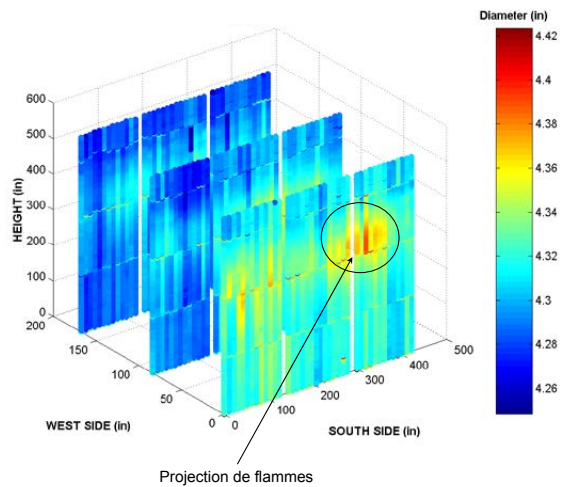
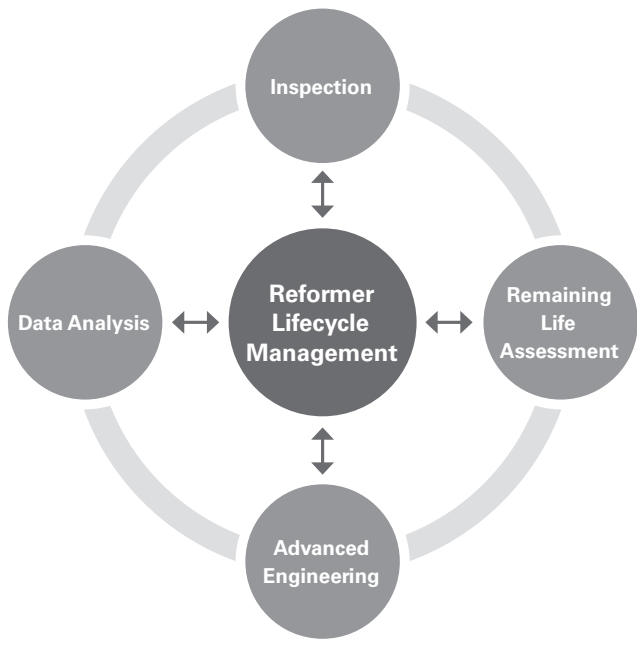
- Rapid inspection process (typically 2-3 minutes per tube) reduces reformer downtime
- Can be performed alongside catalyst loading/unloading teams with no additional time required
- Tube life monitored over entire life cycle; other inspection techniques are useful only at or very near end of tube life which is often too late for remnant life prediction or effective tube replacement management

FAILURE MECHANISMS IDENTIFIED/QUANTIFIED

- Creep strain
- Bulging or swelling
- Manufacturing flaws

FEATURES & CAPABILITIES

- Inspection data feeds directly into LifeQuest Reformer for remaining life assessment
- LOTIS inspects 100% of reformer tube
- Highly accurate and repeatable results
- Collects millions of data points during typical inspection
- No couplant required
- Provides increased confidence in inspection results through combined NDT methodologies
- Performs inspection with or without catalyst in tubes and each time reformer is taken offline



REMAINING LIFE ENGINEERING ASSESSMENT

- Fitness-for-Service and remaining life engineering assessments in accordance with API 579 and ASME FFS-1/2007
- Proprietary materials database for HP alloys and microalloys, representing 25+ years of empirical data
- Proprietary advanced creep model with primary, secondary and tertiary regimes

ADVANCED ENGINEERING ASSESSMENT

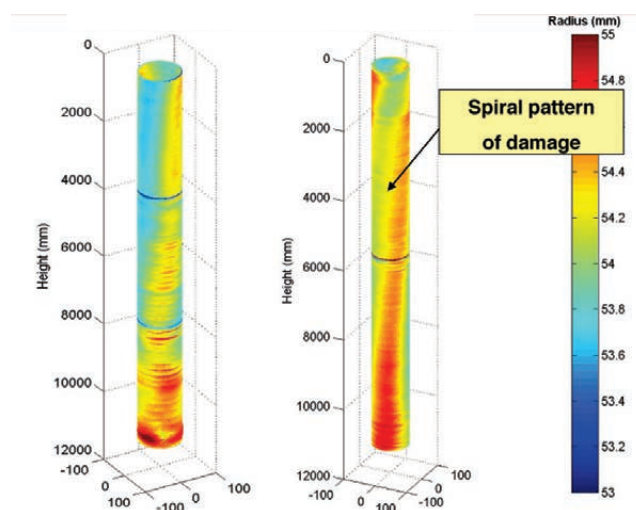
- Assessment of high temperature components such as header systems and inlet and outlet pigtails
- 3D elastic-plastic Finite Element Analysis and Computational Fluid Dynamics modeling of ancillary equipment
- Assessment technology backed by extensive in-house materials testing of post-service HP alloys
- Materials engineering and lab support specializing in high temperature material assessment, including accelerated creep-rupture testing
- World leader in fracture mechanics
- RBI and RBA assessment of all major syngas plant components

LIFEQUEST REFORMER REMAINING LIFE ASSESSMENT SOFTWARE

- Highly advanced tool combines Fitness-for-Service assessment and our proprietary materials database to determine remaining life for each tube; not dependent upon input operating conditions like other assessment methodologies
- Finite Element Analysis assesses through-wall creep damage gradient; includes longitudinal and through-thickness stress gradients to accurately model current condition, historical stresses and predicted stresses
- Measured creep damage is matched with model output to accurately assess effective operating metal temperature
- Developed by leading industry experts

ANALYSIS & ASSESSMENT CAPABILITIES

- Increases confidence in remaining life predictions
- Quantifies and predicts total creep damage
- Provides deterministic and probabilistic life assessments for each tube
- Provides remaining life of each inspected and assessed reformer tube
- Analyzes 100% of LOTIS inspection data



REFORMER CARE OVERVIEW

- Unique solution to attain operational safety and reliability goals
- Enables proactive decision making
- Eliminates premature harvesting of reformer tubes
- Improves knowledge of turnaround requirements and reduces costs with proper planning
- Increases understanding of reformer operation and limitations
- Addresses all reformer systems

QUEST INTEGRITY

Quest Integrity, a Team Industrial Services company, is a global leader in the development and delivery of asset integrity and reliability management services. The company's integrated solutions consist of technology-enabled, advanced inspection and engineering assessment services and products that help organizations improve operational planning, increase profitability, and reduce operational and safety risks. Quest Integrity is built on a foundation of leading edge science and technology that has innovated and influenced industry best practices since 1971.

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