Installation effects at gas flow metering through parallel ultrasonic metering lines. A case study.

Nikolaos A. Tsochatzidis & Nikolaos Katsis

Hellenic Gas Transmission System Operator (DESFA) SA
L. Messogeion 357-359, GR-15231 Halandri, Greece
Overview

- The effect of pipe geometry on gas flow metering is evaluated.
- Field measurements are reported from ultrasonic flow meters.
- Data at real flow conditions are evaluated and compared with similar data of the orifice metering lines (old system) at the same Station.
- Results show that the pipe geometry upstream the metering lines greatly affects the flow through the lines.
Scope of the study

✓ The case study presented here aims to contribute in the design of metering installations and also in better understanding of flow measurements at gas transmission systems.
Case study

Field measurements are reported from DESFA’s Border Metering Station of Sidirokastro, Greece.
The Hellenic Natural Gas Transmission System and future expansions

www.desfa.gr
DESFA’s Border Metering System of Sidirokastro is located 12 km from the Greek-Bulgarian Borders, near the town of Sidirokastro.

Entry Point Capacity
10.8 mNm³/day
Sidirokastro Border Metering Station

(panoramic view of the plant)
Gas Flow Stages & Flow Diagram of BMS Sidirokastro

- 1\(^{st}\) – Station Inlet
- 2\(^{nd}\) – Filtering of Gas
- 3\(^{rd}\) – Quality Control of Gas
- 4\(^{th}\) – Measurement of Gas Volume
- 5\(^{th}\) – Gas Heating
- 6\(^{th}\) – Flow Control
- 7\(^{th}\) – Station Outlet
Ultrasonic Metering System

The Ultrasonic Metering System (*installed recently*) provides high reliability, full redundancy and on-line diagnostics to support full automatic control of custody transfer Gas metering.

Three metering lines with Ultrasonic Meters
Flow & Supervisory Computers

The metering system is supervised by two redundant supervisory computers which are incorporating fault detection techniques monitoring the health status of the system. Supervisory computers are also responsible for the management of the flow computer results and the production of the fiscal reports for Gas invoicing purposes.

The overall Uncertainty of BMS Sidirokastro metering system is better than 0.55%.
Orifice Metering System

Until recently, measurement of Gas Quantity was performed at **five** parallel meter runs by means of **Orifice Meters** (**Meter Run $Q_{max} = 230000 \text{ Nm}^3/\text{hr}$**).

Each run was equipped with two independent Electronic Metering Systems, and a standby Mechanical Metering system [1] [2].
Metering lines configuration

- The new metering system consists of three 16” parallel metering lines, each equipped with a multipath Ultrasonic flow meter, with an upstream flow conditioner.
- Gas is leaded to the metering lines through a vertical header of 30” diameter.
- Upstream of the header there are two bends out of plane, the first of 90° and a second of 45°. Further upstream there are two more bends of 90° out of plane.
- The header has one entrance at the side and an end cap at the other side.

Data at real flow conditions are evaluated and compared with similar data of the previous Orifice metering lines at the same Station.
Metering Lines geometry

- 30” header
- 16” parallel metering lines
- 3000 mm distance between the adjacent parallel lines
- 30 D straight length between header and ultrasonic meter
Metering lines lay out

Bends out of plane upstream of the header’s only entrance
Pipe geometry upstream of the Header
Ultrasonic Metering System
Description & Observations

- The Metering System is in accordance with ISO 17089-1 : 2010 standard [3].

- State-of-the-art multipath Ultrasonic flow meters are utilized [4].

- Due to adequate straight length upstream of the ultrasonic meter (30 D) and also the presence of flow conditioner, essential flow instabilities are not recorded.

- **Significant** differences between the flow rates metered at the identical metering lines, during parallel operation, are observed. Data of these differences are presented, in terms of actual volume of Gas measured every hour of the Gas Day (m³/hr).
Aerial View of Sidirokastro Station (Ultrasonic lines)
Parallel Ultrasonic metering lines operation

two lines in parallel operation

![Graph showing parallel metering lines operation.](image-url)
Parallel Ultrasonic metering lines operation

two lines in parallel operation

There is an almost linear increase of the metering lines’ flow rate difference, with the line’s distance from the entrance of the header.
Aerial View of Sidirokastro Station (Orifice lines)
Parallel Orifice metering lines operation

three lines in parallel operation

1.7% difference between Lines #0 & #3
3.2% difference between Lines #3 & #4
4.9% difference between Lines #0 & #4
Parallel Orifice metering lines operation

two lines in parallel operation
Data evaluation

- In parallel Ultrasonic metering lines operation, differences of the flow rate up to 12% were registered. *Differences are increased almost linearly with the line’s distance from entrance of the header.*

- Always the metering line located further away from the header’s entrance presents the higher flow rate.

- Ultrasonic lines present *much higher differences* of gas flow than Orifice lines at similar conditions of parallel operation. *This fact can be attributed to higher pressure drop associated with Orifice lines.*

- Differences of gas flow among the parallel metering lines are important in the design of metering installations. *For example maximum gas flow cannot be achieved the same time at all metering lines.*
CFD simulation

- Utilizing a Computational Fluid Dynamics (CFD) software, a simulation is attempted to predict Gas flow rate in the metering system under study.
- The simulation predicts qualitatively the data.
- This simulation work is in progress.
Conclusions - Discussion

✓ Field measurements reported show that the pipe lay out upstream the metering lines greatly affects the flow through the lines.
✓ Even though the parallel metering lines are identical, a difference of up to 12% is recorded to the actual gas volume measured at each Ultrasonic line, in parallel operation.
✓ Ultrasonic lines present much higher differences of gas flow than Orifice lines at similar conditions of parallel operation.
✓ To minimize differences reported here, the entrance of Gas may be at the center of the header [5], or on both sides of the header.
✓ Due to adequate upstream straight length and the presence of flow conditioners, essential flow instabilities are not recorded at Ultrasonic meters.
✓ The analysis, reported in this case study, aims to contribute in the design of metering installations and also in better understanding of flow measurements at gas transmission systems.


Installation effects at gas flow metering through parallel ultrasonic metering lines. A case study.

Nikolaos A. Tsochatzidis & Nikolaos Katsis

Thank you for your attendance

n.tsochatzidis@desfa.gr