Fractionation Research, Inc.

RESEARCH – KEY TO BETTER DESIGN

Hydraulics of Kettle-Reboiler Circuit on Distillation Columns

Tony Cai, Mike Resetarits, and Ahmad Shariat

Fractionation Research, Inc.

Distillation Honors Session: Professor Michael Schultes

2010 AIChE Annual Meeting, Salt Lake City, UT

November 9, 2010

Dr. Schultes at FRI Experimental Unit in 1998

Reboiler Circuit

Dr. Schultes at FRI Experimental Unit in 2010

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Captain Dr. Schultes

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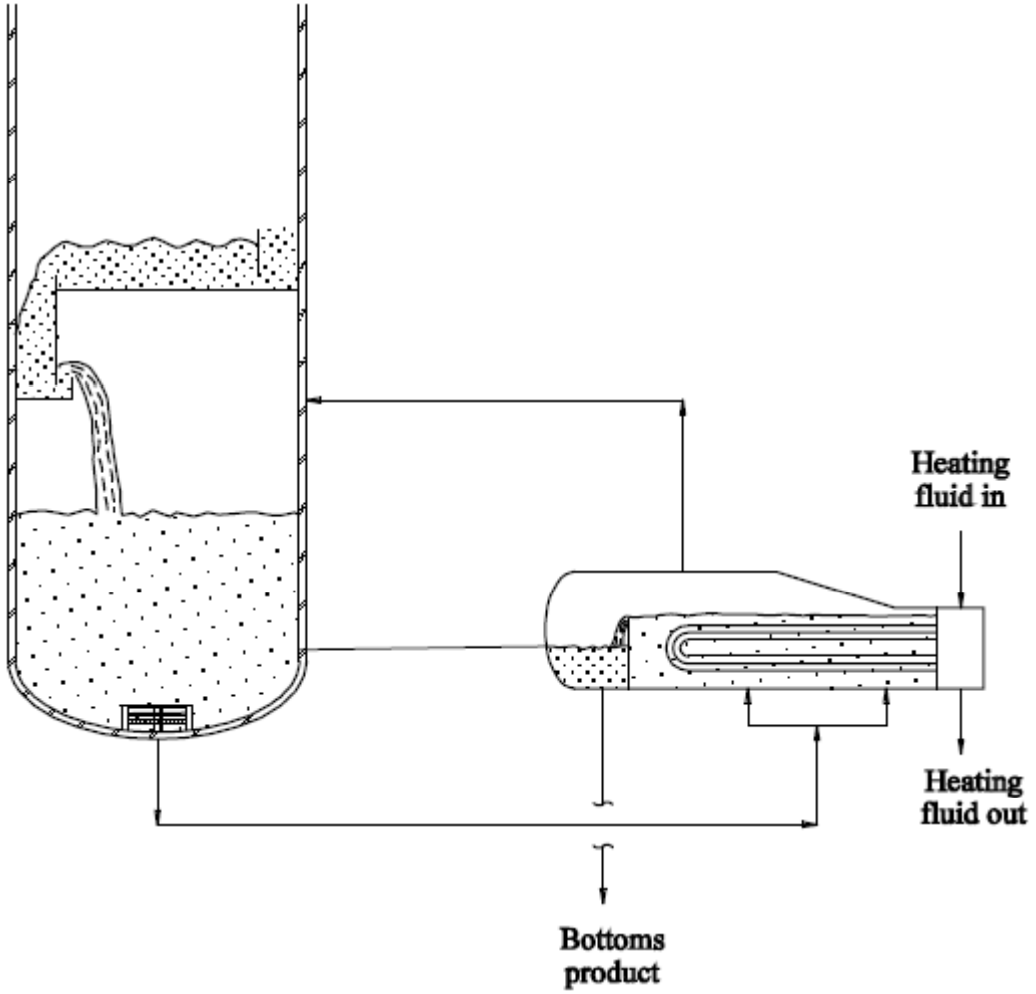
Introduction

- Reboilers are commonly used heat exchangers on distillation columns, supplying most of the energy required for the column
- It is very important to properly design and operate the overall reboiler circuit
  - If too much heat is supplied, the tower will flood; too little heat is available, separation performance decreases
- Significant number of fractionator problems can be attributed to either improper bottom circuit design or poor reboiler circuit layout
- Reboiler problems are thought to be the second-most common cause of tower problems

Typical Kettle Reboiler Circuit



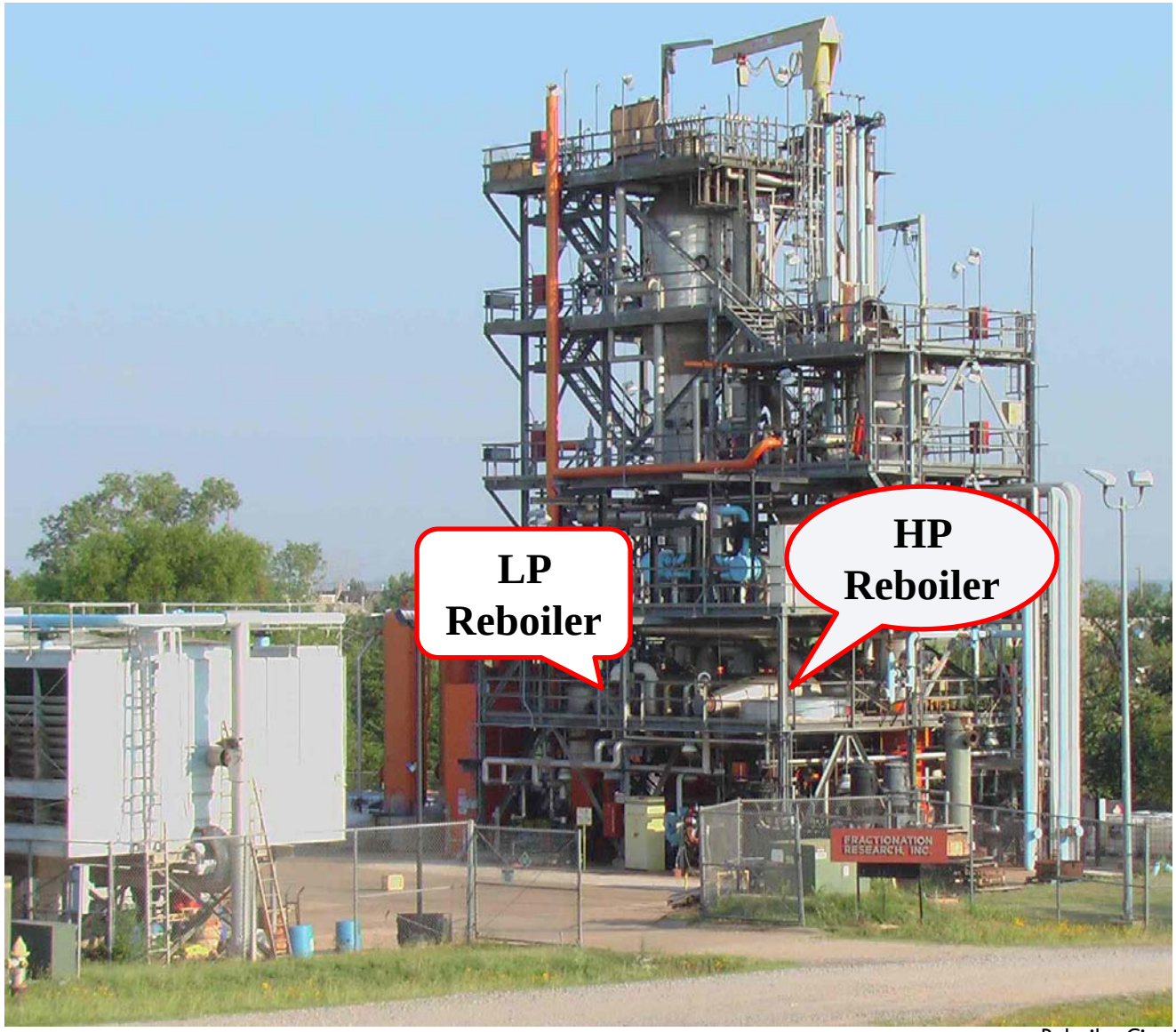
Problems & Objectives

- Tower bottom hydraulics is not generally investigated as mush much as mass transfer is
- This paper focus on the hydraulics of kettle reboiler circuits
- Experimental results are compared to analytical predictions

Approaches

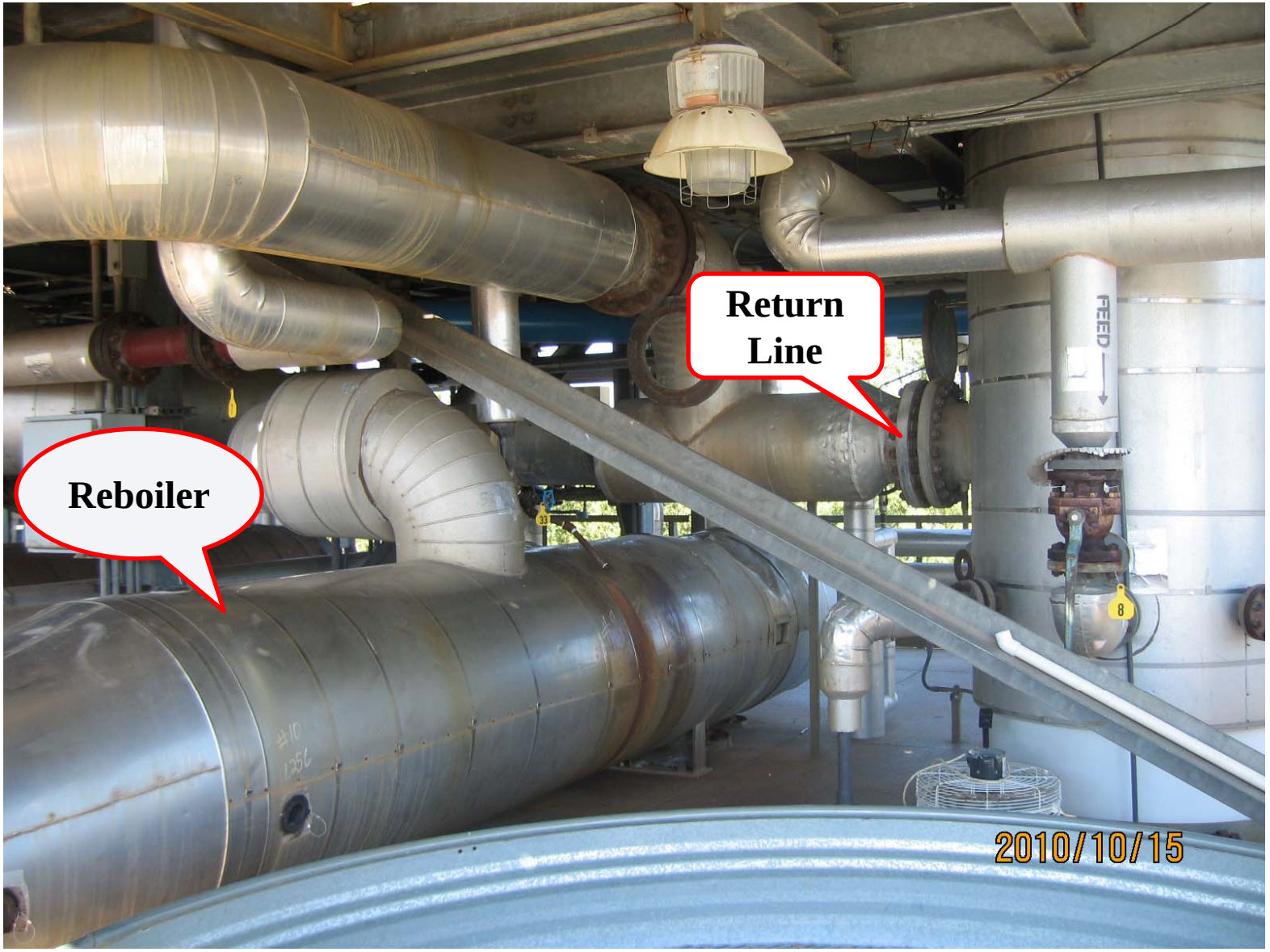
- Pressure drops of vapor phase between the reboiler and the column were measured using differential pressure transmitter
- The liquid level at the bottom of the column was measured using a bubbler
- Pressure drops of liquid and vapor phases across the reboiler circuit were calculated/estimated using basic fundamental fluid dynamics

FRI Experimental Unit



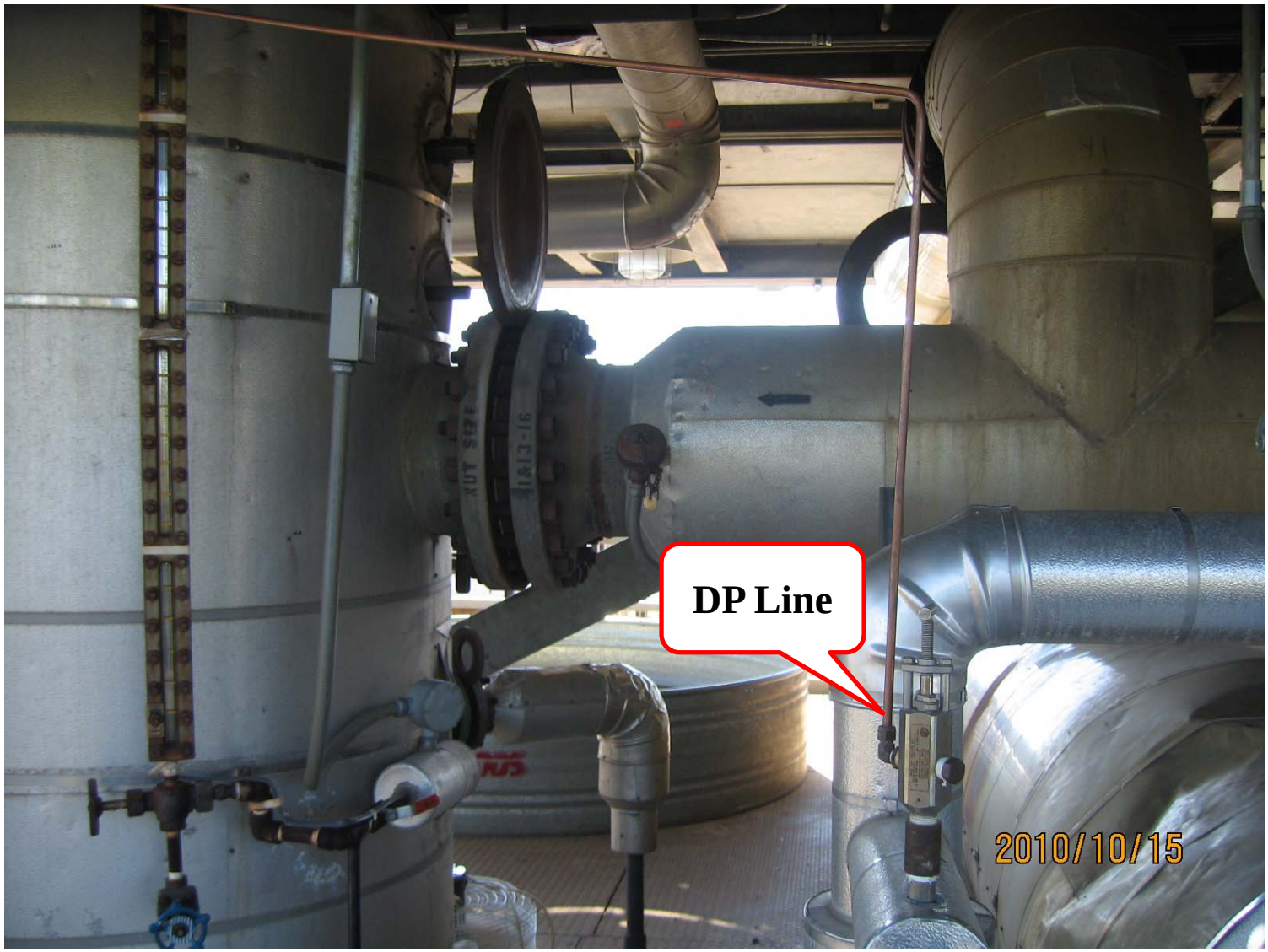
Reboiler Circuit

Kettle Reboiler Circuit



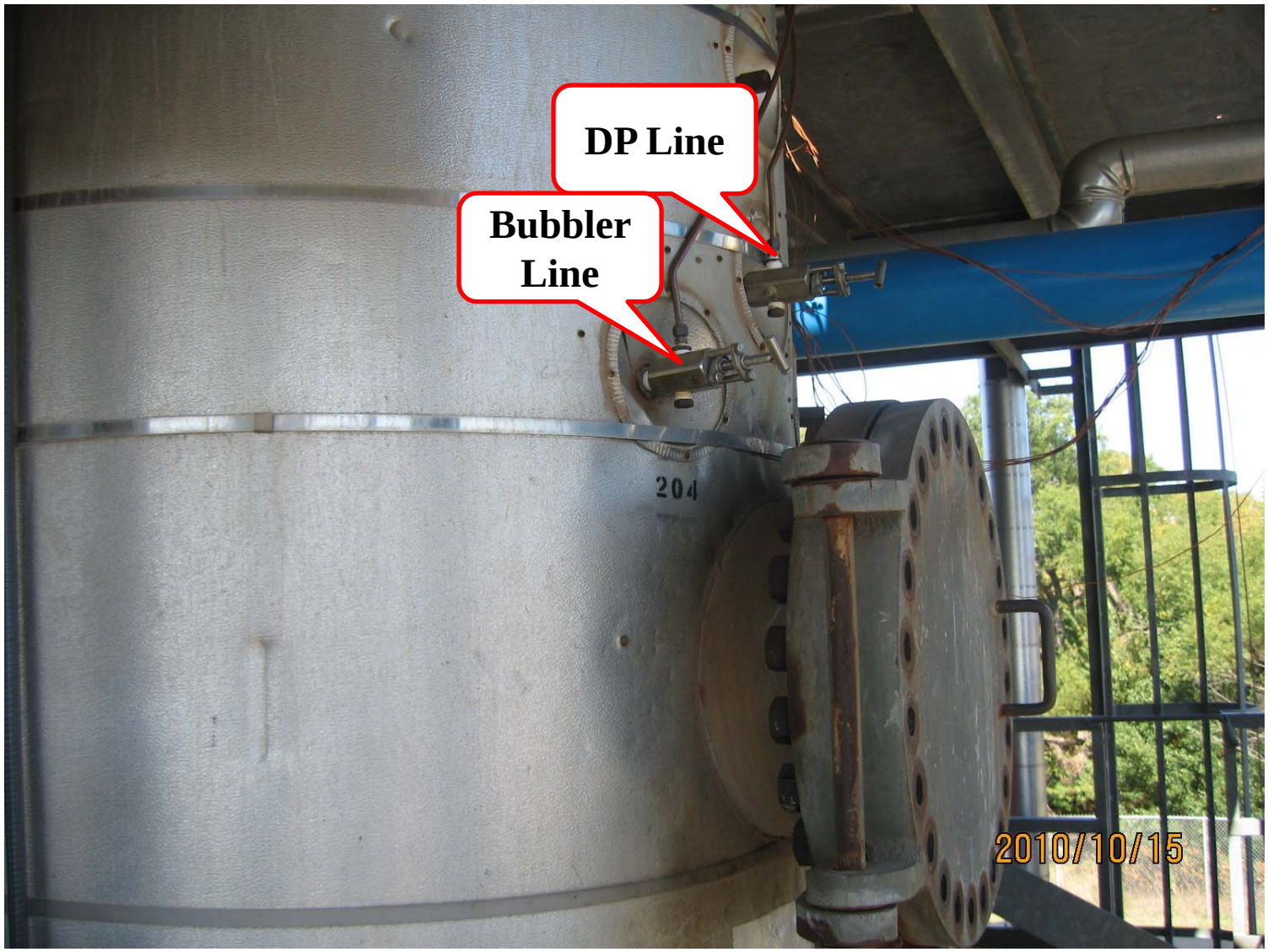
Reboiler Circuit

Locations of Pressure Drop Measurements



Reboiler Circuit

Location of Bubbler

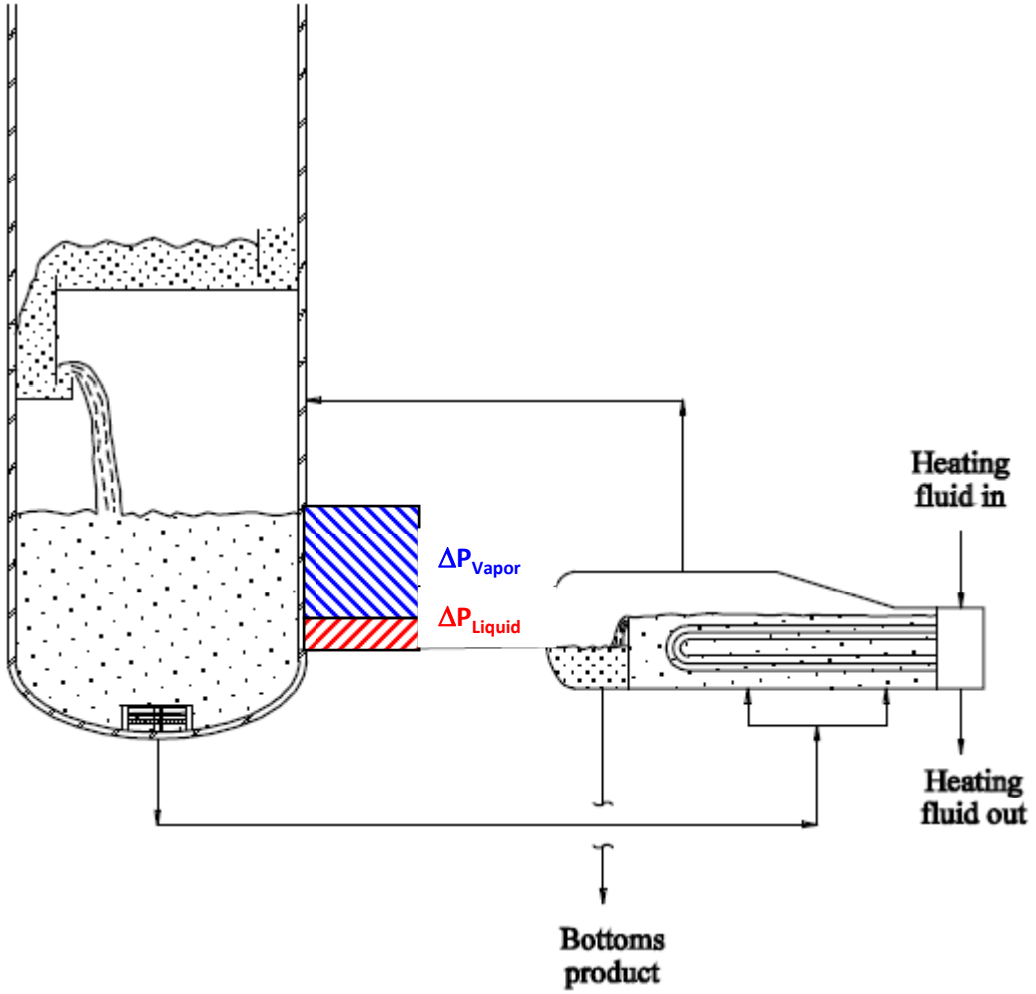


Pressure Transmitter

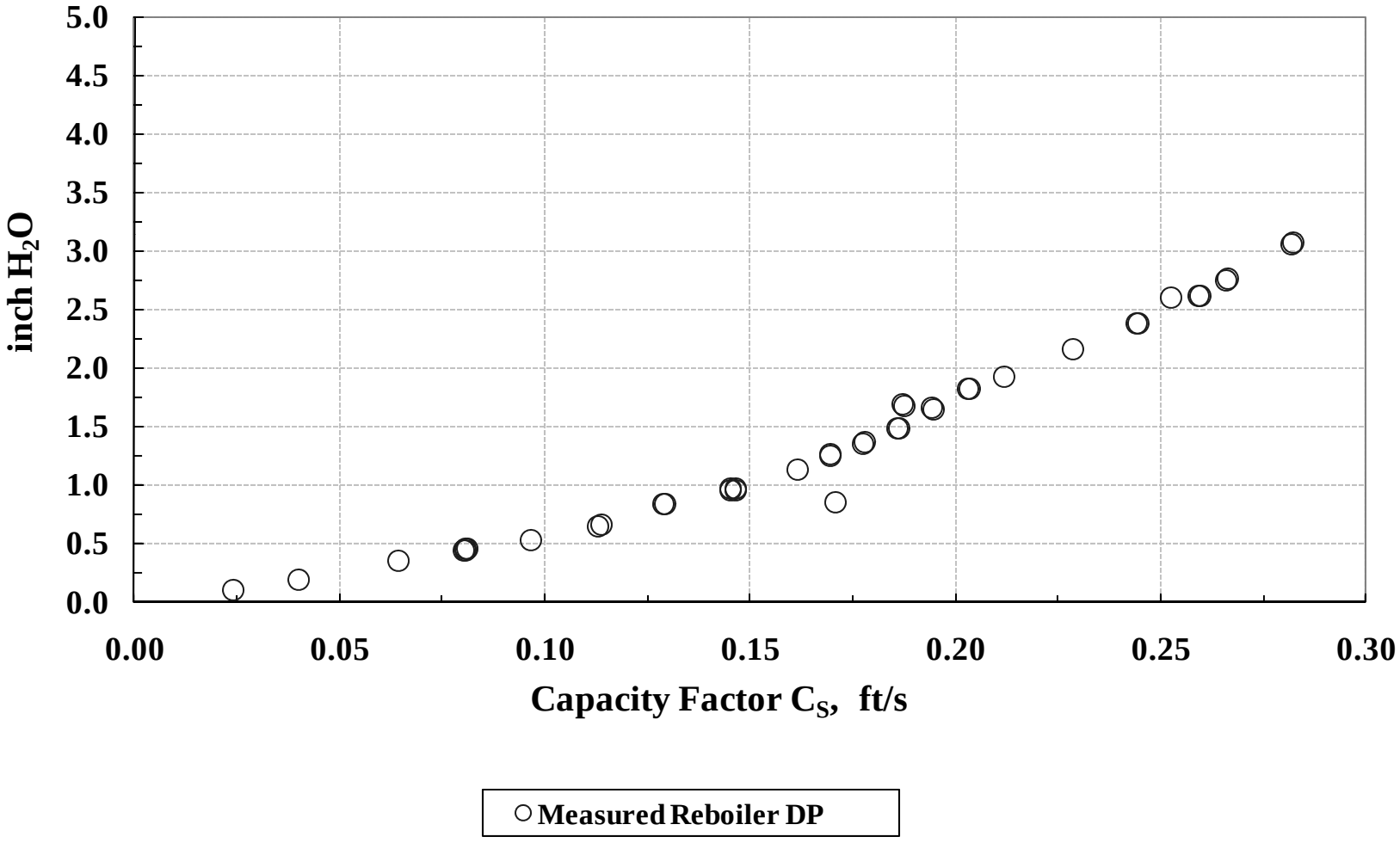
Reboiler Circuit

Results

Standard Kettle Reboiler Circuit



Reboiler Pressure Drop (Vapor Phase)
iC_4/nC_4 165 psia (11.4 bar)



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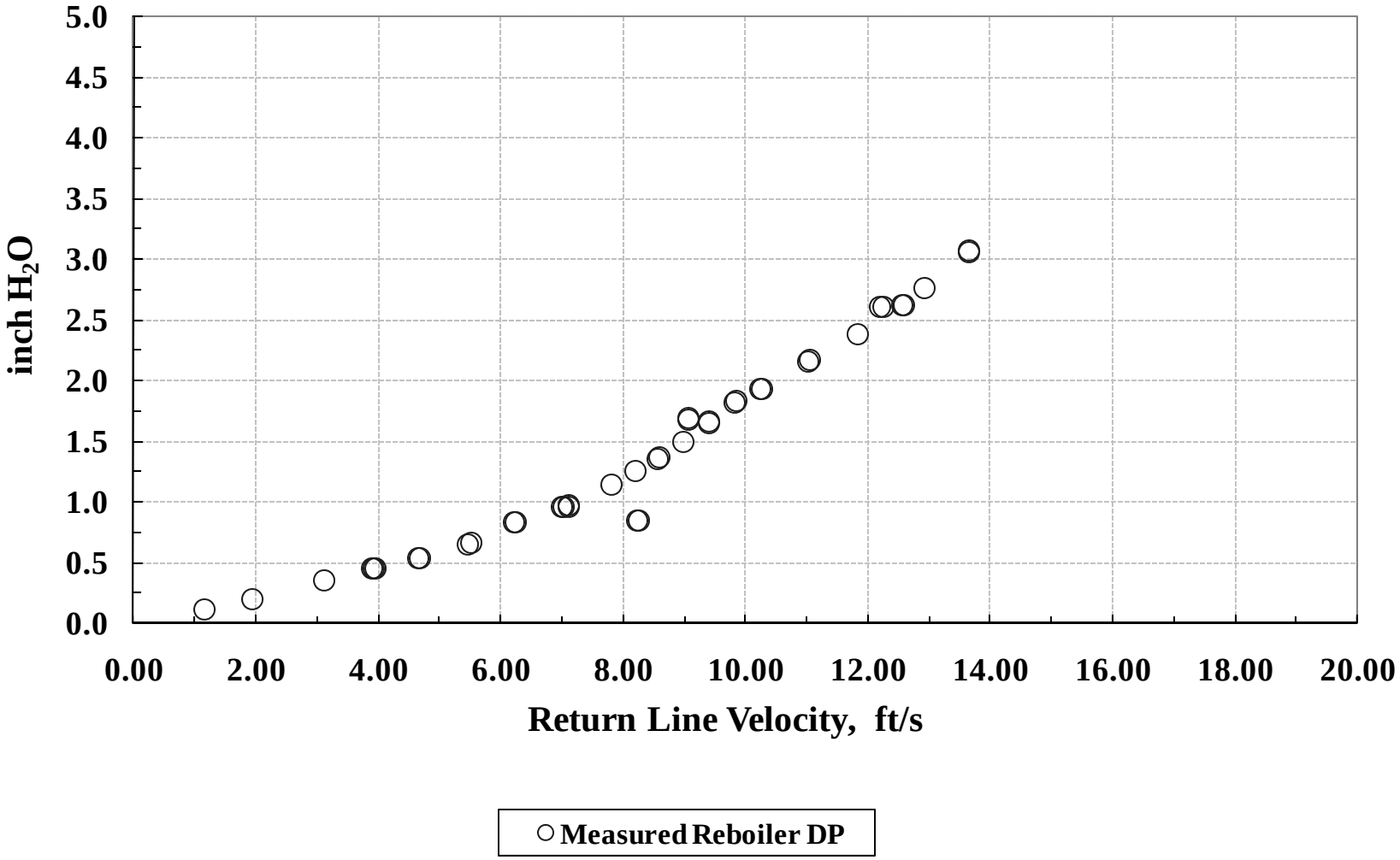

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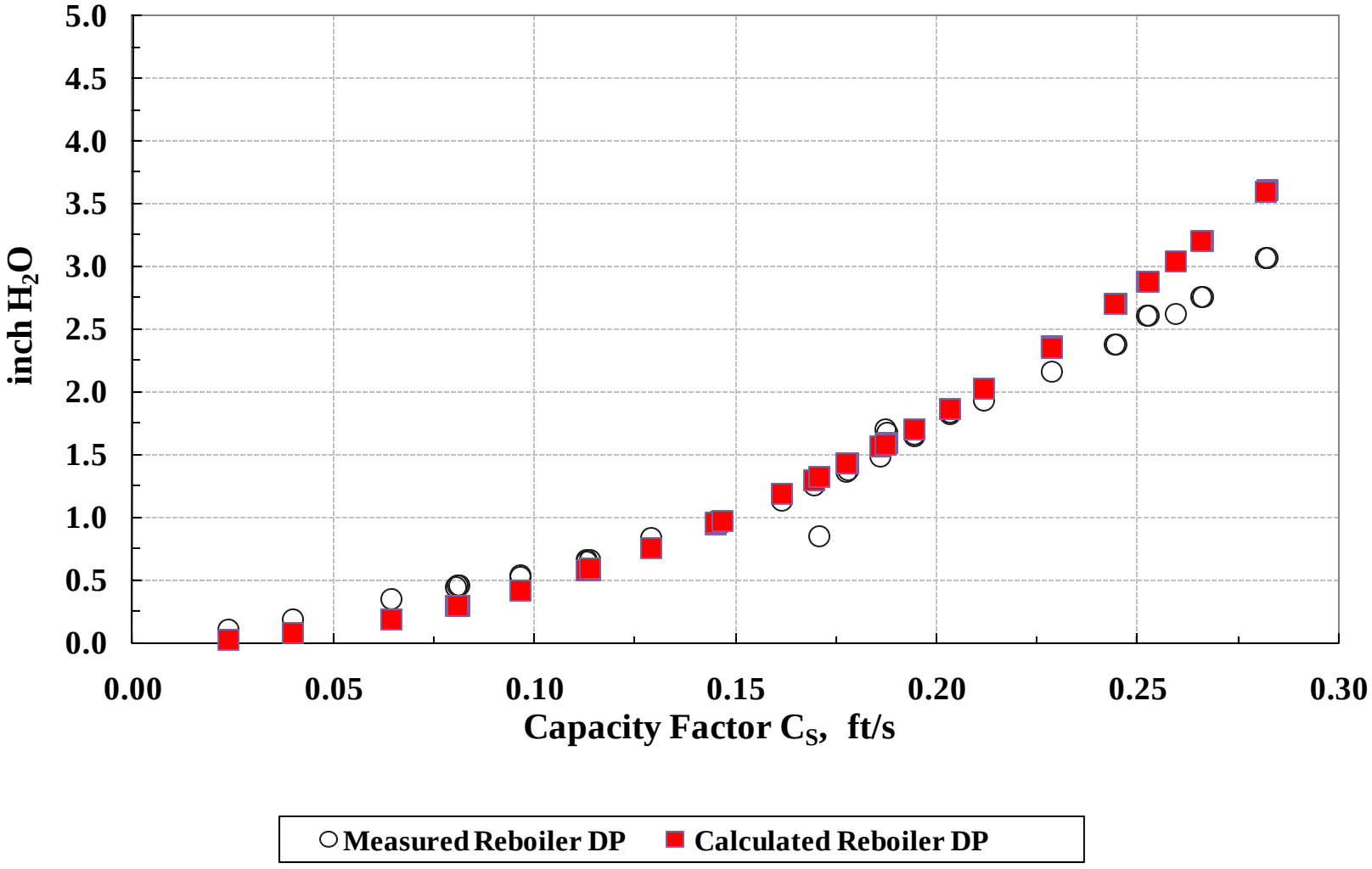

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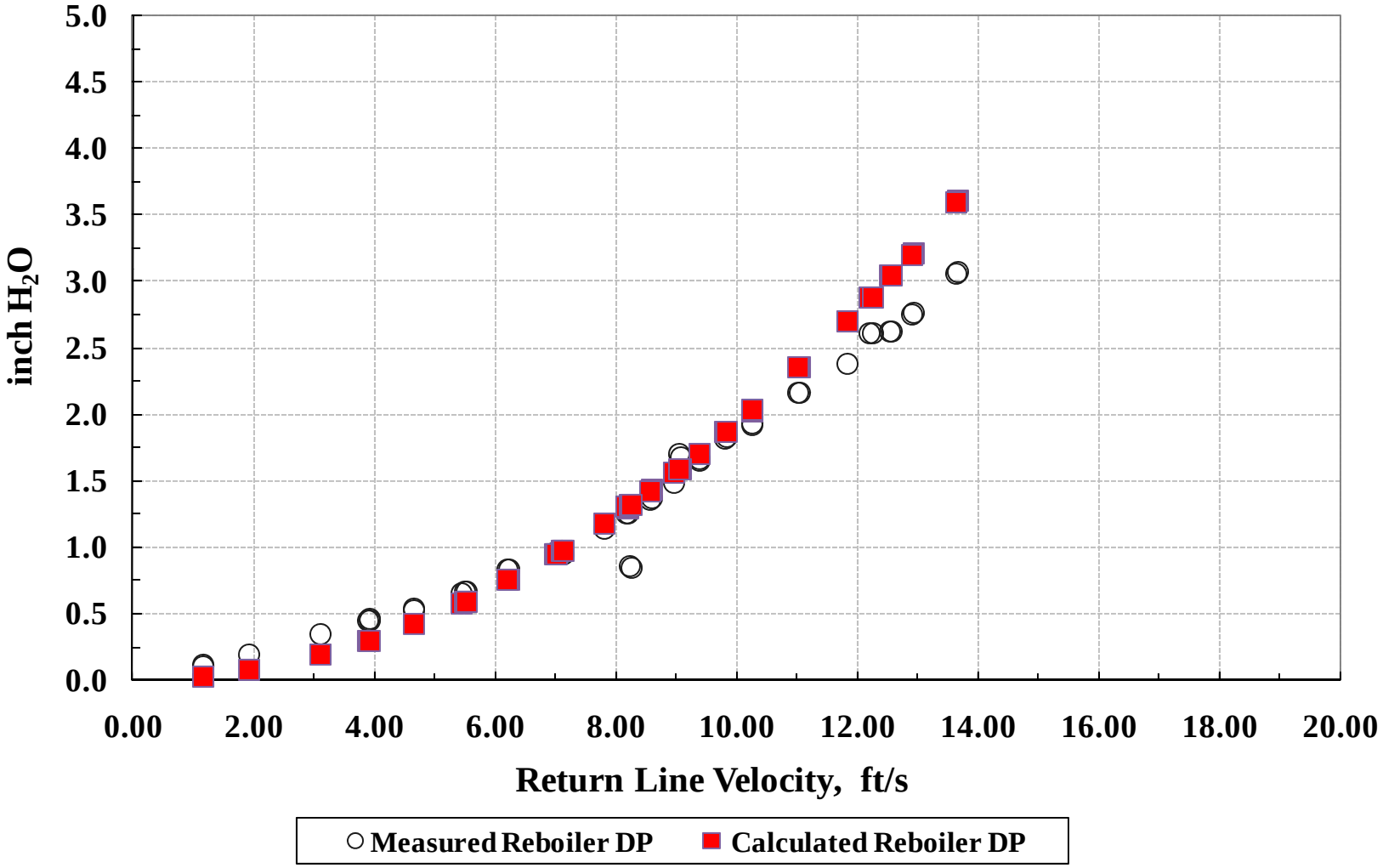
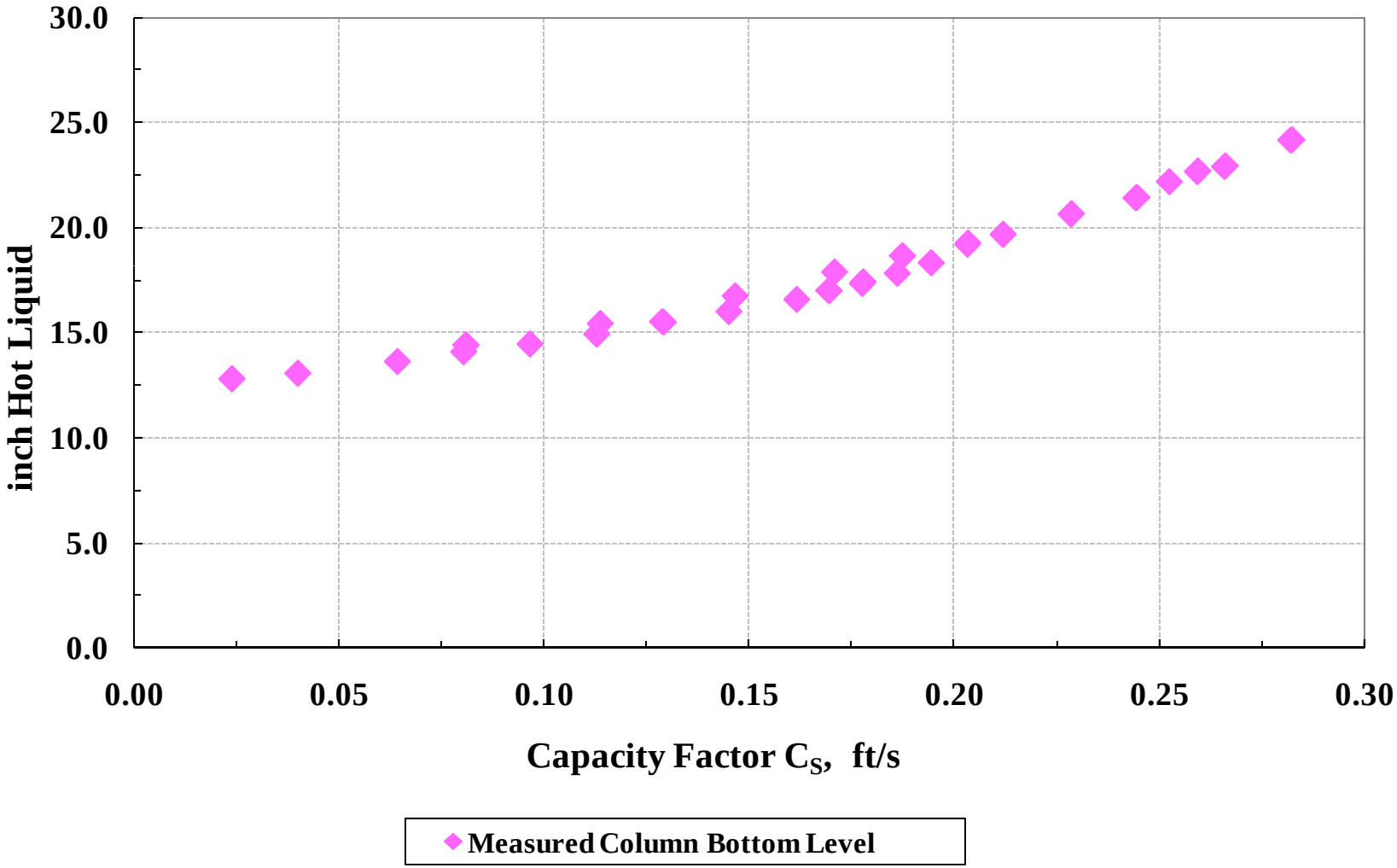


Column Bottom Liquid Levels
iC_4/nC_4 165 psia (11.4 bar)



Column Bottom Liquid Levels
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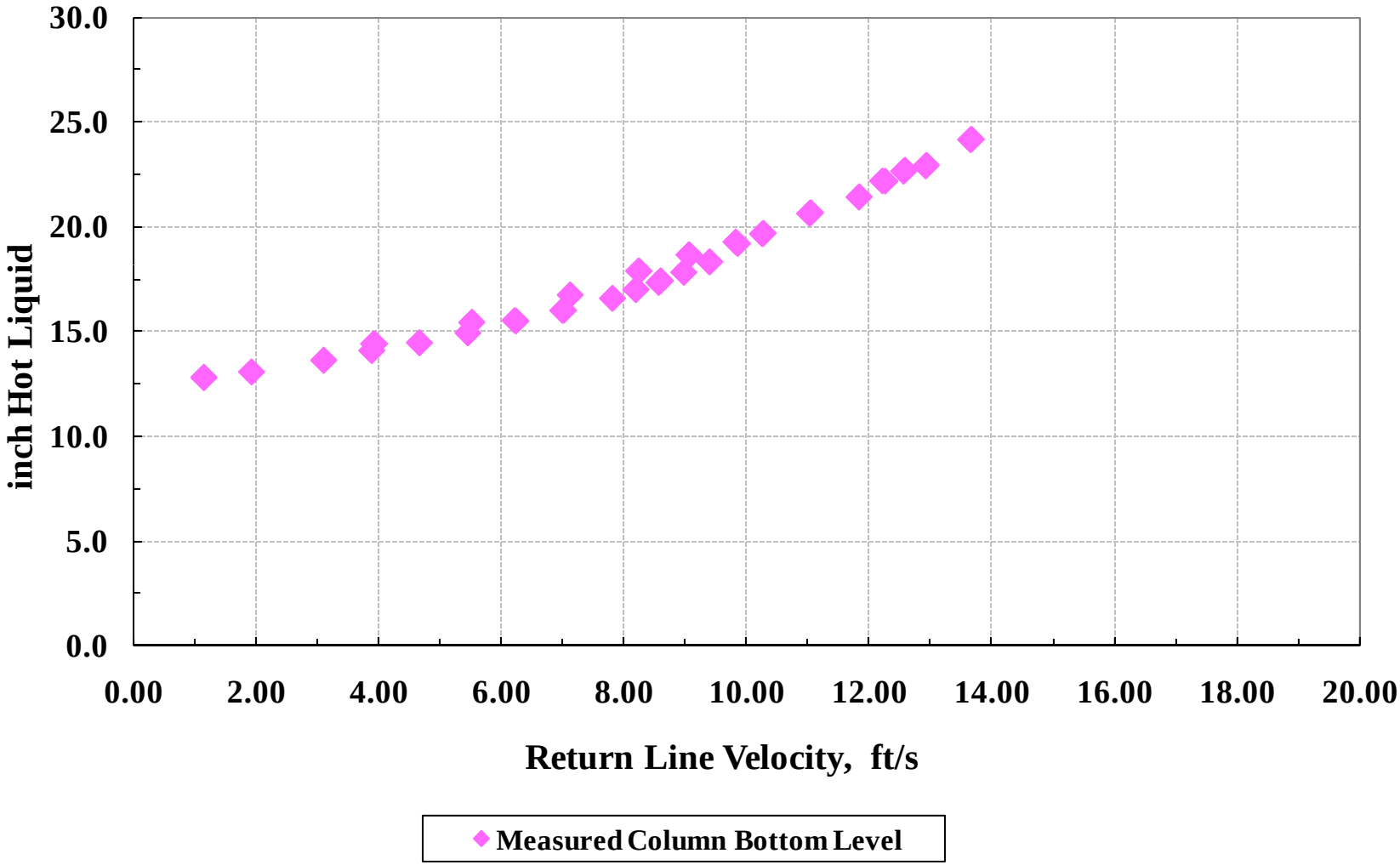
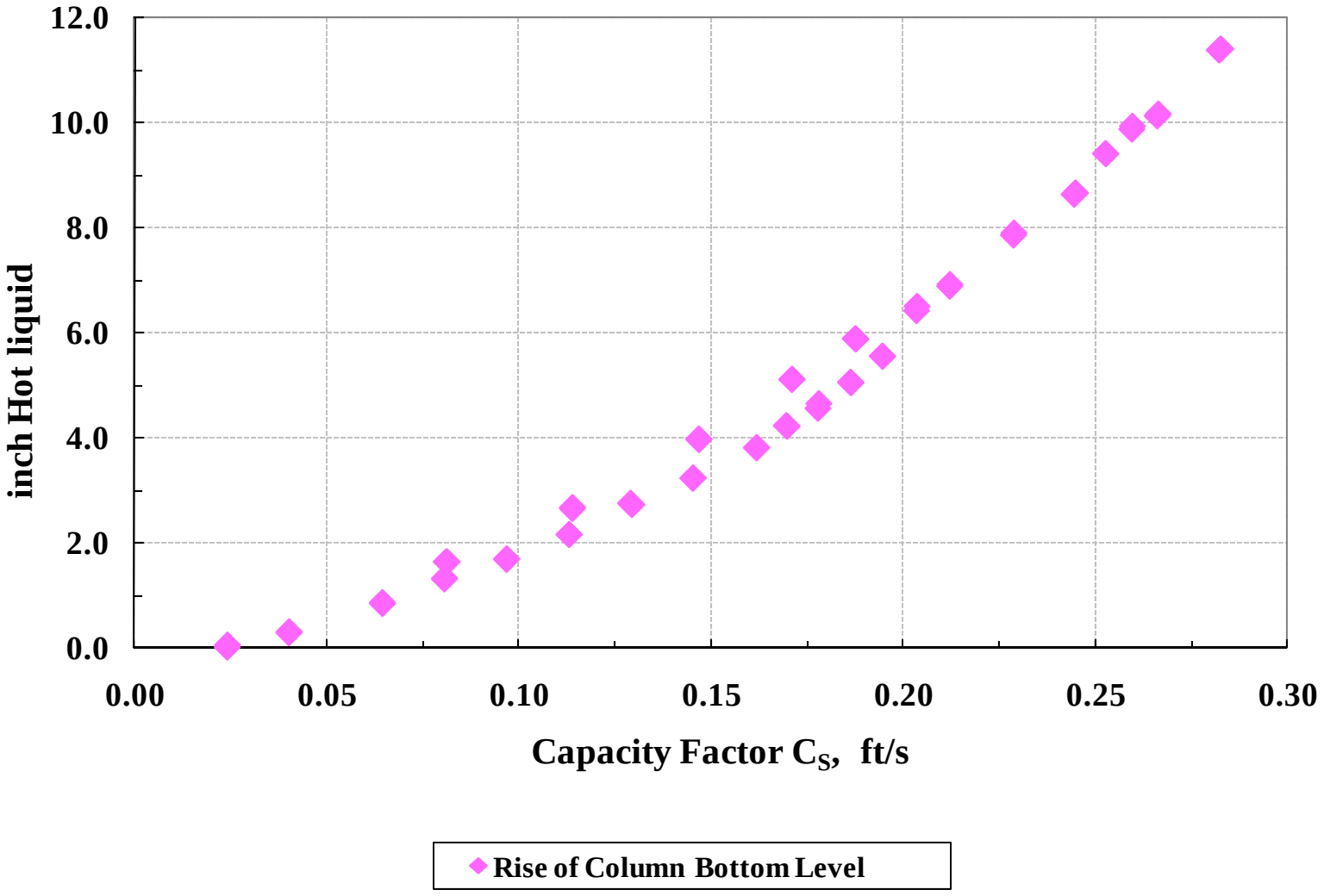


Rise of Column Bottom Liquid Level
iC_4/nC_4 165 psia (11.4 bar)



Rise of Column Bottom Liquid Level
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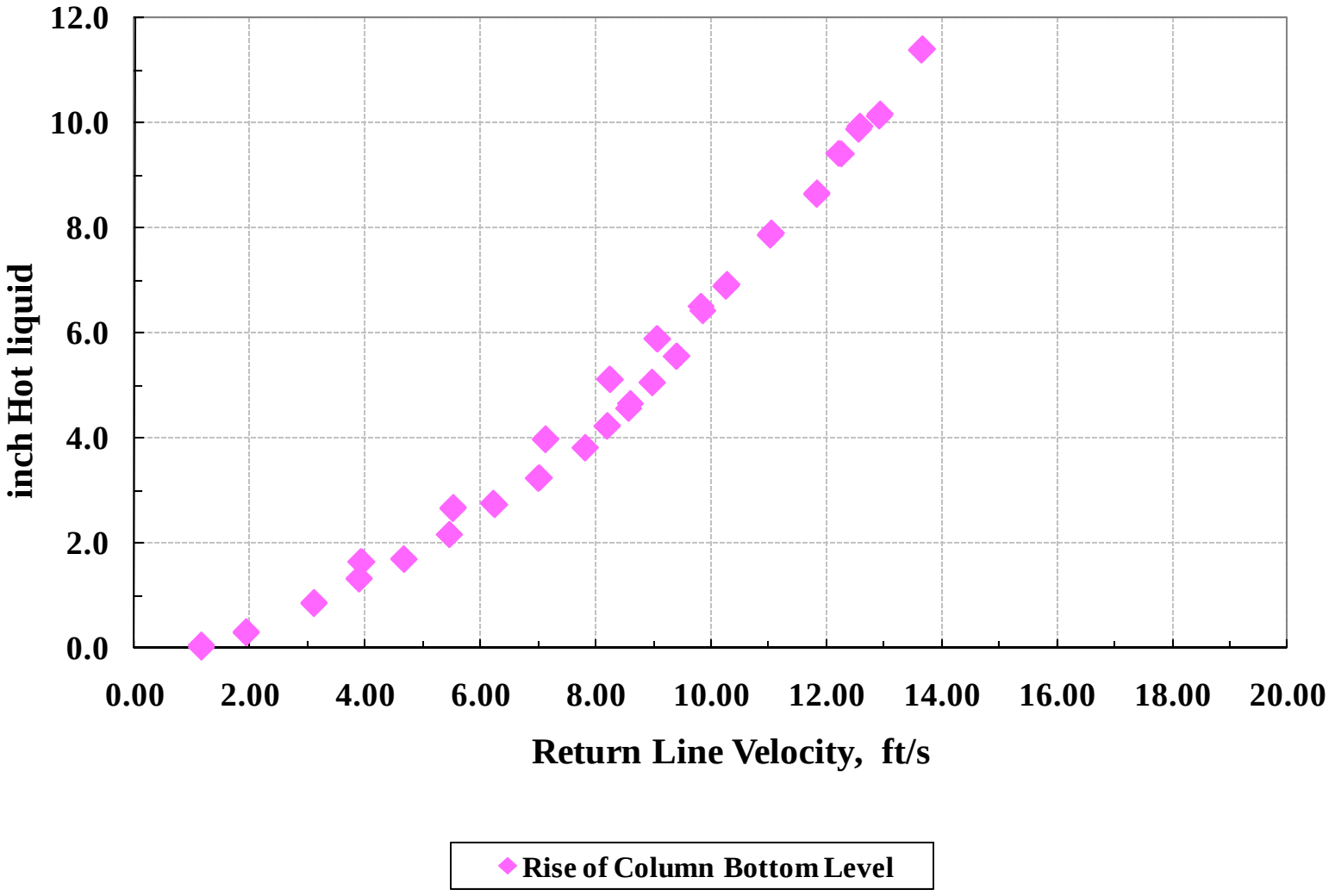
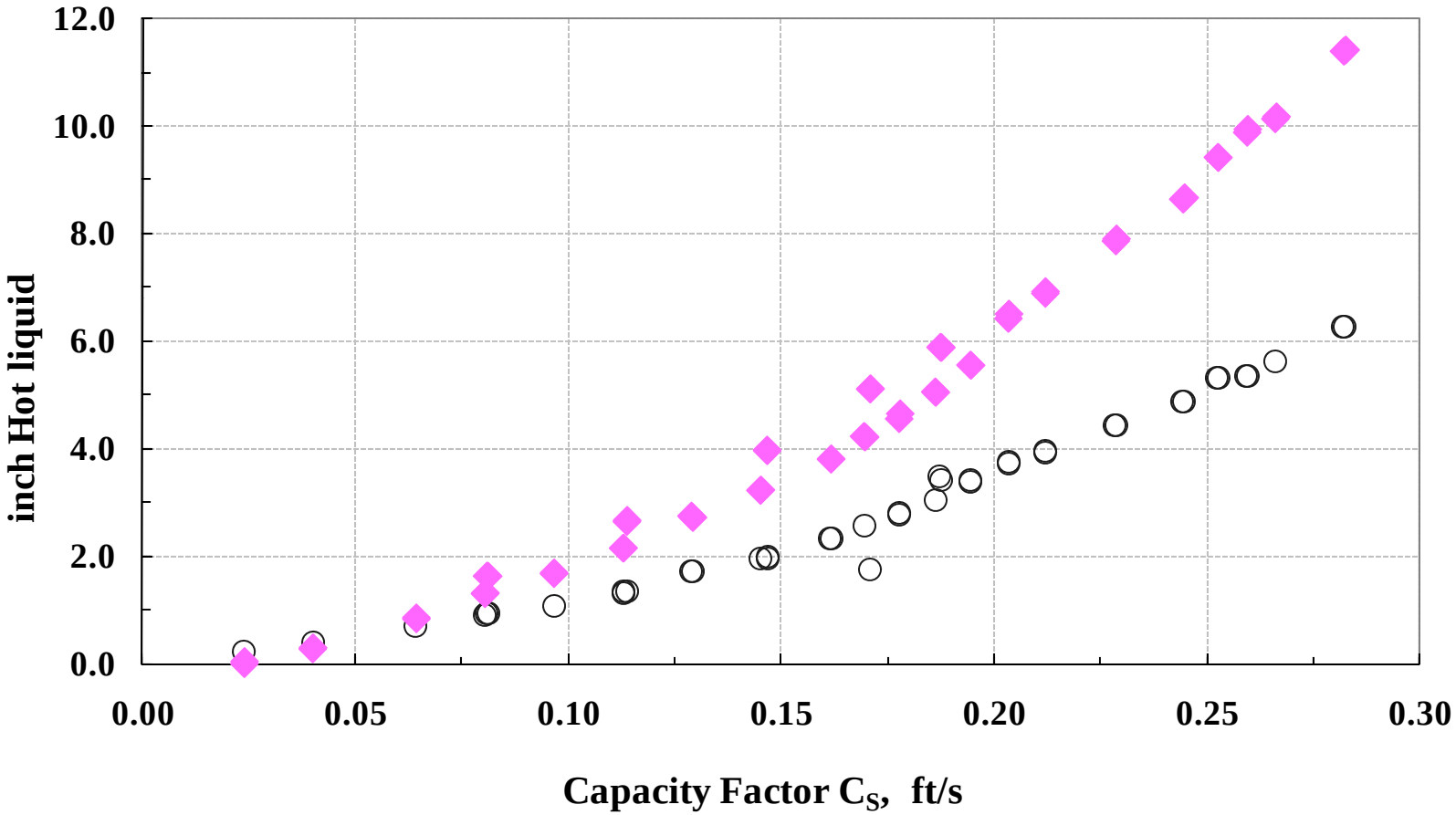


Rise of Liquid Level and Reboiler Pressure Drop
iC_4/nC_4 165 psia (11.4 bar)



Rise of Liquid Level and Reboiler Pressure Drop
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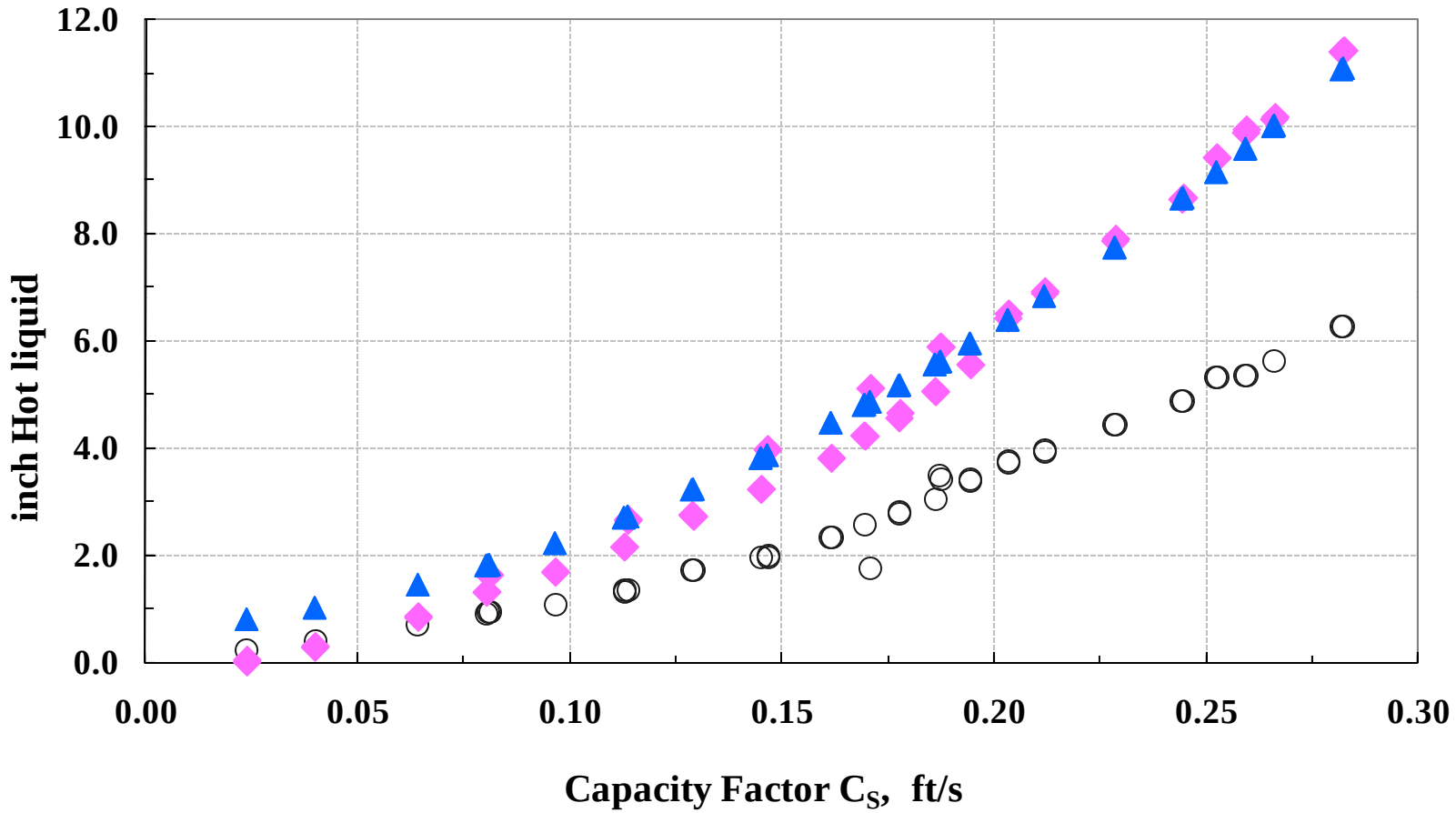
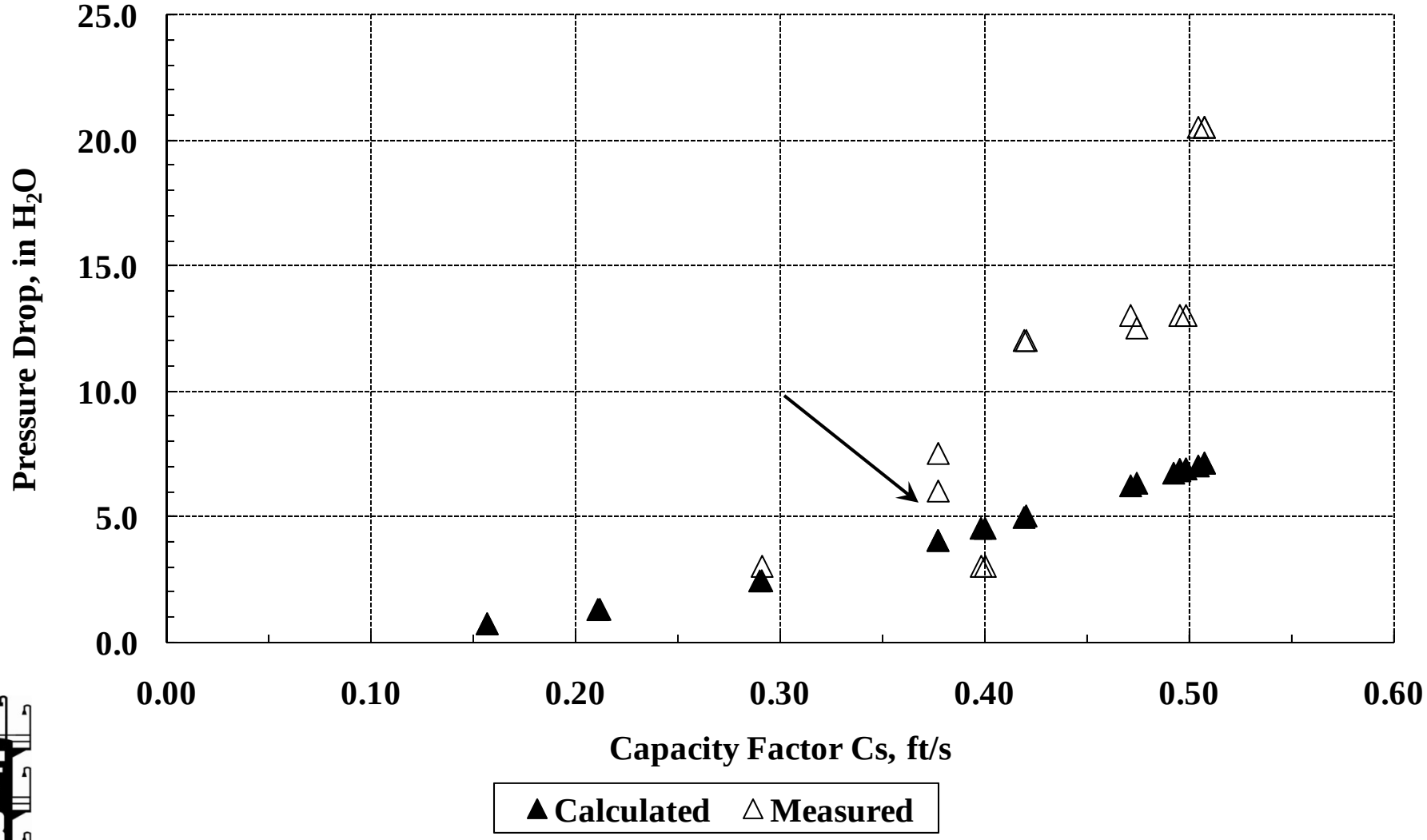
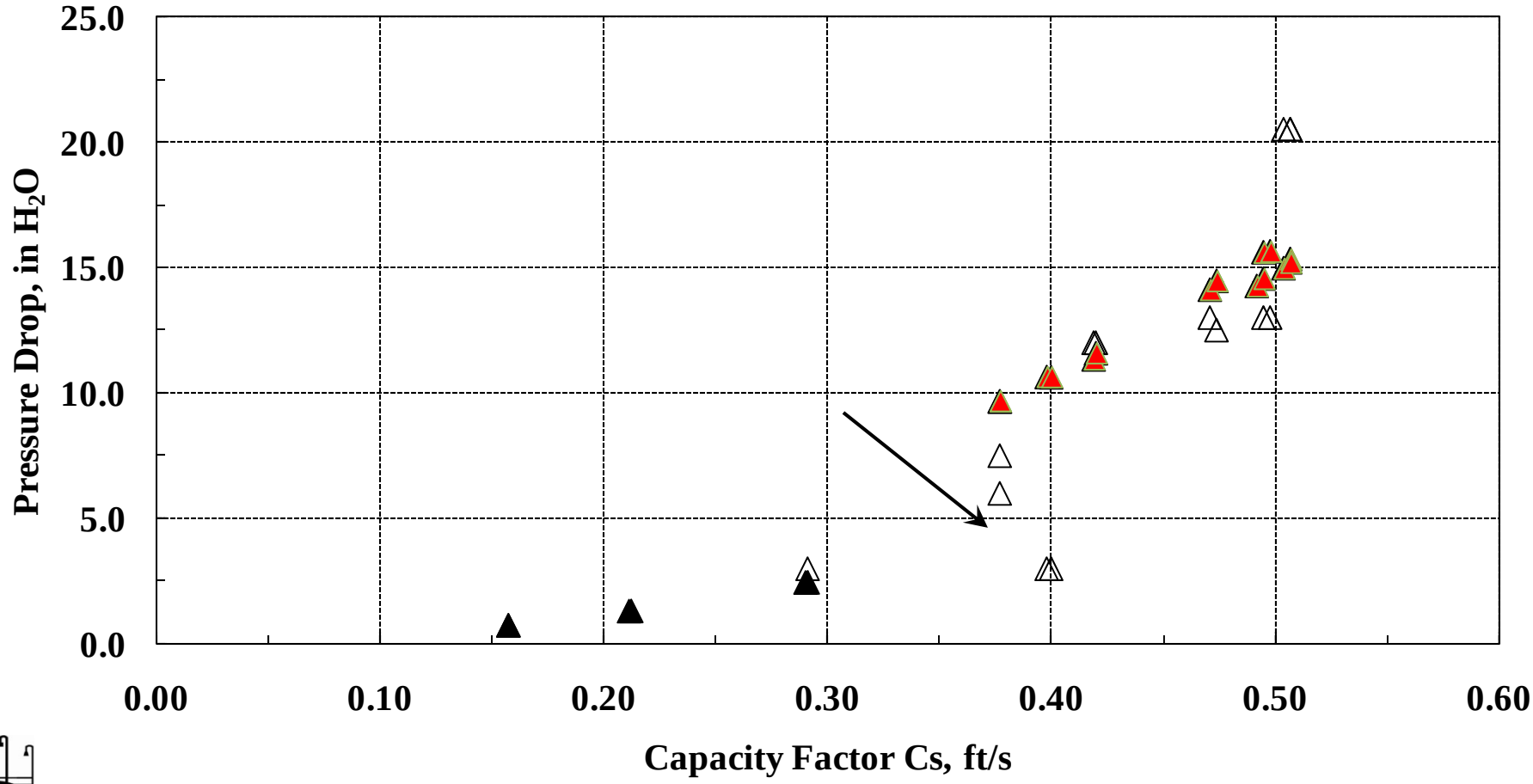


Reboiler Pressure Drop (Vapor Phase)
C_6/C_7 5 psia (1.65 bar)



Reboiler Pressure Drops (Vapor Phase)
C_6/C_7 5 psia (1.65 bar)



Conclusions

- Pressure drops across the reboiler circuit and liquid levels can be measured and monitored using differential pressure transmitters
- Measured pressure drops and liquid levels agree reasonably well with the calculated/estimated values
- Pressure drop of liquid phase can be significant portion of total pressure drops, which needs to be considered and included in the reboiler circuit designs

Acknowledgements

- Authors would like to extend their great appreciations to:
  - FRI memberships for their continuous support to FRI research programs
  - Professor Michael Schultes for his excellent work and guidance to FRI research program as FRI Technical Committee member
  - Professor Olujic and Mr. Urbanski for their great work on this session

Q&A