Wet Gas Flowmetering Guideline

ASME MFC-19G-2008

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Three Park Avenue

New York, New York 10016-5990

CONTENTS

Foreword		V	
Standards Committee Roster			
1 2 3 4 5 6 7 8 9	Introduction Symbology and Definitions Types of Wet Gas Flows Flow Pattern Flow Pattern Maps Meters Used With Wet Gas Flows Wet Gas Sampling Pressure, Volume, and Temperature (PVT) Phase Property Calculations. Wet Gas Flowmetering Practical Problems and Recommended Practices Uncertainty of a Wet Gas Metering System	1 12 16 18 57 58 59	
Figures 4-1 4-2 5-1 5-2 6.1.1-1	Horizontal Wet Gas Flow Patterns Vertical Wet Gas Flow Patterns A Horizontal Flow Pattern Map General Flow Pattern Map Reproduction of Murdock's Two-Phase Flow Orifice Plate Meter Plot	15 17 17	
6.1.1-2 6.1.1-3 6.1.1-4 6.1.1-5	Wet Gas Flow Venturi Meter Data	22 22 22	
6.1.1-6 6.1.1-7	NEL 4-in., Schedule 80, 0.75 Beta Ratio Venturi Meter, Gas-to-Liquid Density Ratio of 0.046, Gas Densiometric Froude Number of 1.5	25	
6.1.1-8	NEL 4-in., Schedule 80, 0.75 Beta Ratio Venturi Meter, Gas-to-Liquid Density Ratio of 0.046, Gas Densiometric Froude Number of 4.5	26	
6.1.1-9	4-in. and 2-in. Venturi Meters With Similar Wet Gas Flows Showing a DP Meter Diameter Effect		
6.1.2.1-1	NEL/Stewart's Turbine Meter Wet Gas Response for Liquid Mass Fraction of 2%		
6.1.2.1-2 6.1.2.1-3 6.1.2.2-1 6.1.2.2-2	Ting's Turbine Meter Wet and Dry Gas Flow Rate Results at CEESI	30 31	
6.1.2.2-3	NEL Nitrogen/Kerosene Vortex Shedding Meter Data Capped at Maximum Lockhart–Martinelli Parameters Before Data Becomes Erratic		
6.1.2.2-4	Results of the Linear Fit Wet Gas Correlations Presented in Fig. 6.1.2.1-2 for Known Liquid Flow Rates		
6.1.2.3-1 6.1.2.3-2	NEL 4-in. Coriolis Meter 30 bar Wet Gas Data		
6.1.2.3-3	2-in. Micro Motion Coriolis Flow Meter Wet Gas Test Data	36	
6.1.2.3-4 6.1.2.3-5 6.1.2.4-1	Endress + Hauser Coriolis Flow Meter, X_{LM} < 0.035	37	
6.1.2.4-2	Gas Flow Error of a 6-in., Four-Path Ultrasonic Meter With Wet Gas Flow at 50 bar (Superficial Velocity in m/s)	39	

6.1.2.4-3	6-in. Two-Path Ultrasonic Flowmeter Wet Gas Overrreading Vs. LVF%	
6.1.2.4-4	6-in. Clamp-On Ultrasonic Gas Meter Wet Gas Flow Performance	41
6.1.4.1	Separator Vessel That Separates Gas, Oil, and Water	44
6.1.4.2-1	Schematic Diagram of a Throttling Calorimeter	
6.1.4.2-2	Mollier Diagram Sketch for Wet Steam With Throttling Process Shown	
6.1.4.3	Tracer Dilution Method Being Applied Across a Venturi Meter	
6.2	Jamieson's Multiphase Flow Triangle	
6.2.2	4-in., 0.4 Beta Ratio Venturi Meter Pressure Loss Ratio Vs. Lockhart-Martine	elli
	Parameters at 45 bar	
6.4	Schematic of a Generic Multi-Wet Gas/Multiphase Flow Satellite Well Tie-Bac	
	to an Offshore Platform	56
9.1-1	Hydrate Blockage in a Section of Pipe	60
9.1-2	Pressure-Temperature Phase Boundary Conditions for Methane Hydrate	62
9.1-3	Cross-Sectional View of Hydrates in a Flow Stream	
9.1-4	Orifice Plate Removed From a Coal Bed Methane Wet Gas Flow After	
	Three Months' Service	63
9.1-5	Sample of a Scale Taken From a Wet Gas Meter	64
9.1-6	Wet Gas Flow Scale Buildup Around a DP-Based Wet Gas Meter	
9.1-7	Wet Gas Flow Meter After Scale Removed	65
9.1-8	Salts Built Up in Natural Gas Production Line	66
9.1-9	Orifice Plate Buckled by a Slug Strike While in Wet Gas Service	68
9.1-10	Example of Poor Level Control in Three-Phase Separator, Leading to Water i	n
0 4 44	Oil Leg PDO Wet Gas Venturi Meter With Frost and Frost Clear Sections Showing	ხ8
9.1-11	Thermodynamic Effects as Significant	72
Table		
10	Conversion Factor for Uncertainty at Different Confidence Levels	73
Nonmand	atory Appendices	
Α	Details Involving the Definition of Terms	75
В	Difference Between the Gas Volume Fraction and the Gas to Total Volume R	atio
	Per Unit Length of Pipe in Steady Flow	85
С	Incompatibility of Different Suggested Wet Gas Definitions	
D	Equations and Graphs for Conversions of Wet Gas Flow Parameters	
Ε	API Wet Gas Definitions	
F	Wet Gas Flow Condition Sample Calculations	. 107
G	Differential Pressure Meter Wet Gas Correlations	. 136
Н	Origins of the Existing Wet Gas Flow DP Meter Correlations	
1	Throttling Calorimeter Worked Example	
J	Details of Generic Wet Gas Flow Metering Concepts	206
K	Available Published and Presented Information on Marketed Wet Gas Meters	
	the Oil and Gas Industry	. 215
L	Technical Details of Wet Gas Flowmeter Prototype Designs	
M	Oil and Gas Industry-Based Multiphase Meters and Phase Fraction Devices	
	Used for Wet Gas Metering	. 236
N	Wet Gas Flowmetering Uncertainty	
0	Practical Issues Regarding Metering Stream Flow	
Р	Bibliography	