Advanced gas flow measurement in Oil & Gas and Power Industries

Flowmeters based on Thermal Dispersion technology

Fluid Components International
Introduction
Fluid Components International

**Company is Fluid Components International [FCI]**
- Since 1964 focused on one technology: Thermal Dispersion
- Over 500,000 instruments in operation during 50+ years
- Family owned 230 person mid sized company

**Customized solution with in house Engineering and Competence on:**
- Meeting EMC requirements
- To meet codes in relation to welding, materials and processes
- Products are custom made based on proven in use designs
- Largest expense: meet global certifications and industry standards

**Industries served:**
- Oil and Gas, Petrochemical, Chemical
- Waste Water Treatment, Digesters, Biogas
- Power Generation, Fossil and Nuclear
- Steel, Cement, Glass, Automobile and others
Direct mass flow measurement
Thermal dispersion technology

Construction
• Unheated sensor: PT1000 RTD
  Heated sensor: PT1000 RTD + Heater

Operating principle
• Adaptive power to the heater
• Creating temperature difference $[\Delta T]$  
  $\Delta T$ represents the cooling effect
• Heated sensor is cooled by passing gas molecules
• $\Delta T$ is direct proportional with mass flow rate
• No pressure or temperature corrections needed
• Fast response, instrument will track changes in mass flowrate within 1 second

Summary
FCI measures cooling rate of the gas molecules passing the thermowells
Cooling rate depends on actual density, actual velocity times pipe ID
Thermal dispersion technology provides direct mass flow measurement
Oil and Gas Industry

Overview

Upstream → Midstream → Downstream

Exploration & Production → Pipelines, Tank Terminals & Oil Tankers → Refining & Processing
What are typical Upstream Oil and Gas applications?

**Thermal dispersion flow/level measurement**

**Typical applications at Exploration & Production:**

1. Vent, relief and flare gases
2. Purge gases in flare systems
3. Monitor flow rate of chemical injection fluids
4. Leakage Flow Rates at Dry seals Compressors
5. Alert closing and opening PV Valves
6. Monitor Flow and Level as Pump protection
7. Measure Sampling Flowrates to Analyzers
What are typical Midstream Oil and Gas applications?

Thermal dispersion flow/level measurement

**Typical applications at**

1) Monitor Flow and Level as Pump protection
2) Vapor Recovery Systems
3) Measurement Flowrates Flares and Off gasses
4) Dry detection Loading Arms
5) Nitrogen flow rate Tank Blanketing System
6) Alert opening and closing PV Valves
7) Natural Gas Pressure Reduction Stations
What are typical Downstream Oil and Gas applications?

Thermal dispersion flow/level measurement

**Typical applications at Refineries:**

1) Air Feeds to Boiler as Burner Control
2) Air feed to Sulphur Recovery (SRU)
3) Exhaust Gas to Thermal Oxidizer
4) Flue gas Continuous Emission Monitoring System [CEMS]
5) Measurement of Off, Vent and Flare gasses
6) Nitrogen flow rate Tank Blanketing System
7) Flowrates in analyzer sampling system
8) Measurement flow rate Ventilation systems
9) Pump protection
What are the requirements for measuring chemical injection?

**Typical Requirements and FCI Solution**

**Requirements Chemical injection systems / Corrosion inhibitors:**

- Low flow alarm to ensure dosing is above pre-set flow rate
  - High pressures up to 800 bar(g)
  - NACE compliance wetted parts
  - Detecting very low flow rates

**FCI Thermal Dispersion flow switch:**

- Low flow alarm to ensure dosing is above pre-set flow rate:
  - Two alarms:
    - Flow confirmation near normal operating flow to indicate health of dosing system
    - Low flow alarm to detect flowrate is below pre-set flowrate
  - Wetted parts 316L SS/Hast C (NACE)
  - Hi pressure version up to design pressure of 1200 bar(g)
  - Measure flowrates down from 0.015 cc/sec (~18 drops/min!)
  - Extremely reliable, no moving parts and tolerant to fouling
  - SIL2 (HFT=0) Compliant, confirmed by FMEDA report by TÜV
What are the requirements for Dry Seal flow monitoring?

**Typical Requirements and FCI Solution**

**Requirements Dry Seals Flow Monitoring:**
Measure leakage flow rates of seal gases to determine health condition of sealing system:

- At inlet Primary seal process gas
- At inlet Secondary seal gas
- At outlet Sealing system (primary vent)
- At separation gas seal (secondary vent)

**FCI Thermal Dispersion inline gas flow meter:**
Inline all welded flowmeter models ST75AV/ST100L:
- Measure flowrates from 0.01 NCMH [0.1 LPM]
- Turndown 100:1
- Virtually no pressure drop [Less than 1 mbar at 20 NCMH in DN25 pipe]
- No moving parts, easy to re-scale flow range
- SIL1 (HFT=0) Compliant, confirmed by FMEDA report by TÜV
- Alu or SS electronics enclosures
- Optional built-in flow conditioner for short inlet length
- Vertical (flow up or down) or horizontal installation

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**Dry Seals Monitoring Compressors**

**ST75AV with Flowconditioner**

**ST75A with Tube Tee**

**ST100L - Dry Seal System**
What are the requirements for Flare Gas flow measurement?

**Typical Requirements and FCI Solution**

![Upstream](image1.png) ![Downstream](image2.png)

**Requirements Flare Gas flow measurement:**
- Reliable and accurate under variable process conditions
- Instrument should not create pressure drop
- Must allow to be installed/retracted during normal operation
- Measuring very low flow and keep operating at blowdown
- Robust mechanical design to survive blowdown
- Verification of performance on-site (in operation)
- Strong local support offering preventive maintenance

FCI Thermal Dispersion insertion flare gas flow meter ST100/ST110:
- Multivariable transmitter (Mass flow, Temperature, opt Pressure)
- Easy to install, Hot Tap, no spool piece required
- Virtually no pressure drop [Typical less than 1 mbar]
- Measure flowrates from 0.08 Nm/s to 300 Nm/s
- Range-ability 1000:1 [Digital, split over 3 x 4-20mA ranges)
- Complex gas composition calibration
- Up to five different calibrations (different gas compositions)
- Single or Dual sensing for larger pipe sizes
- In-situ electronics verification (opt. on-site cal verification, VeriCal)

**Flare Metering Booster Station**

**ST100 Performance 1000:1**

**ST110 Flare Gas Flow Meter**
What are the requirements for Pump Protection?

Typical Requirements and FCI Solution

**Requirements Pump Protection:**
Protect pump from overheating, because of:
- Running dry
- Running with blockage of product flow downstream of pump

Within 30 seconds the pump protection device has to confirm either flow and/or product in pipe after pump starts.

**FCI Thermal Dispersion flow switch:**
Flow and Level switch as Pump Protection
- Two alarms:
  - Low flow alarm (=Flow)
  - Empty pipe alarm (=Level)
- Wetted parts 316L SS/Hast C/Titanium (NACE compliant)
- Threaded (NPT) or Flanged (ANSI/DIN) process connections
- Optional Retractable Hot Tap
- Extremely reliable, no moving parts and tolerant to fouling
- SIL2 (HFT=0) Compliant, confirmed by FMEDA report by TUV
What are the requirements for Nitrogen Blanketing flow meters?

Requirements Nitrogen Blanketing:
Measure inlet nitrogen flow rate to improve efficiency, lowering nitrogen consumption and costs, and to eliminate supply shortages:

- Large range ability to follow all loading sequences
- Pressure drop to be kept as low as possible
- Simple and reliable measurement required
- Short installation length available

Typical Requirements and FCI Solution

FCI Thermal Dispersion inline gas flow meter:
- Turndown 100:1
- Virtually no pressure drop [Typical less than 1 mbar]
- SIL1 (HFT=0) Compliant, confirmed by FMEDA report by TUV
- Built-in flow conditioner, 3D straight inlet length required
- Vertical (flow up or down) or horizontal installation
- No moving parts, easy to re-scale flow range
- SIL1 (HFT=0) Compliant, confirmed by FMEDA report by TUV
- Built-in flow conditioner, 3D straight inlet length required
- Vertical (flow up or down) or horizontal installation

Nitrogen tank blanketing system on tanks

ST75AV with Flowconditioner
ST100L With Flow Conditioner
What are the requirements for emission monitoring?

Typical Requirements and FCI Solution

Requirements Flue Gas Emission Monitoring:
Measuring flue gas for reporting emissions to local government.

- Flow rate can be very low
- Flue gas can be dirty and hot
- Typically one platform available on stack to install flowmeter
- Compliance with CEMS
- Large diameters

FCI CEMS Flue gas flow meter:

- MT100 of FCI is design to meet EPA CEMS 40 CFR60, 40 CFR75 and US EPA CHG 40 CFR 93,34
- Measure flowrates from 0,08 Nm/s to 35 Nm/s
- Sensor design very tolerant to dust and rated up to 455°C
- Installation can take place at same position
- Averaging Multi-Point Flowmeter for large pipes

MT Sensor after two years operation with fly ash built-up but still operational

FCI Sensor
What is the FCI Solution for large pipe diameters?

Averaging multi-point flow measurement system

Up to 8 measuring points

14.6% Pipe ID [ISO 10780:1994]

14.6% Pipe ID [ISO 10780:1994]
What are the requirements for air feed to SRU units?

Typical Requirements and FCI Solution

The ratio between Acid Gas, Tail Gas and available Oxygen (=Air) is crucial to SRU operation, for purpose of exact ratio control most SRU will have a Main Air feed and a Trim Air feeding line. Response time for Air Feed Control is important to avoid over or undershooting Air flow into SRU Unit.

For this purpose FCI has developed an accurate, reliable and fast responding Thermal Mass Flow Meter, the ST100 with unique Adaptive Sensing Technology for fast air/gas ratio control.
Why FCI thermal dispersion?

Direct mass flow
• Real time measurement of Mass Flow
• No need for Pressure or Temperature Correction
• Fast response, instrument will track changes in mass flowrate within 1 second

Wide flow range
• Can measure from 0.08 nm/sec up to 305 nm/sec
• Turndown standard 100:1, optionally 1000:1

No pressure drop
• Less as 0.9 mbar in 100 mm pipe at 4000 Nm3/hr

Easy to install
• Only one process entry required
• Hot tap versions available for installation under Pressure
• Received fully pre-calibrated, no set-up time lost

Reliable/Maintenance
• No moving parts and no small holes to get dirty
• SIL 1 & 2 Compliance with no drift in measurement

Support
• Represented in more than 115 countries ensuring local global service support