Orifice Meters and Wet Gas Flow

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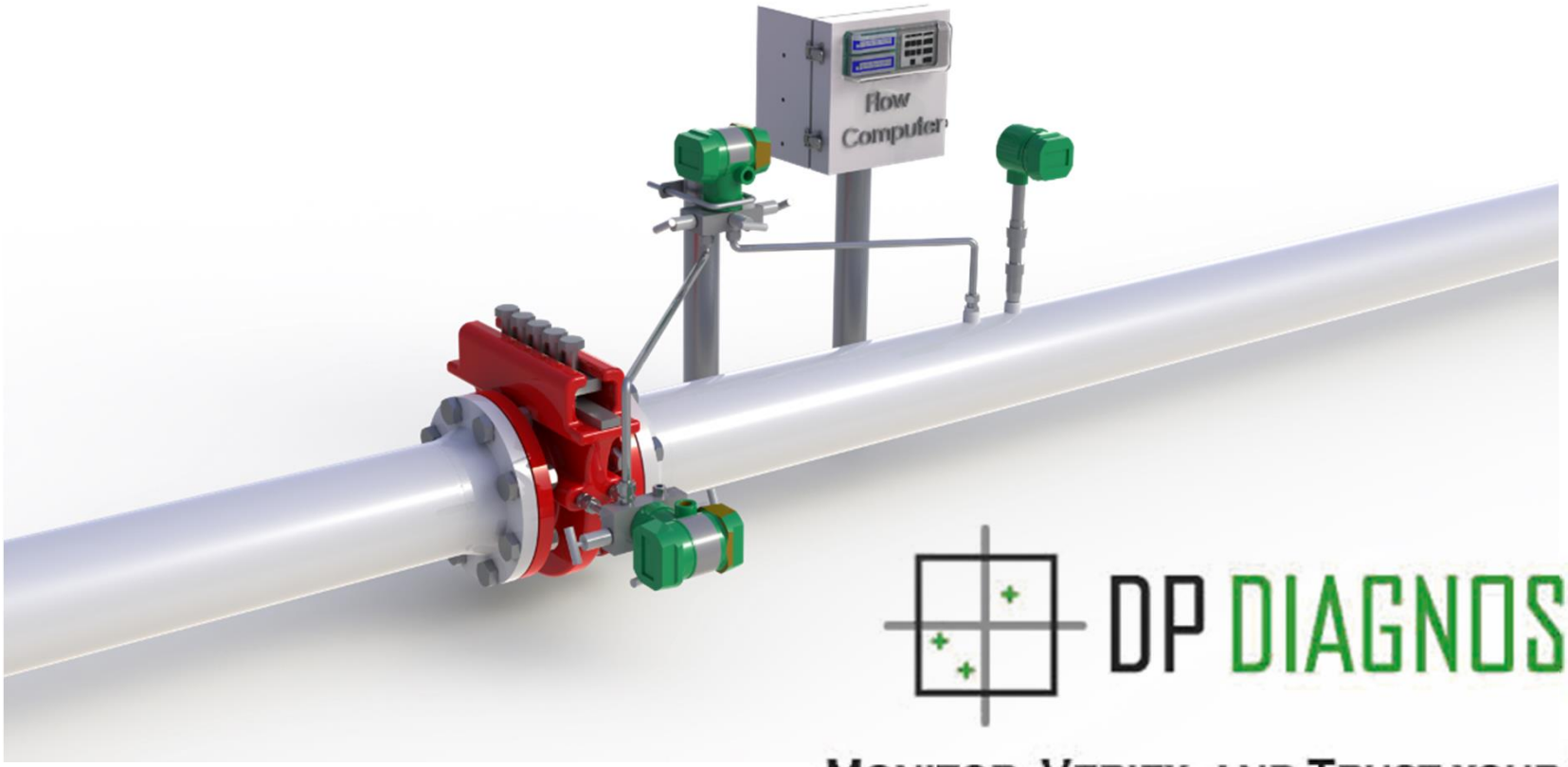
Richard Steven, DP Diagnostics



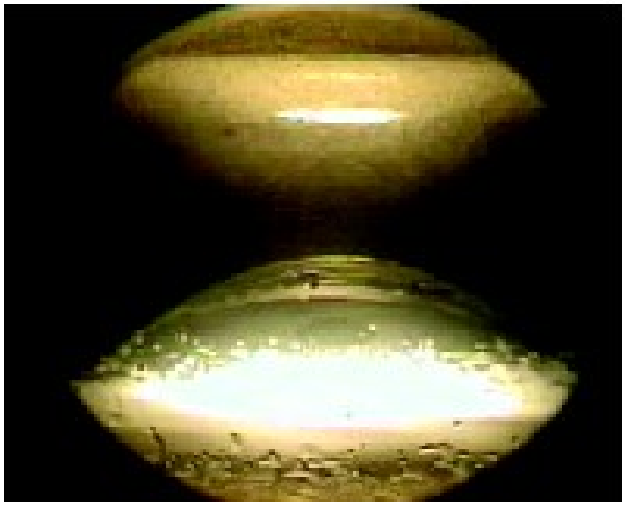
DP DIAGNOSTICS

MONITOR, VERIFY, AND TRUST YOUR DP METER

Introduction

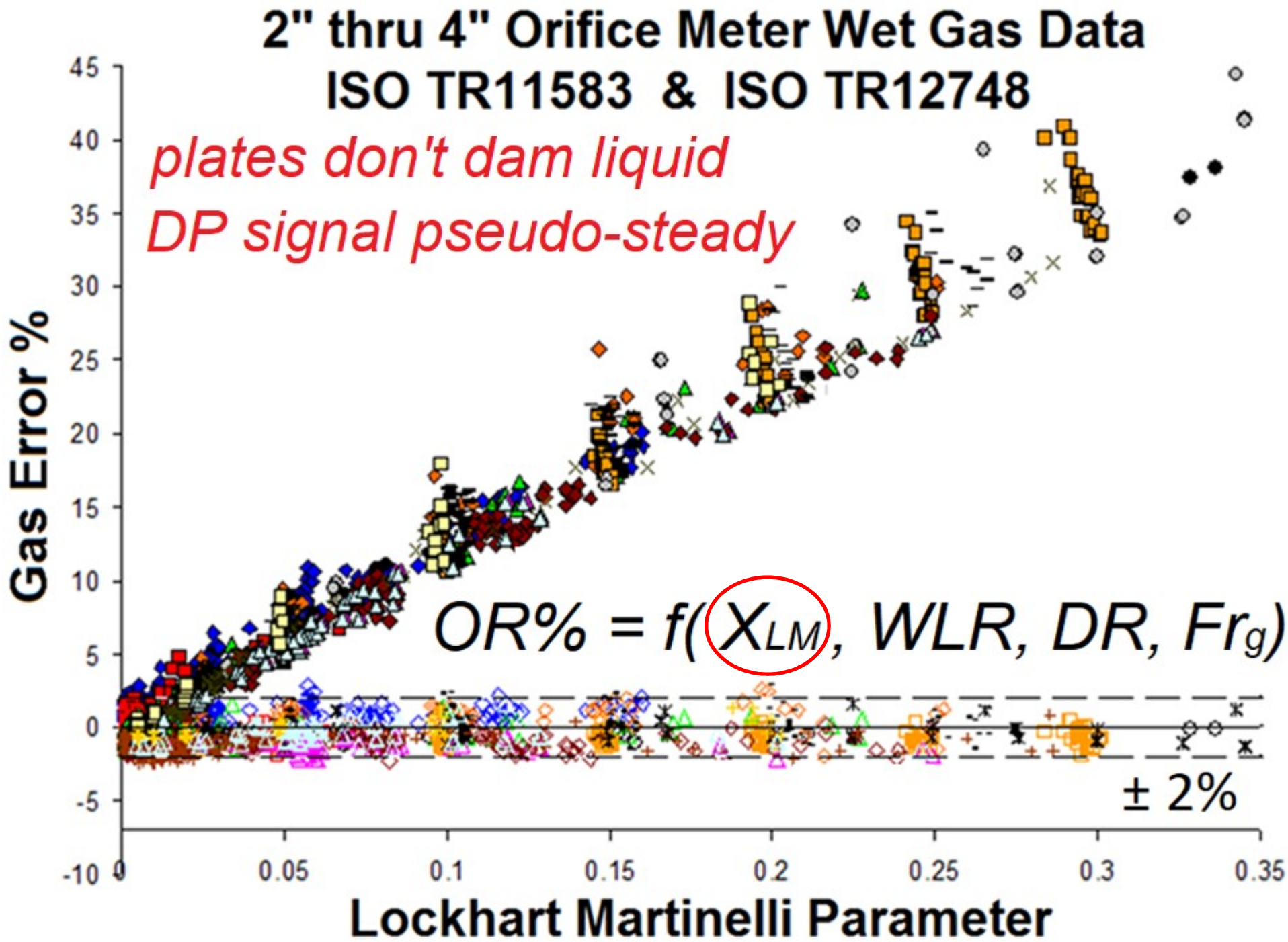
- Much wet gas metering is done with ***gas*** meters.
- Wet gas is an extremely adverse flow condition for ***all*** gas meter designs.
- In this presentation we will discuss:
  - select gas meter reactions to wet gas,
  - recap on the *counter-intuitive*, *relatively* good orifice meter performance (as stated by ISO), &
  - a 'wet gas orifice meter' design.

Wet Gas Terminology

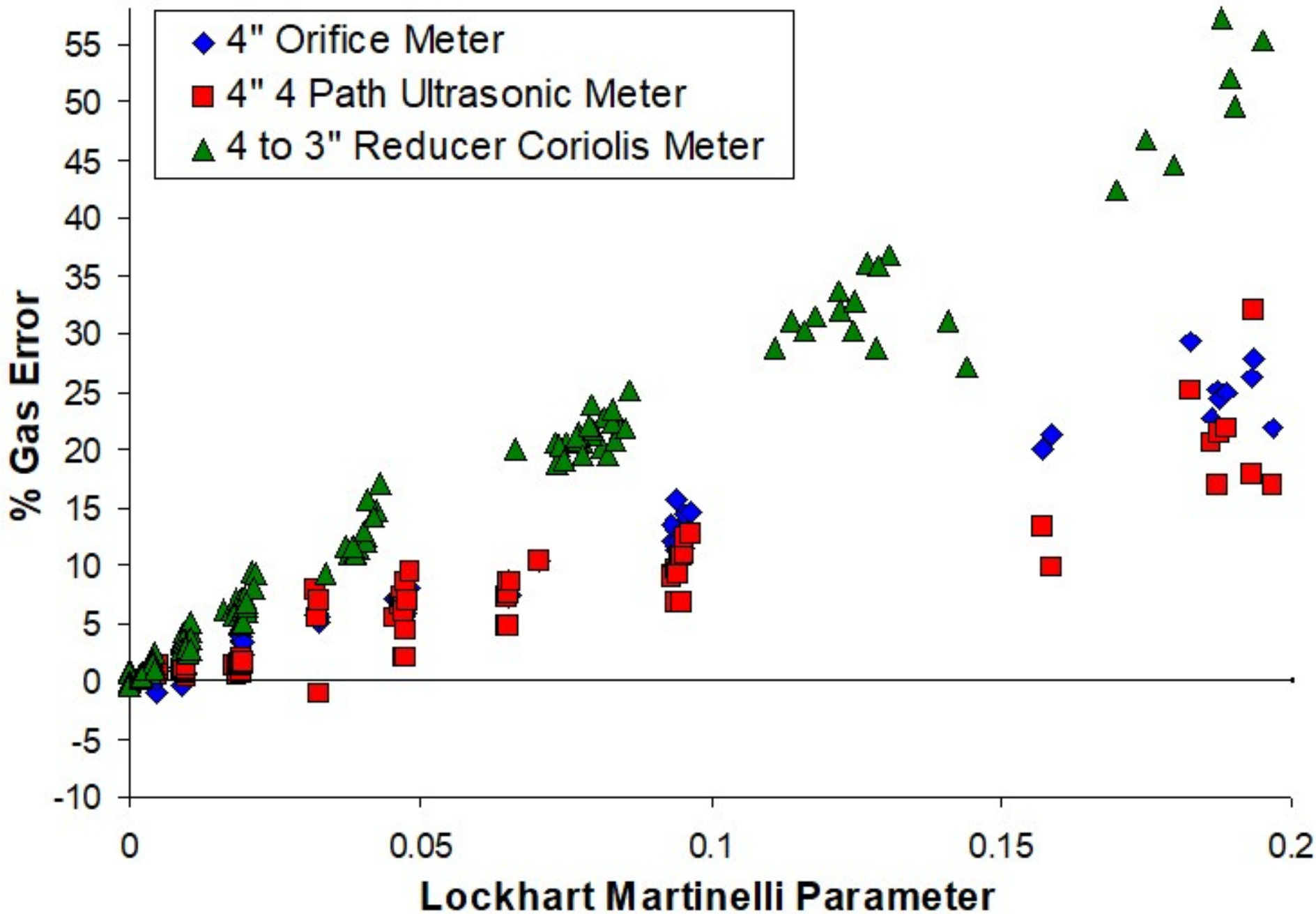


Flow conditions dictate the flow pattern and hence the orifice meter *OR%*, i.e.:

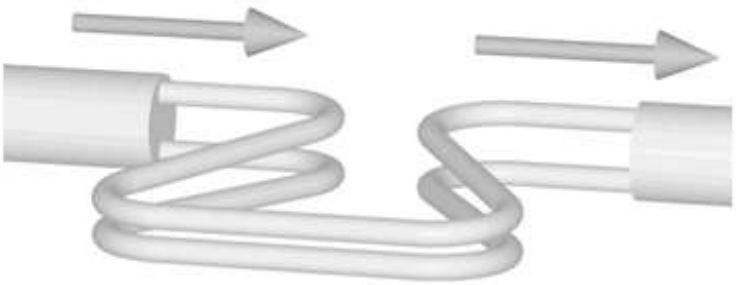
$$OR\% = f\,(X_{LM},\ WLR,\ DR,\ Fr_g)$$

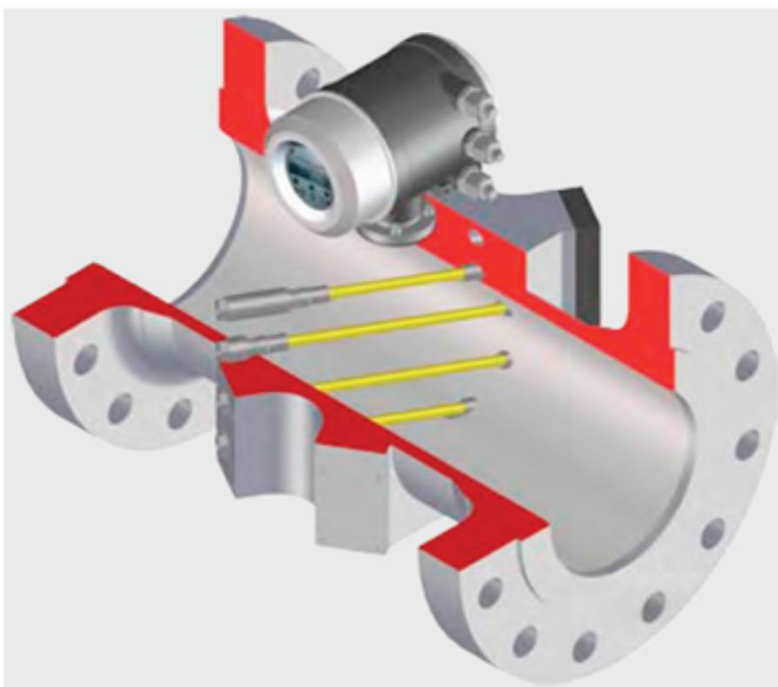

2" thru 4" Orifice Meter Wet Gas Data
ISO TR11583 & ISO TR12748
plates don't dam liquid
DP signal pseudo-steady
OR% = f(XLM, WLR, DR, Frg)
± 2%
Gas Error %
Lockhart Martinelli Parameter
45
40
35
30
25
20
15
10
5
0
-5
-10
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35

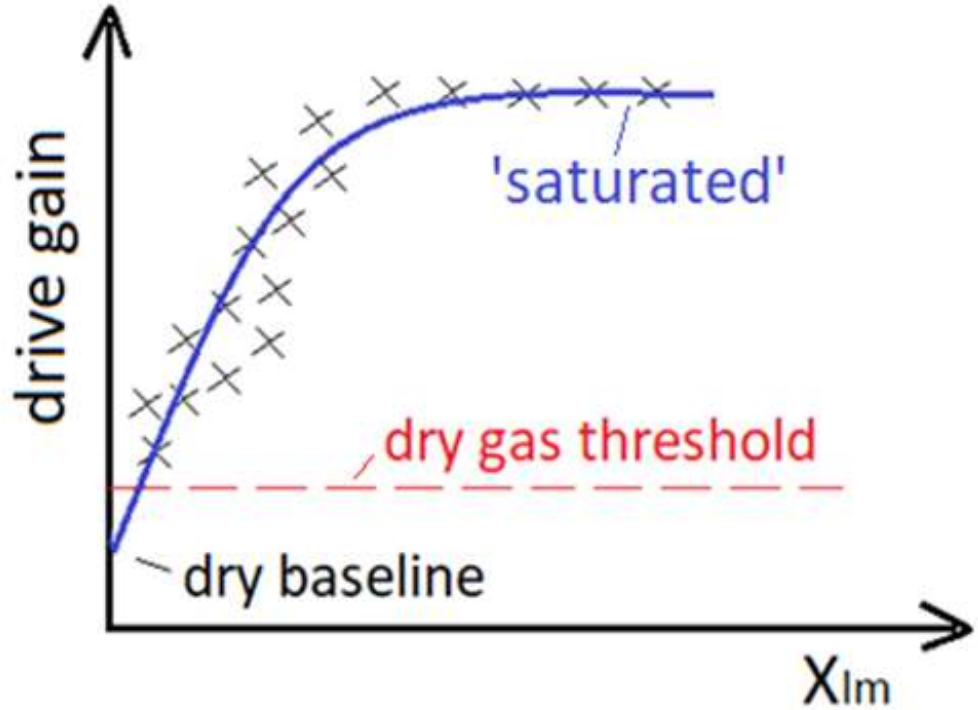

Flow
Computer

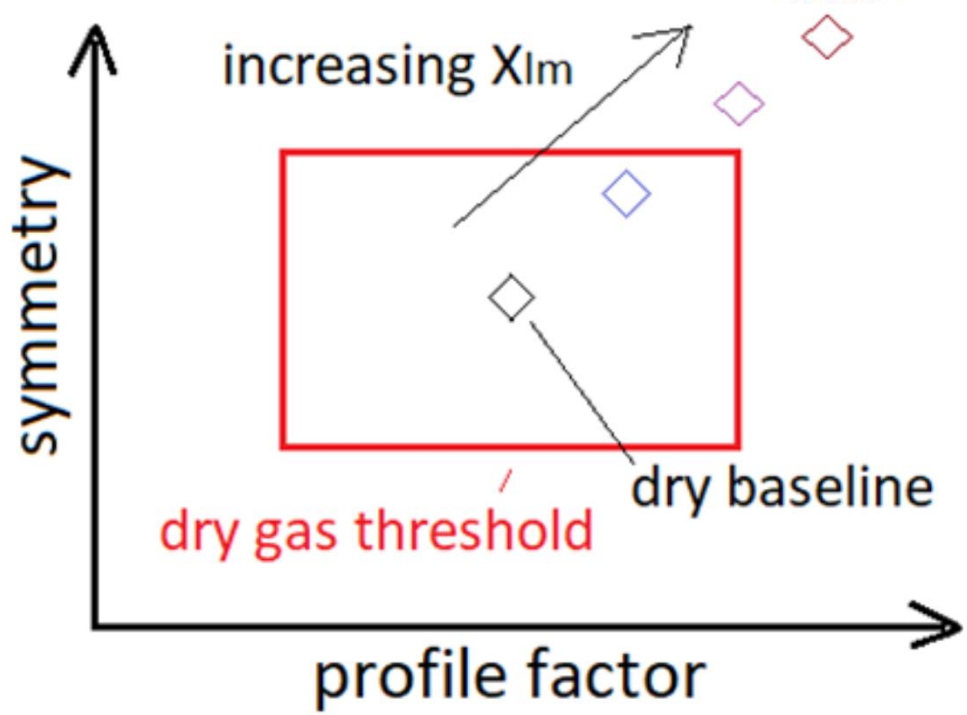

4" Orifice Meter
4" 4 Path Ultrasonic Meter
4 to 3" Reducer Coriolis Meter
% Gas Error
55
50
45
40
35
30
25
20
15
10
5
0
-5
-10
0
0.05
0.1
0.15
0.2
Lockhart Martinelli Parameter

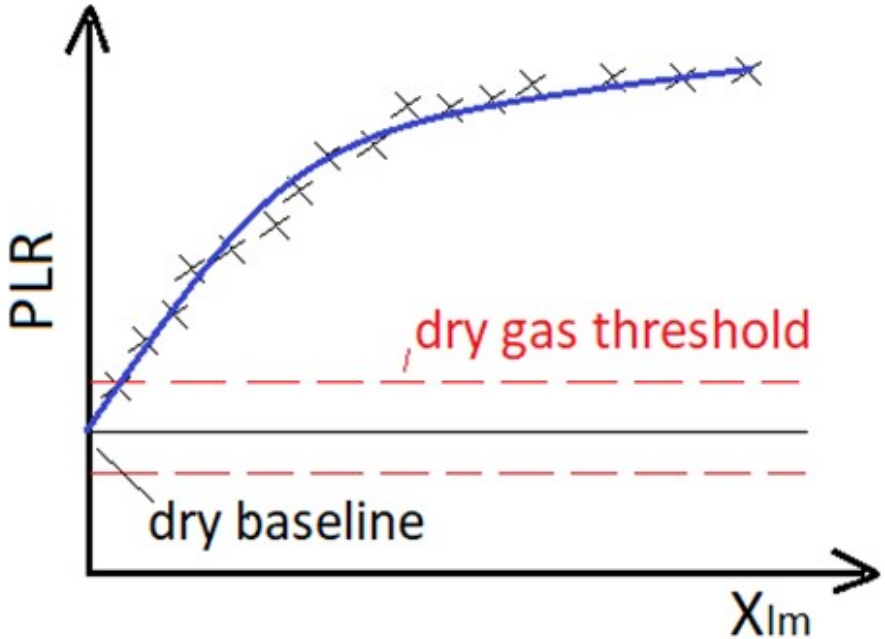
Coriolis Meters



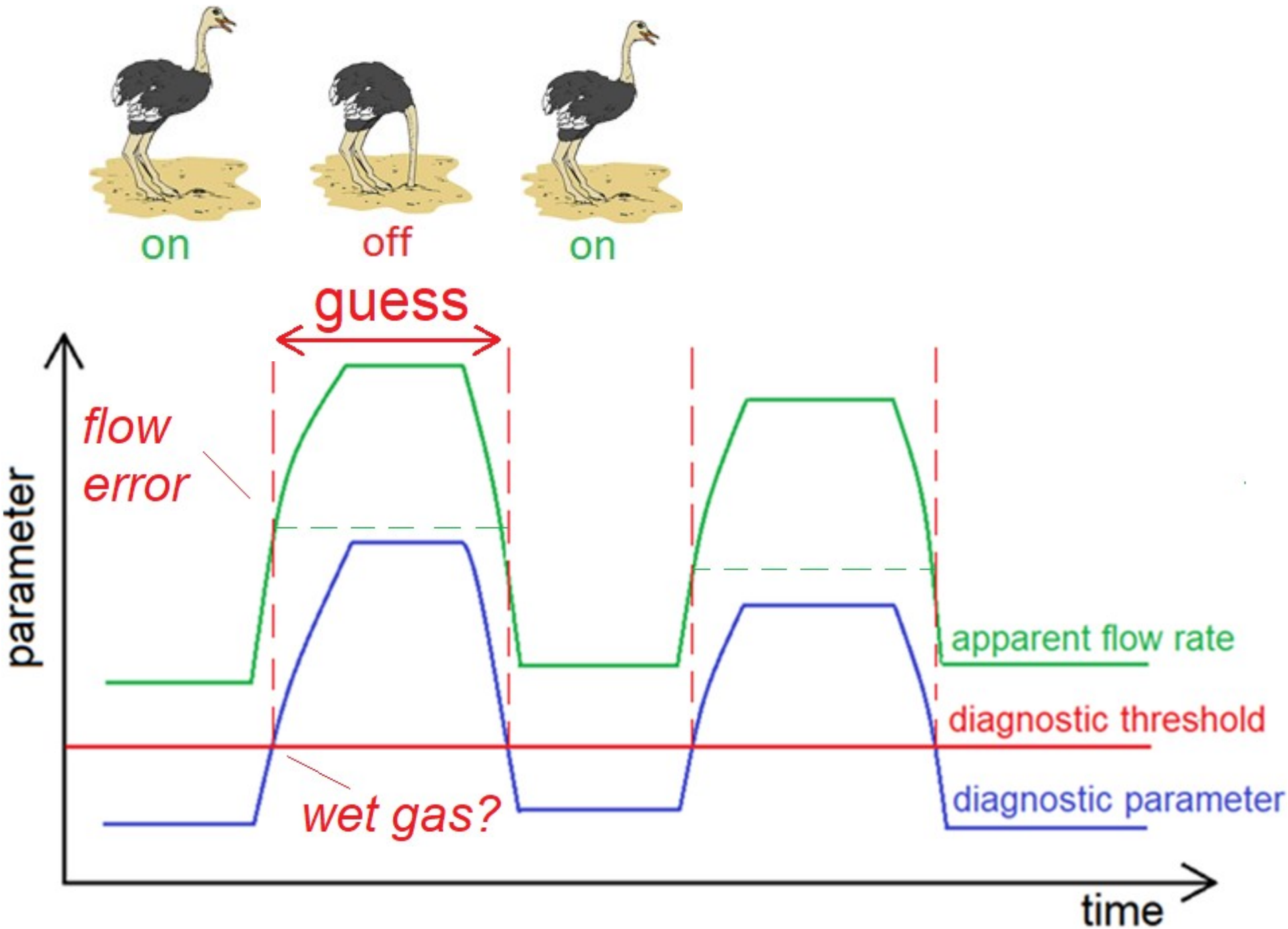


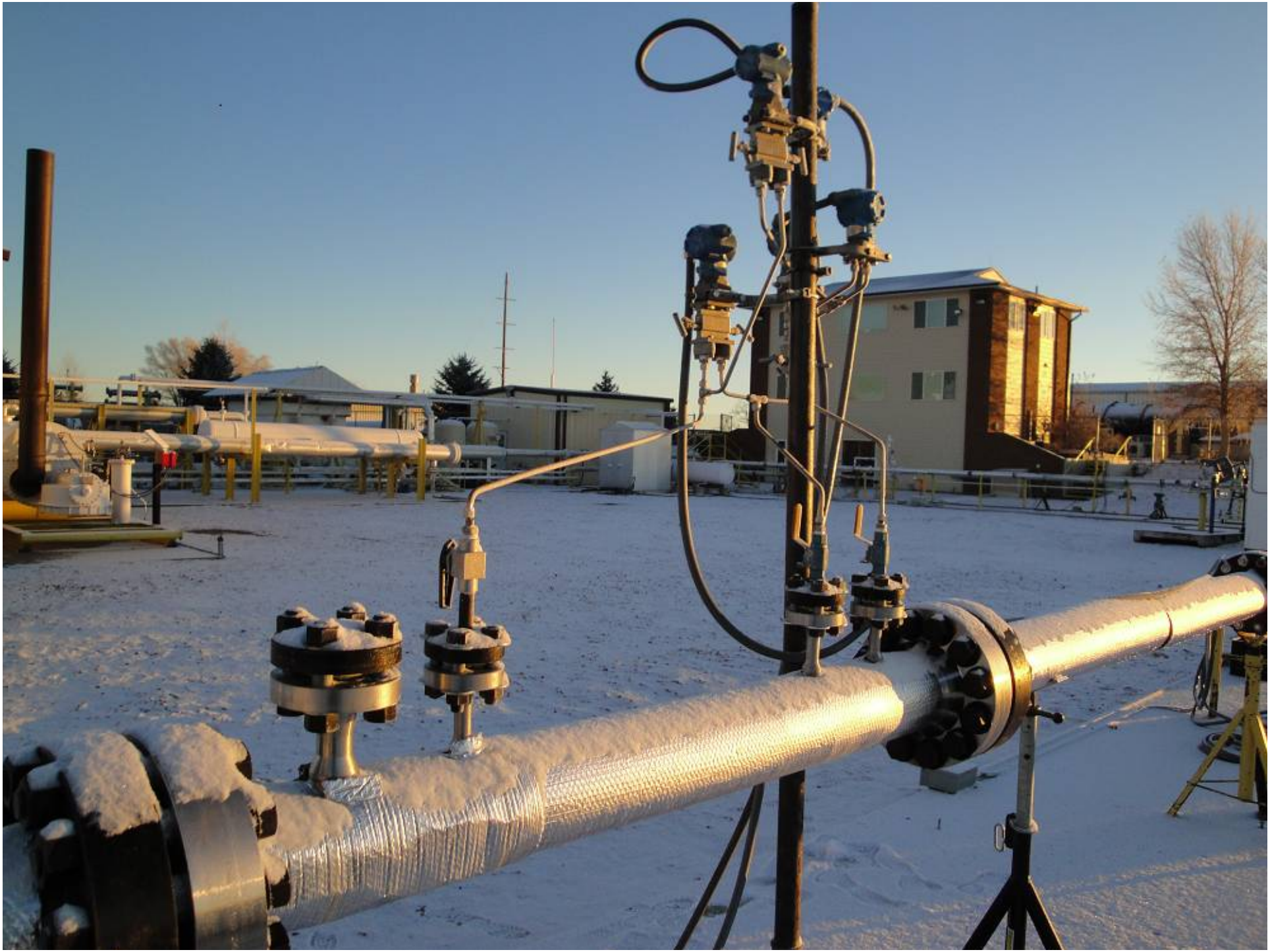


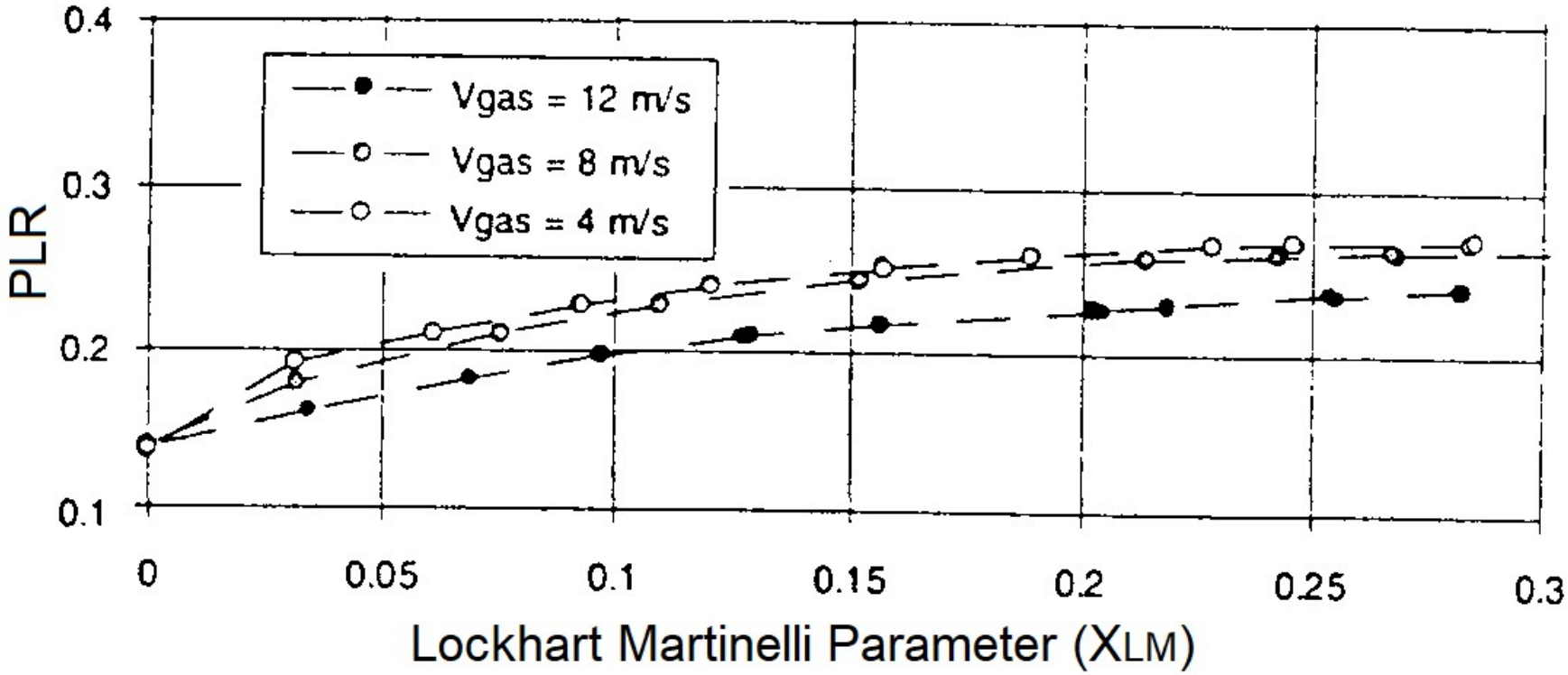




- Coriolis, ultrasonic, and DP meters all have diagnostic suites that can ‘indicate wet gas’.
- ***But…*** a gas meter diagnostic suite does not a wet gas meter make…..


on
off
on
guess
flow
error
parameter
apparent flow rate
diagnostic threshold
diagnostic parameter
wet gas?
time





"The potential for the PLR is to use it to determine the liquid content of the flow, from which the OR% can be determined. In essence this could form a simple two phase meter".

R. de Leeuw, October 1997

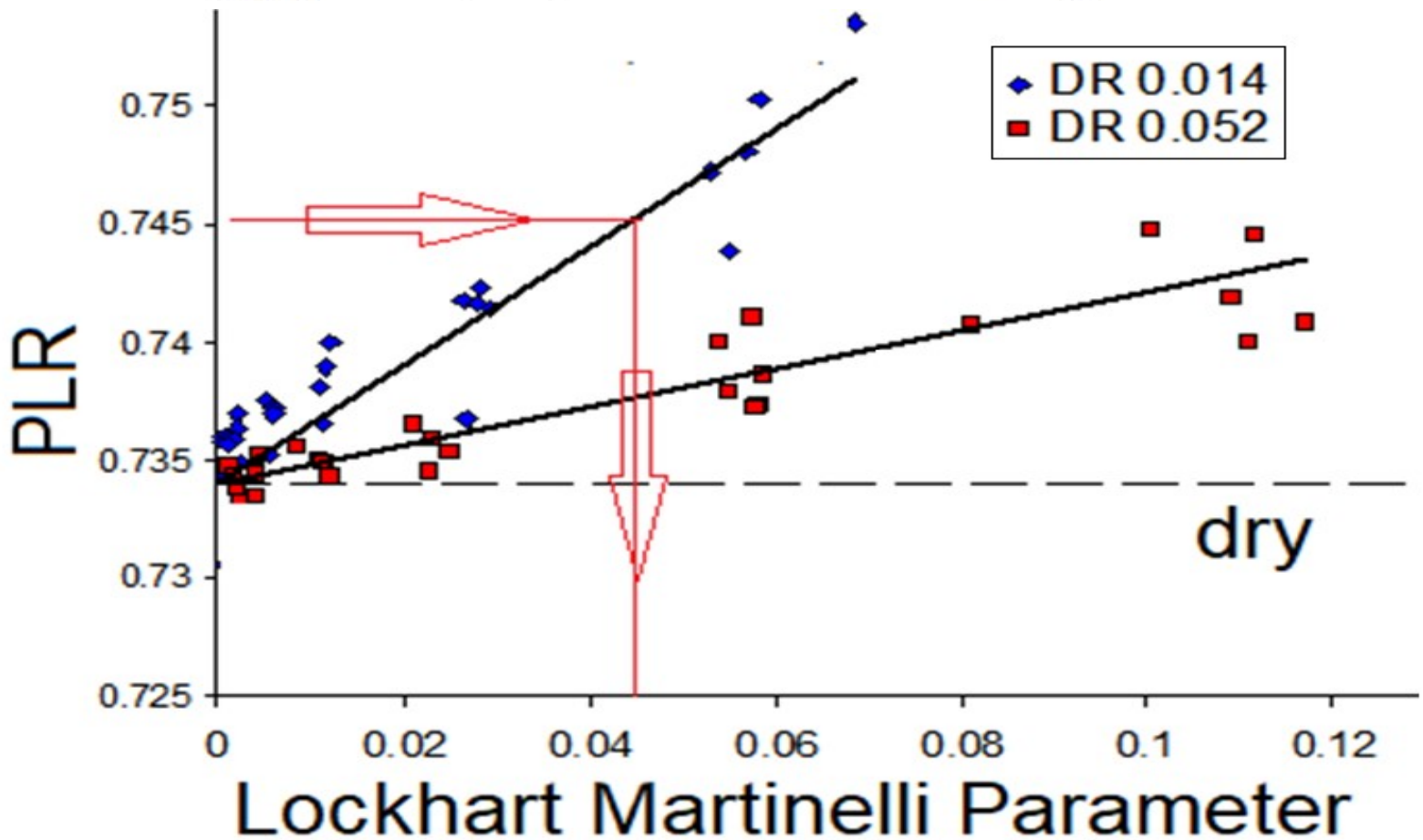
DP Meters & $X_{LM} = f(PLR)$

- This method *is generic* to the DP meter group of meters.
- In 1999-2002 a CEESI run JIP wet gas flow tested orifice meters where *PLR vs.* X_{LM} data was noted.
- ISO TR 11583 (2012) shows a detailed $X_{LM} = f(PLR)$ data fit based on the CEESI JIP data…

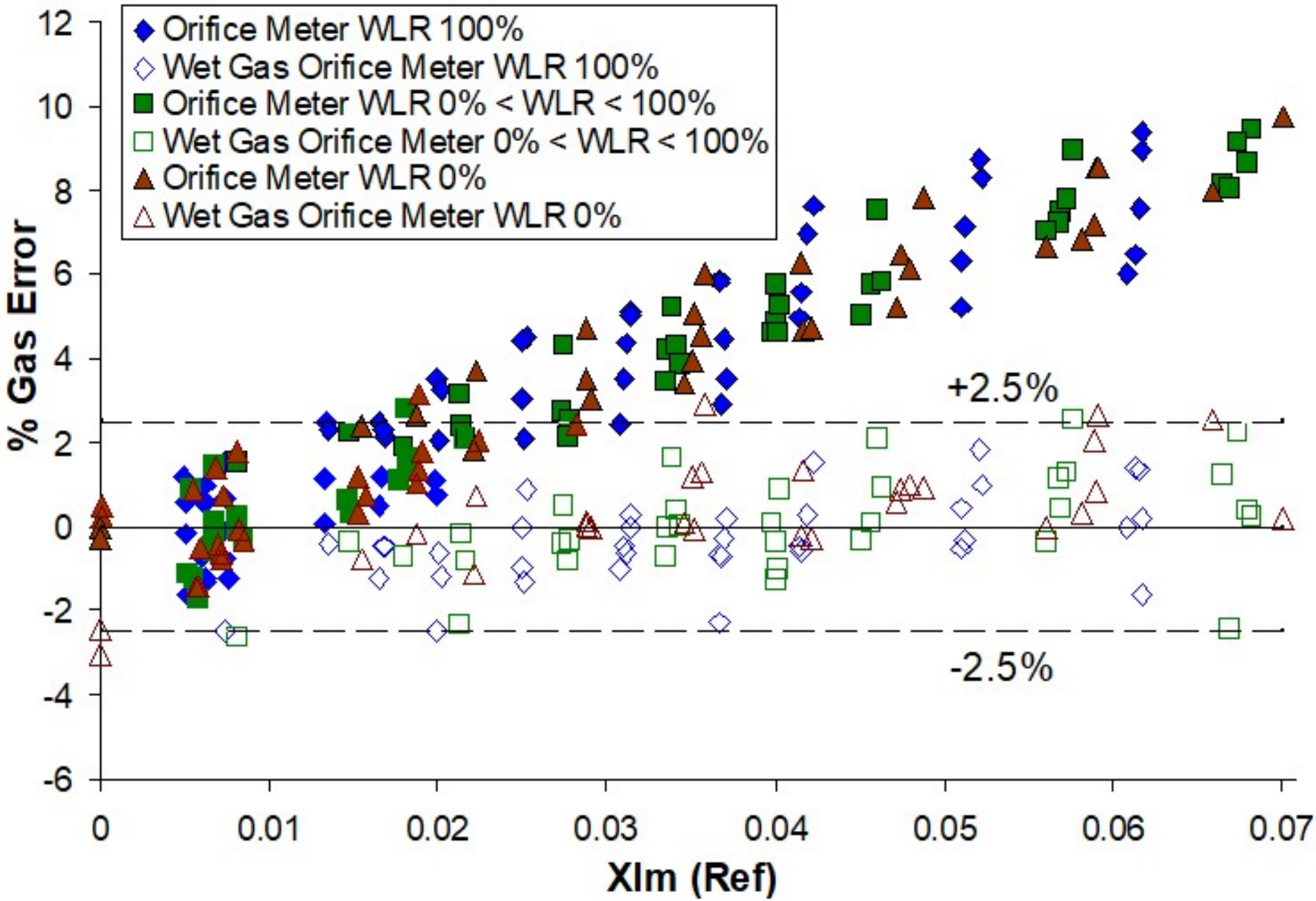
JIP / ISO: 4”, 0.5β Orifice Meter

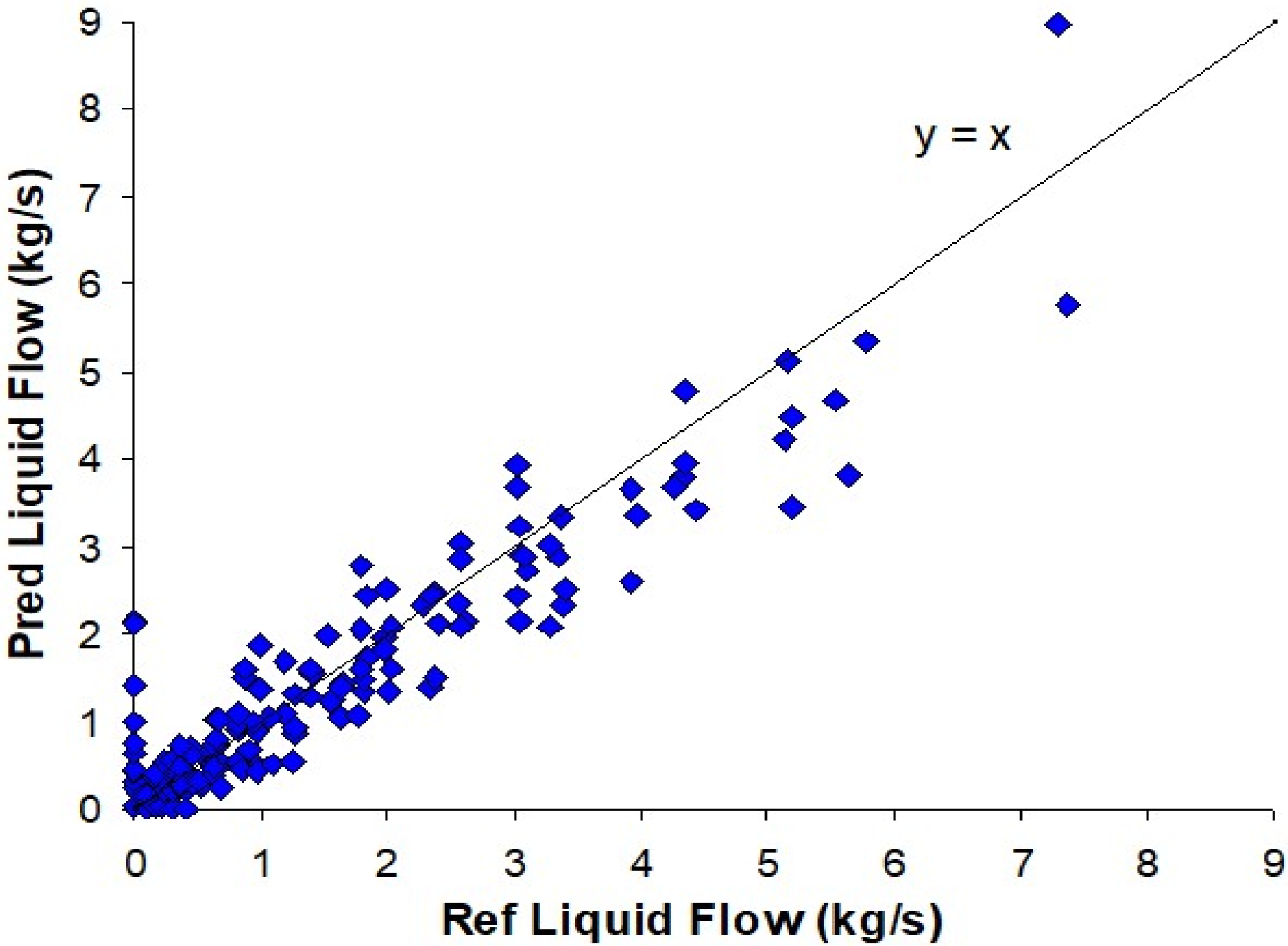
$$OR\% = f\left(X_{LM}, DR, Fr_g\right)$$

$$X_{LM} = f\left(PLR, DR, \beta\right)$$

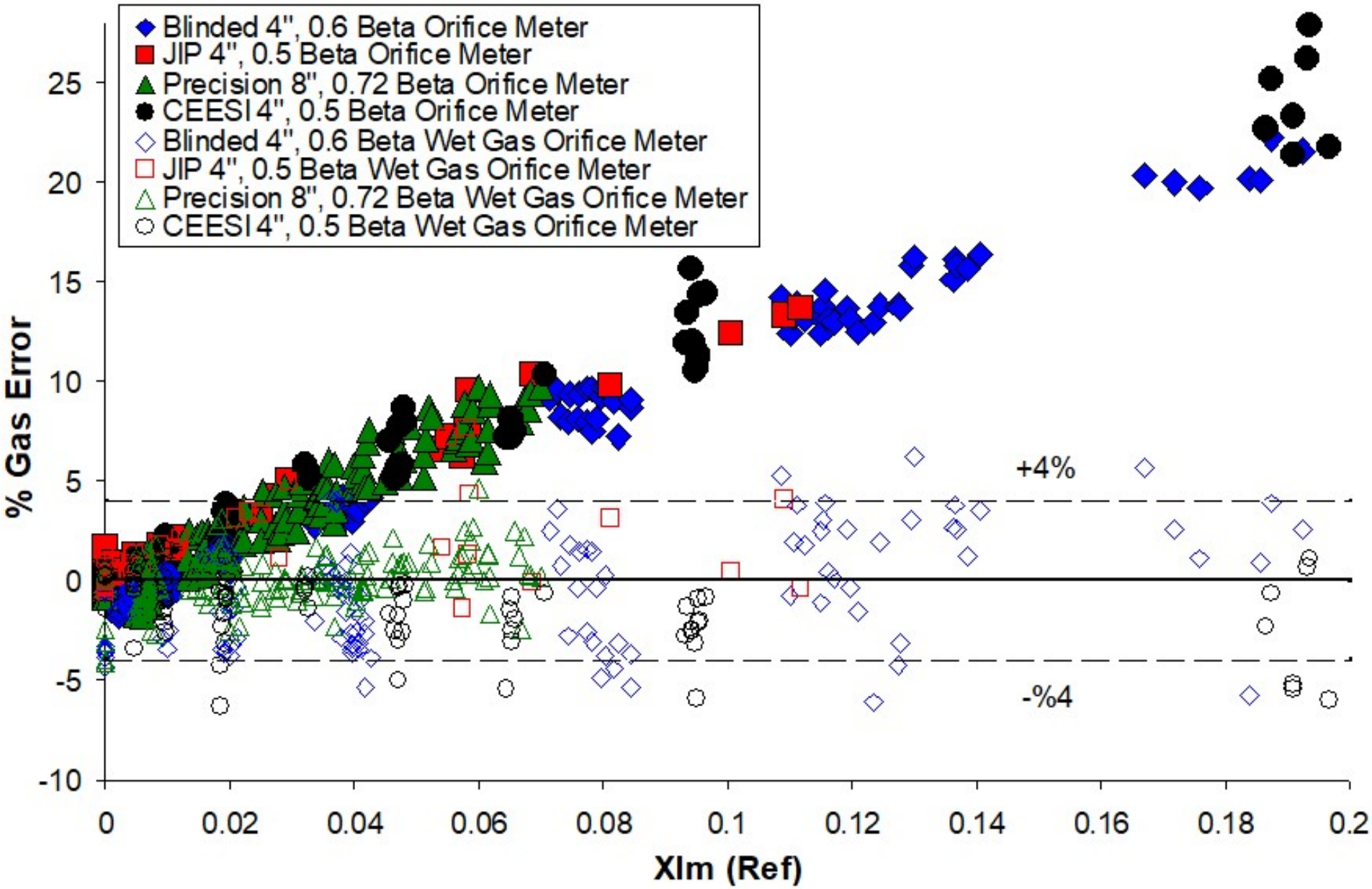


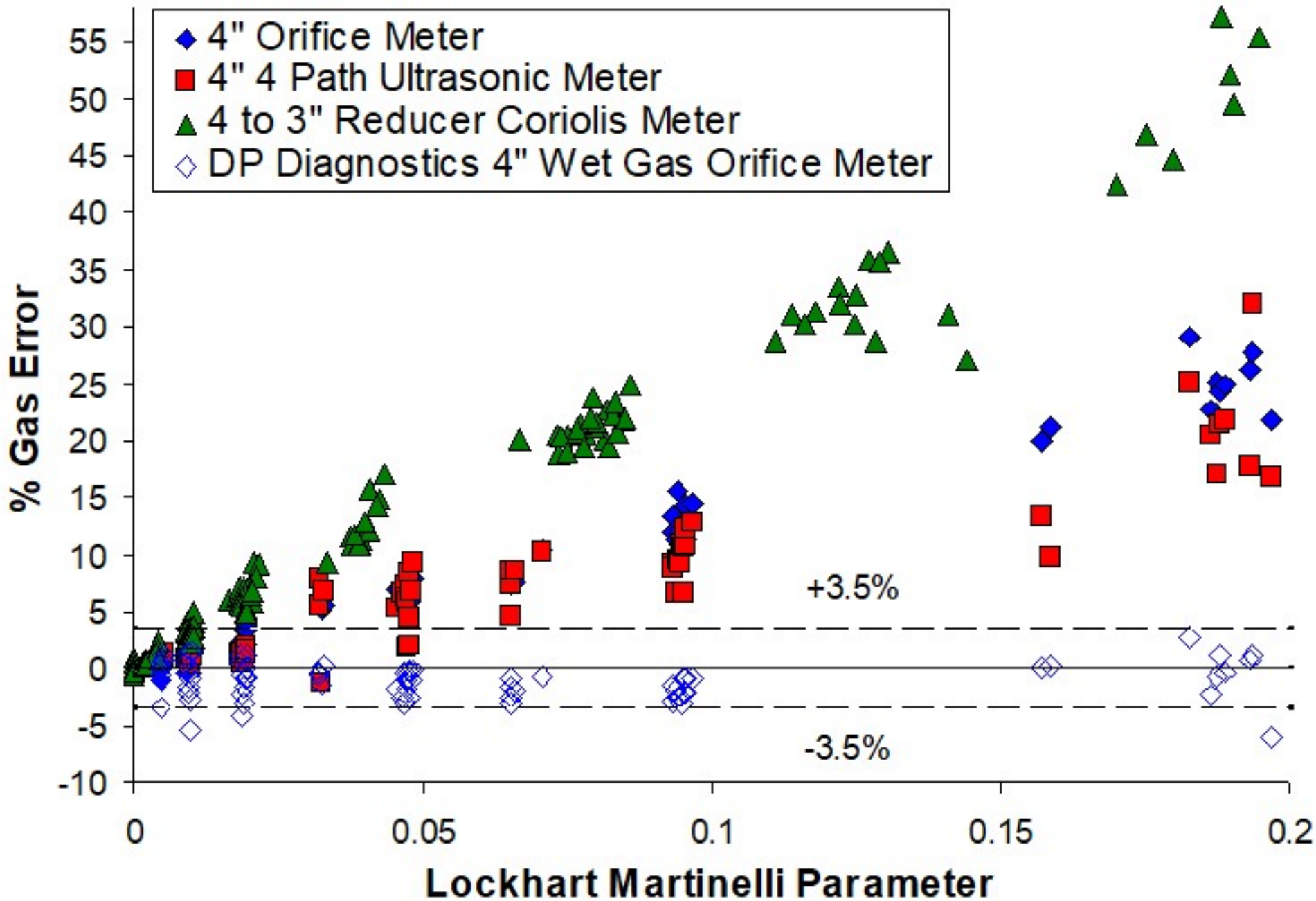
ISO TR 11583	DP Diagnostics Fit
$OR\% = f(X_{LM}, DR, Fr_g)$	$OR\% = f(X_{LM}, WLR, DR, Fr_g)$
$Urner\ PLR_{dry} = f(C_d, \beta)$	$fit\ PLR_{dry} = f(\beta)$
$0.5 \leq \beta \leq 0.68$	$0.5 \leq \beta \leq 0.75$
≤ 4”	≤ 8”
$X_{LM} \leq 0.45(DR^{0.46})$	$X_{LM} \leq 0.2$
$DR \leq 0.21\beta - 0.09$	$DR \leq 0.1$
Gas Flow Uncertainty 6%	Gas Flow Uncertainty < 4%
160 points at $X_{LM} > 0$	622 points at $X_{LM} > 0$


Orifice Meter WLR 100%
Wet Gas Orifice Meter WLR 100%
Orifice Meter WLR 0% < WLR < 100%
Wet Gas Orifice Meter 0% < WLR < 100%
Orifice Meter WLR 0%
Wet Gas Orifice Meter WLR 0%
% Gas Error
12
10
8
6
4
2
0
-2
-4
-6
+2.5%
-2.5%
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
XIm (Ref)


y = x
Pred Liquid Flow (kg/s)
Ref Liquid Flow (kg/s)
0
1
2
3
4
5
6
7
8
9


CEESI


Blinded 4", 0.6 Beta Orifice Meter
JIP 4", 0.5 Beta Orifice Meter
Precision 8", 0.72 Beta Orifice Meter
CEESI 4", 0.5 Beta Orifice Meter
Blinded 4", 0.6 Beta Wet Gas Orifice Meter
JIP 4", 0.5 Beta Wet Gas Orifice Meter
Precision 8", 0.72 Beta Wet Gas Orifice Meter
CEESI 4", 0.5 Beta Wet Gas Orifice Meter
% Gas Error
25
20
15
10
5
0
-5
-10
+4%
-%4
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
XIm (Ref)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DP Diagnostics 4" Wet Gas Orifice Meter
% Gas Error
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35
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25
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15
10
5
0
-5
-10
+3.5%
-3.5%
0
0.05
0.1
0.15
0.2
Lockhart Martinelli Parameter

Conclusions

- Most wet gas flows are metered by dry gas meters.
- Wet gas is an adverse condition for all gas meters.
- Most gas meters have diagnostic suites that can identify ‘a’ problem if wet gas is present.
- The operator then ***reacts*** to the presence of liquids.
- The orifice meter, like the Venturi meter, allows a ***pro-active*** approach to wet gas flow…
- It can actively meter the wet gas flow’s gas flow and liquid loading.

Thank You

Questions?

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