GPA MIDSTREAM ASSOCIATION

A NEW LOOK

2017 GPA MIDSTREAM CONVENTION • APRIL 9 - 12 • SAN ANTONIO

Steve Green, Southwest Research Institute®

GAS-LIQUID SCRUBBER PERFORMANCE TESTING AT FIELD-LIKE CONDITIONS

AGENDA

- Overview of STAR Program
- Current STAR Program Research Plans
- Gas/Liquid Scrubber Performance Testing Project
  - Testing Needs
  - Test Objectives, Setup, and Plan
  - Results
- Conclusion

The Separation Technology Research (STAR) Program JIP

OVERVIEW

BACKGROUND

- STAR Program is a Joint Industry Project (JIP) initiated for conducting research, conducting systematic testing, and enabling qualification of separation equipment
- Research project plans are developed by the participating companies

www.starprogram.swri.org

VISION STATEMENT

Advance separation research that will result in accurate performance data to validate equipment and standardized test protocols.

BENEFITS

- Leveraged research (USD $3.65 million)
- Standardized testing on a range of products
- Reduced risk of implementing technologies
- Independent data/physics-based models
- All data available to all participants, including vendors
- Minimize capital costs by use of available worldwide facilities, where possible
- Members decide direction

PARTICIPANTS

The Separation Technology Research (STAR) Program JIP

CURRENT RESEARCH PLANS

RESEARCH PLANS

- Proposed projects identified by:
  - Technical Advisory Committee (TAC)
  - Steering Committee (SC)
- Plans developed by:
  - Project Champion
  - Project Committee
  - TAC and SC
  - SwRI

RESEARCH PROJECTS

- *Scrubber Internals Performance Testing* **(Complete)**
  - Develop performance data on scrubber internals (vane inlet device, mesh pad, and demisting cyclone pack) with model oil and methane gas at field conditions
- *Liquid/Liquid Coalescing Media Characterization with Model Oil at Low Pressure* **(Complete)**
  - Obtain performance data on a standard plate pack device to characterize the system under controlled conditions
- *Compact Gas/Liquid Separators* **(Underway)**
  - Develop performance data on compact separator devices with model oil and methane gas at field conditions
  - Testing to be completed in April 2017

PHASE 2 RESEARCH PLANS

- *Impact of Glycol (MEG) on Scrubber Performance*
- *G/L Separation with Cyclonic Inlet Devices*
- *G/L Scrubber Tests without Mesh and with Different Fluids*
- *Non-Commercial and Novel Scrubber Internals*
- *Vane Pack (Demister) Tests – Vertical and Horizontal Vane Pack Designs (Gas/Liquid Separation)*
- *L/L Separation with Different Inlet Devices and Cyclonic Inlet Devices and Determining the Impact of Adding Gas*
- *The Effect of Flow Conditioning on G/L/L Separation*

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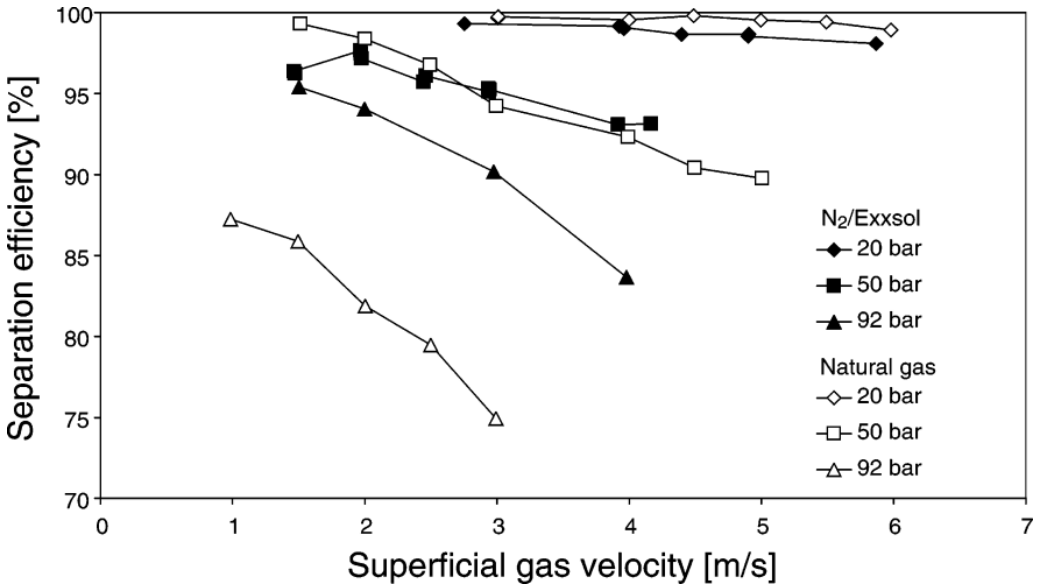
GAS/LIQUID SCRUBBER PERFORMANCE TESTING PROJECT

TESTING NEEDS

- Separation equipment performance depends on the operating pressure AND the liquid-gas interactions
  - Testing with real fluids is best, but impractical
  - Model fluids can be selected to approximate real fluid effects
- The STAR Program scrubber test uses Exxsol D110 and methane



Separator performance can be significantly impacted by pressure, fluids, and fluid characterization.

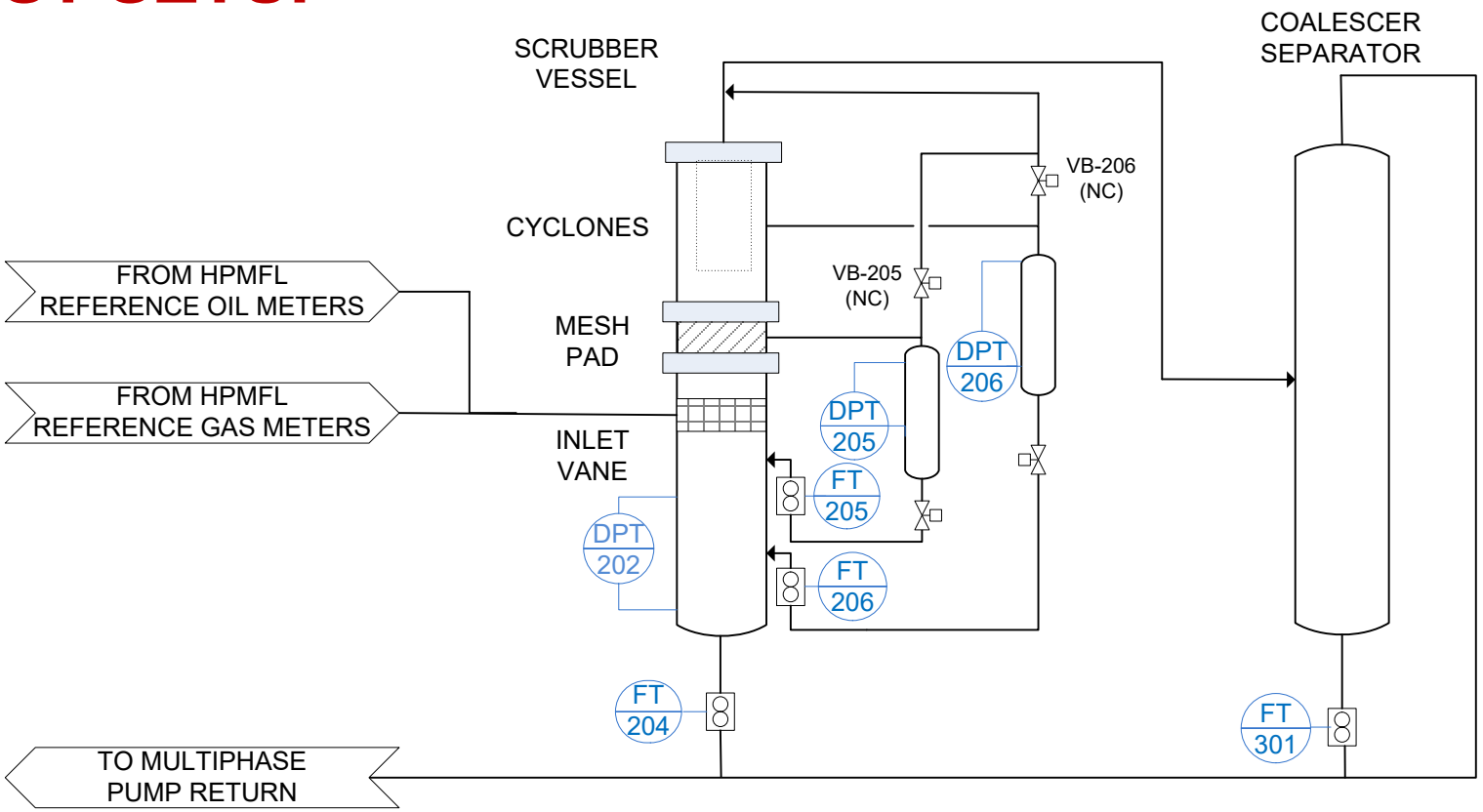
Reprinted with permission from Trond Austrheim et al., "Re-entrainment Correlations for Demisting Cyclones Acting at Elevated Pressures on a Range of Fluids," Energy Fuels, 2007, 21 (5), pp 2969–2976, American Chemical Society.

TEST OBJECTIVES

- Develop a standard test procedure for gas/liquid scrubber testing
- Develop baseline scrubber data that can be used to validate future testing
- Develop scrubber internals performance data for products from seven manufacturers
  - Range of realistic test conditions
  - Characterized fluids: methane gas and refined oil
- Provide data for:
  - Validation of performance of internals for field applications
  - Driving technology development

MULTIPHASE FLOW FACILITY

TEST SETUP



- Test setup is designed to measure the overall performance of gas scrubber internals
- Scrubber liquid carryover is measured via the use of a filter/coalescer
- Instrumentation is designed for accurate liquid and gas flow measurement

TEST PLAN

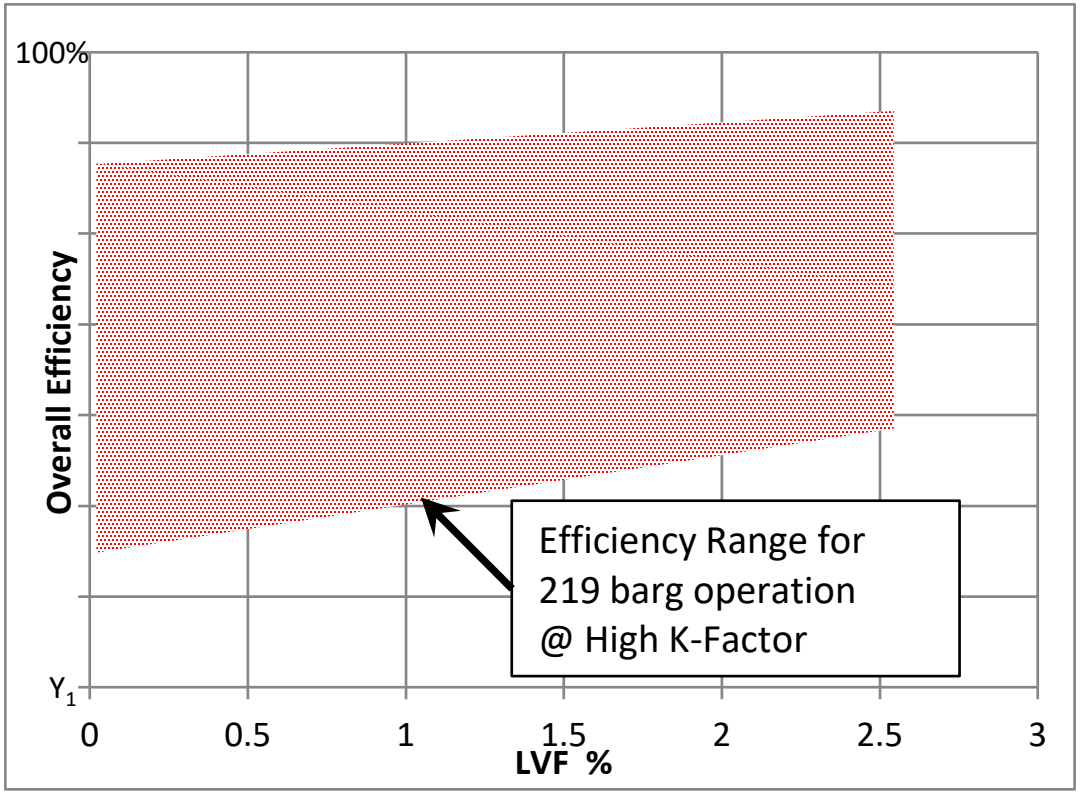
- Baseline tests – vane-type inlet device
- Seven sets of internals – vane-type inlet device, mist pad, cyclone pack
- Test conditions
  - Pressure range up to 220 bar
  - LVF range up to 15%
  - Flow rate range up to 200 m^3/hr
- Measure separation efficiency, including performance of mist pad and cyclone bank

RESULTS: OVERVIEW

- Empty scrubber performed well, especially at lower pressure, with only inlet vane device – this may be due to scaling issues (may not hold in a larger vessel)
- Tested vendor's scrubber internals as part of a system and not individual components
  - Testing of individual components is on our long-term planning list
  - STAR Program tests measured liquid collected from each of the devices (when available)
- Importance of drainage capacity/liquid handling for each component cannot be underestimated

RESULTS: OVERVIEW

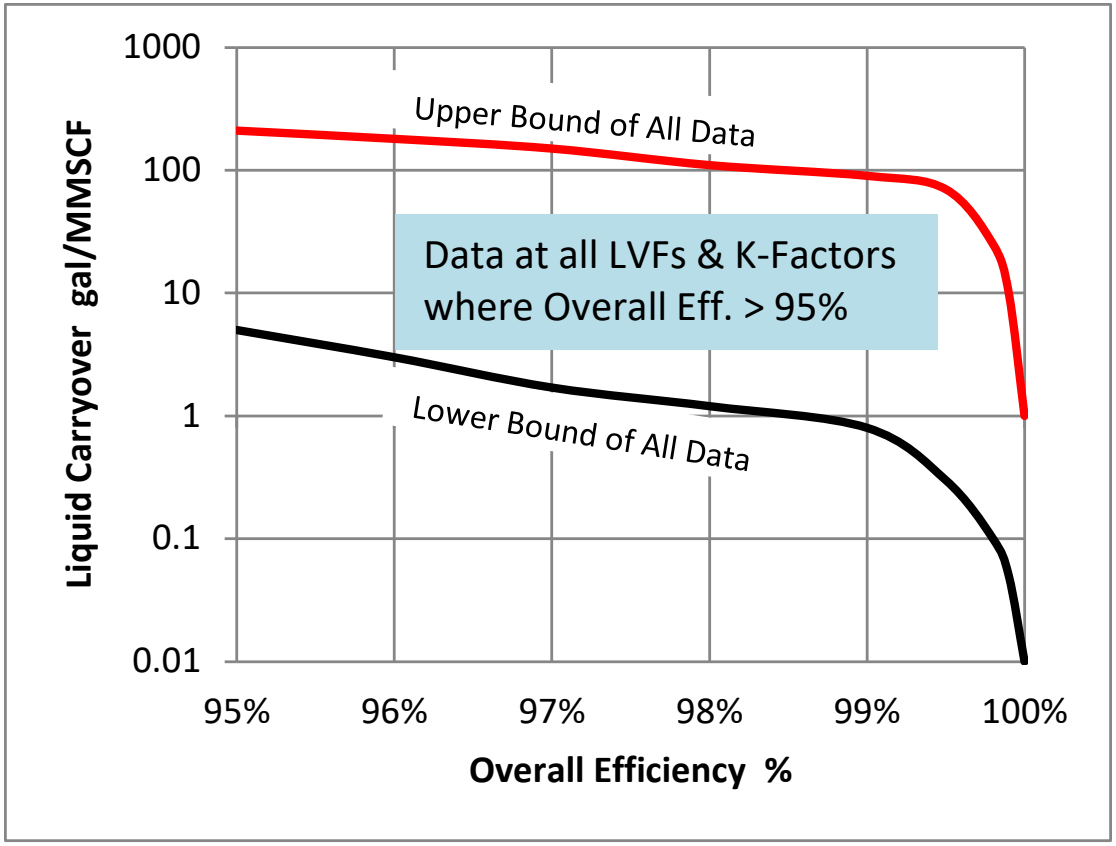
- Most of the vendors' scrubber internals behaved similarly at lower pressure
- At higher pressures, valuable performance data were obtained that support the need for appropriate selection of internals



RESULTS: SPECIFICS

- For 69 barg – over the range of conditions tested, K-factor and inlet LVF had little impact on overall efficiencies
- For 149 barg – for K-factor of 0.15 m/s and lower, inlet LVF (over the range tested) had little impact on overall efficiencies
- For 219 barg – for K-factors of 0.12 m/s and lower, inlet LVF (over the range tested) had little impact on overall efficiencies

RESULTS: APPLICATION



- For high pressure, high K-factor:
  - overall efficiency increases with liquid loading
  - but overall liquid carryover increases
- Very few points where carryover was 0.1 gal/MMscf or below, even if overall efficiency was 99.95%

RESULTS: APPLICATION

- The selection of internals is important:
  - inlet device
  - agglomerator
  - liquid handling collection system
  - mist eliminator style
  - number of cyclones
- Inlet piping likely important (this testing used long, straight inlet piping – didn't challenge the scrubber with bubbly or slug flow)

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QUESTIONS?