



Texas Commission on Environmental Quality 2010 Flare Study Update

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Multi-Media Forum
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Overview

- Objectives
- 2010 TCEQ Flare Study Conclusions
- Flare Study Information
- Particulate Matter Results
- Training



Flare Study Objectives

- Assess the impact of high turndown (low flow) rate of vent gas on flare destruction and removal efficiency (DRE) and combustion efficiency (CE)
- Assess if flares operating within 40 Code of Federal Regulations (CFR) §60.18 achieve the assumed hydrocarbon DRE of at least 98% at high turndown, varying assist ratios, and vent gas heat content
- Identify and quantify the hydrocarbon species in flare plumes



2010 TCEQ Flare Study

Key Conclusions

- The flares tested were able to achieve greater than 98% destruction and removal efficiency (DRE) and combustion efficiency (CE) for vent gas streams with low heating value and under low flow rate conditions.
- The most efficient operation, as measured by the DRE and CE, was achieved at or near the incipient smoke point.



*Photo: Air-Assisted Flare
Measured at 99.4% Efficiency*



2010 TCEQ Flare Study

Key Conclusions

A flare can be operated according to 40 Code of Federal Regulations (CFR) §60.18 criteria and not achieve 98% DRE.

Flares were easily over-assisted.



Flare DRE 99.2% at steam-to-vent gas (SVG) ratio of 0.29.



As the SVG almost doubles to 0.54, the flare DRE decreases to 90.6%. Note the flame is disappearing.



As the SVG almost doubles again to 1.05, the flare DRE drops to 27%. Note the flame has disappeared.



2010 TCEQ Flare Study

Key Conclusions

- There is a narrow operating range of assist-to-vent gas ratios for an assisted flare to burn low heating value vent gas at or above 98% DRE.
- Particulate matter data analysis indicates that fine particulate matter (less than 2.5 microns in diameter) emissions increase at high DRE.
- All steam is not equal.
 - Center steam can reduce DRE under certain conditions.

Test Point S3.1

Vent Gas	Btu/scf	Upper Steam	Center Steam	DRE (%)
937 lb/hr	350 Btu	540 lb/hr	430 lb/hr	46.6

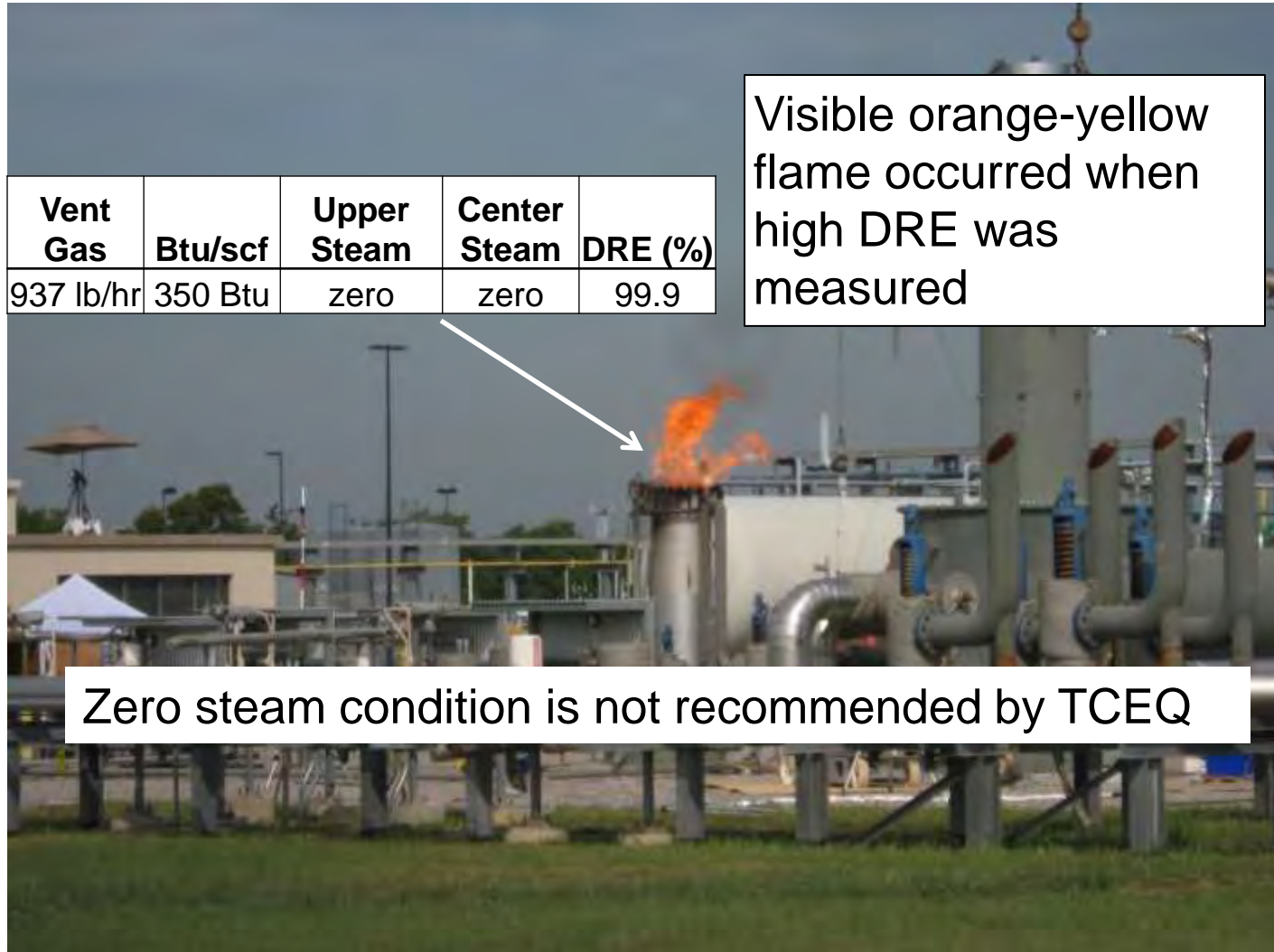
At minimum recommend steam

“Transparent” flame occurred when low DRE was measured

Test Point S3.6

Vent Gas	Btu/scf	Upper Steam	Center Steam	DRE (%)
937 lb/hr	350 Btu	zero	zero	99.9

Visible orange-yellow flame occurred when high DRE was measured

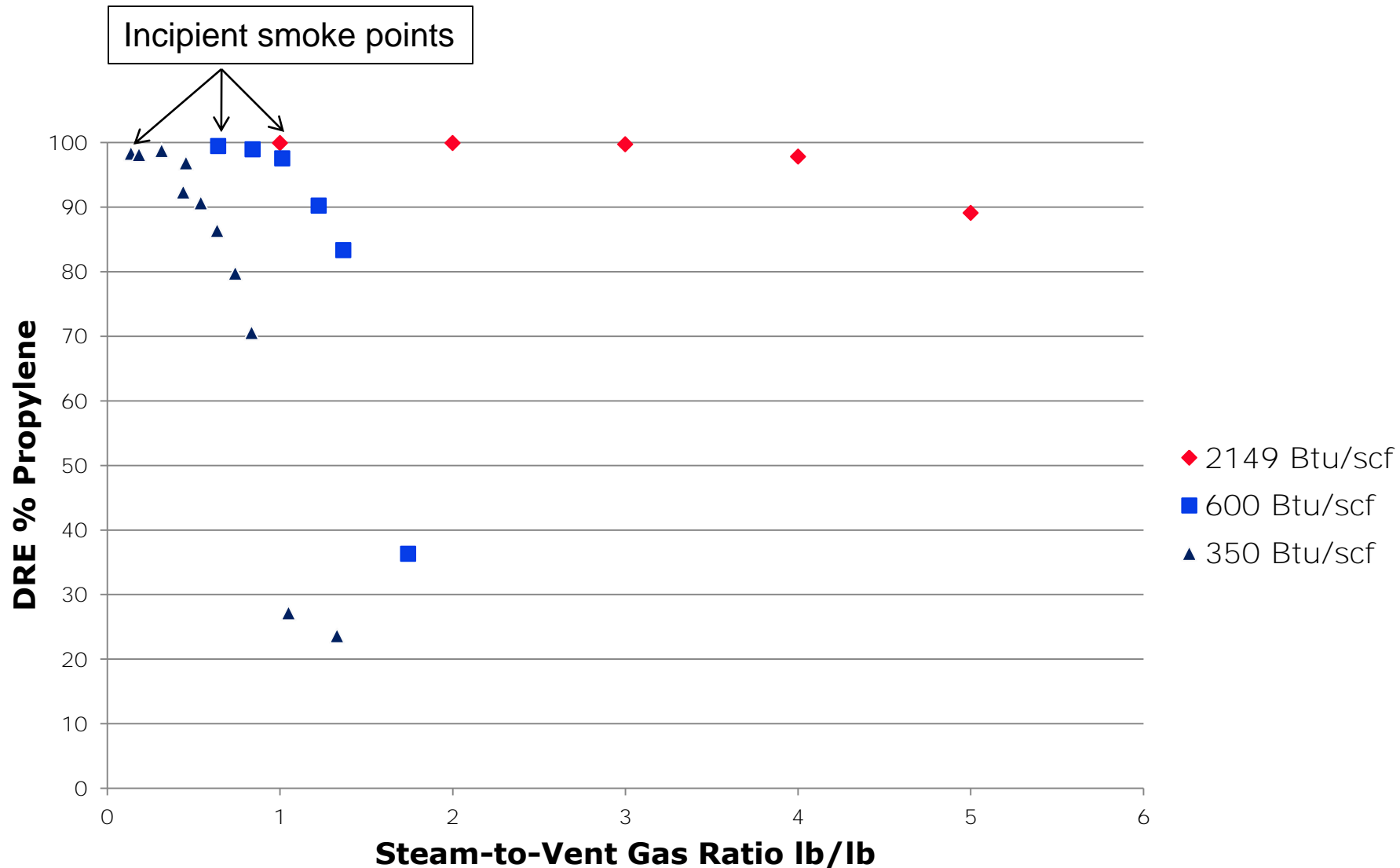


Zero steam condition is not recommended by TCEQ



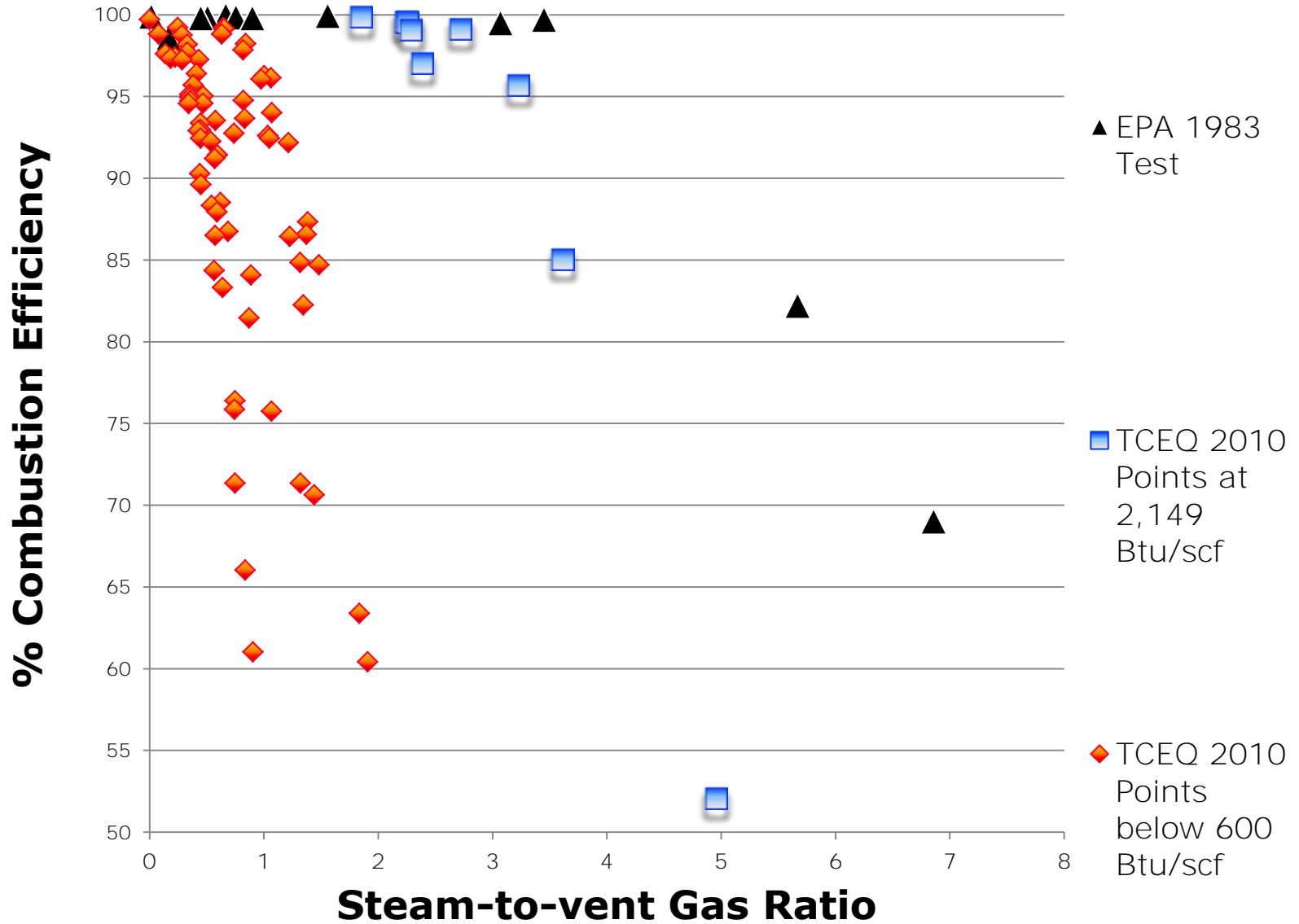
Steam-Assisted Flare DRE

Constant Vent Gas Flow Rate of 2,342 lb/hr



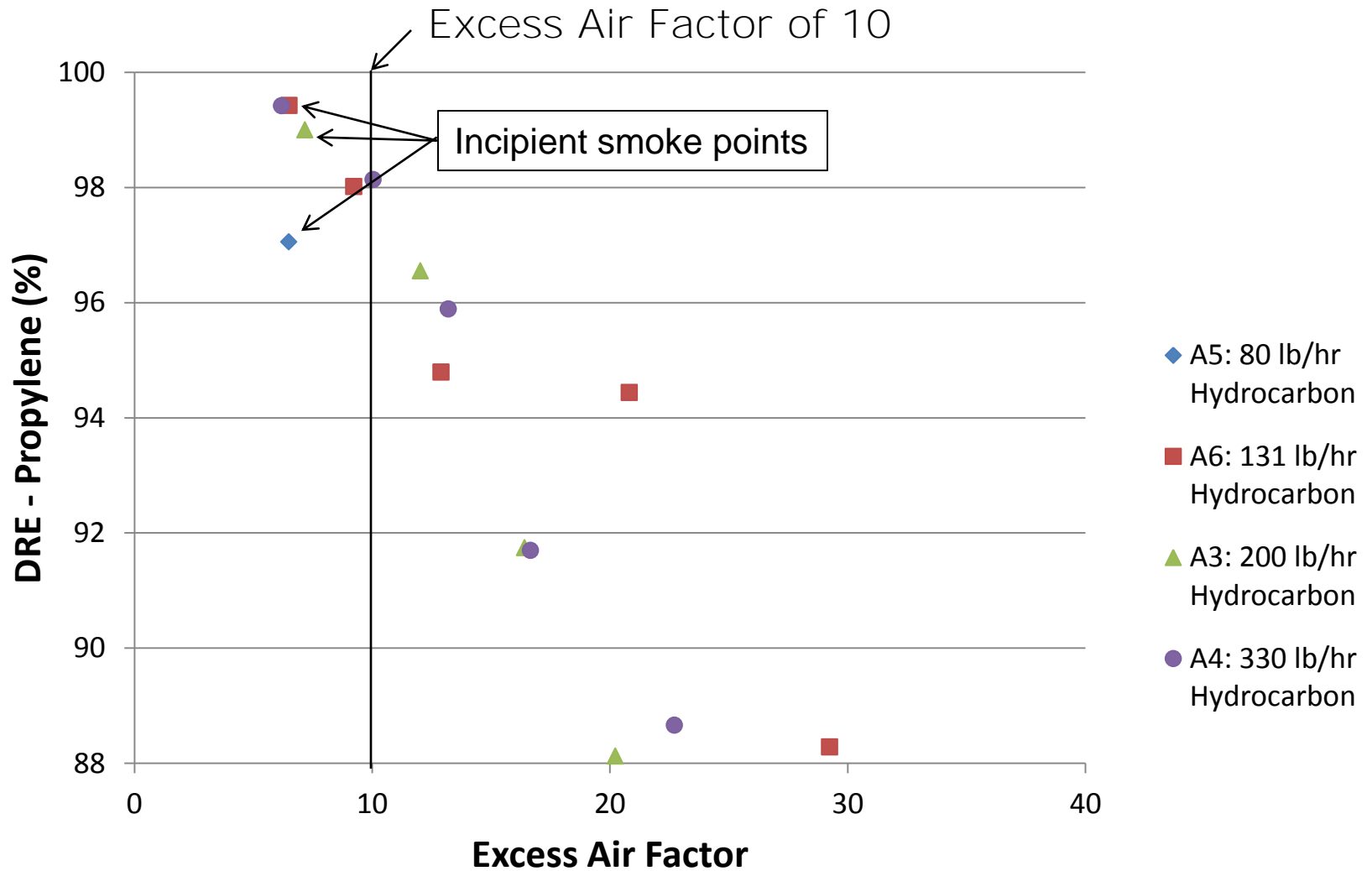


TCEQ 2010 and EPA 1983 Steam-Assisted Flare Test Data





Air-Assisted Flare DRE Versus Excess Air





Flare Particulate Emissions (PM)

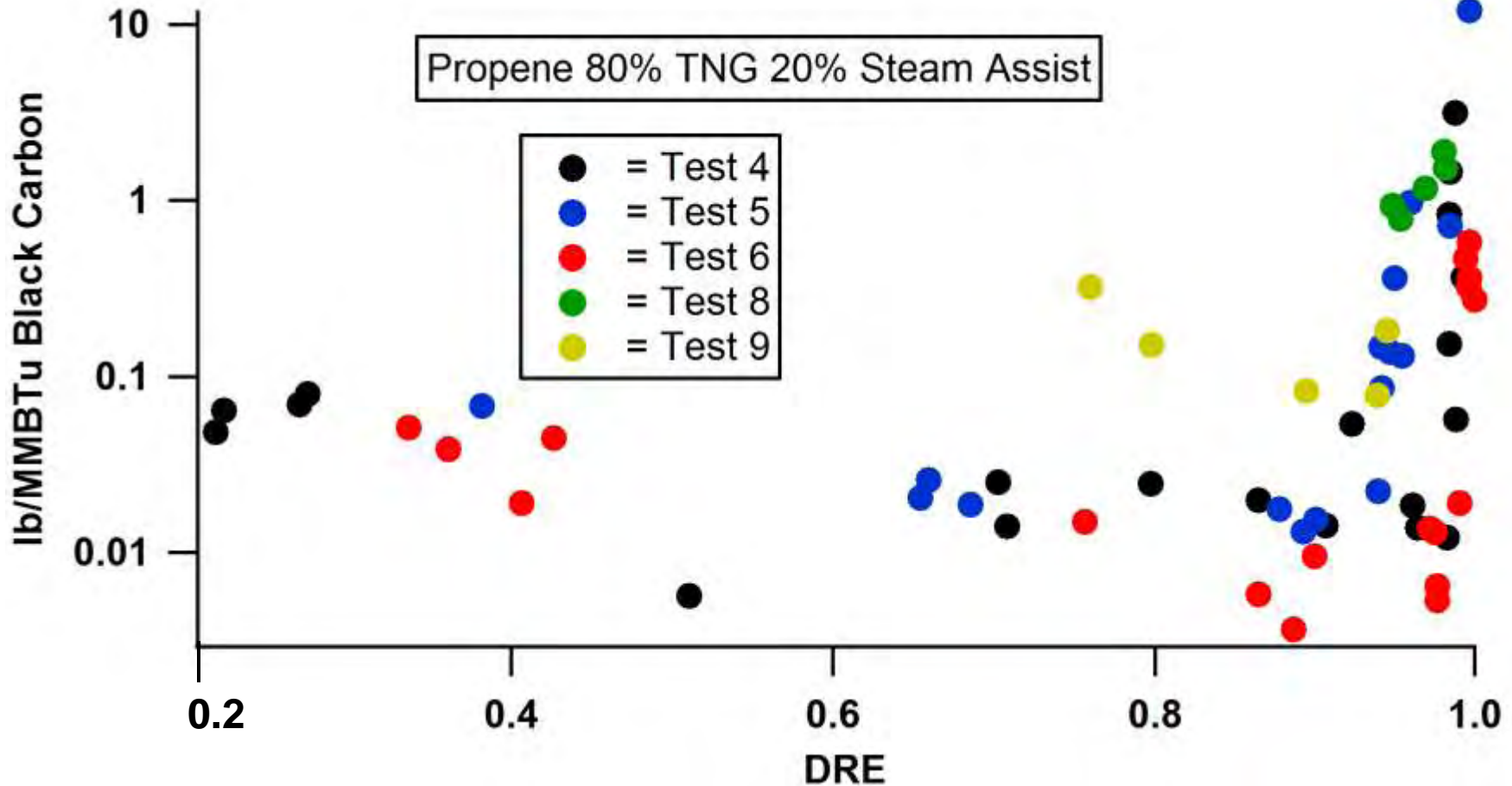
- PM emissions are fine particulate less than 2.5 microns.
- **At high DRE, PM emissions are $\geq 95\%$ carbon (black carbon).**
- PM emissions increase as propylene DRE increases above 95%.

Substantial increase in PM from 98% to 99% DRE when flaring propylene

- Propane did not produce PM emissions above background levels.
- The steam-assisted flare had lower PM emissions than the air-assisted flare under similar conditions.



Steam-Assisted Flare Particulate Emissions



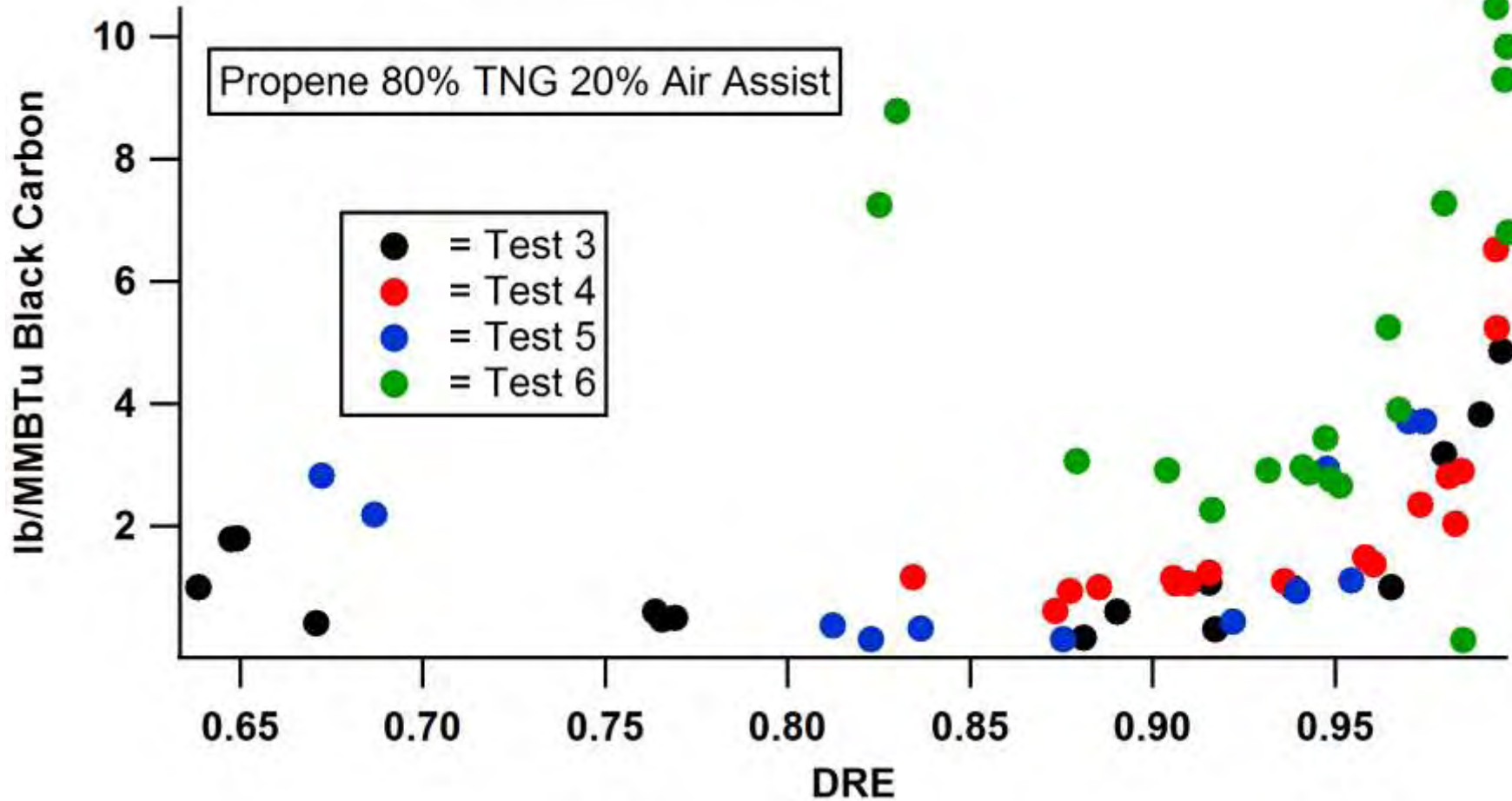
TNG- Tulsa natural gas

DRE- destruction and removal efficiency

Ib/MMBTu – pounds per million British thermal units



Air-Assisted Flare Particulate Emissions



TNG- Tulsa natural gas

DRE- destruction and removal efficiency

Ib/MMBTu – pounds per million British thermal units



Flare Training

- TCEQ is developing a cooperative flare training program with stakeholders including industry groups and flare manufacturers.
- TCEQ has entered into an agreement with the University of Texas at Austin to develop flare training.
- Training concepts are currently under development and will be discussed with stakeholders.



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- Study results are posted at:
 - TCEQ's Flare Task Force Stakeholder Group Web site
http://www.tceq.texas.gov/airquality/stationary-rules/flare_stakeholder.html
 - Sign up for e-mail updates through TCEQ's GovDelivery listserver. Select "*SIP Hot Topics*" under the "*Air Quality*" heading to receive Flare Task Force updates.