



Non-Intrusive Ultra-Sonic Flow Meters On Coker Feed



Presentation Agenda

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- Coker Feed Challenge
- □ Coker Feed Issues & Economics
- Feed Measurement Options
- □ Clamp On USFM Technology & Examples
- □ Clamp-On Economics
- Diagnostics





Coker Feed Challenge



Coker feed liquid is

- Hot
- Viscous
- Generation "Chunky"
- Dangerous



Coker Feed Issues Accuracy & Reliability



Accurate & reliable flow measurement is important

- □ Inaccuracy can trigger false (= costly) alarms
- Real flow drop-outs cause lines to cake up = costly cleaning
- □ Loss of signal to furnaces causes shut down for safety reasons = no room for error in safety matters

Coker Feed Issues Health & Safety



Health & Safety must be top priority in any operation Fire prevention is important

- Coker feed is a closed system
- But leaks can release liquids, vapors, gases
- In-line flow meters have flanges, gaskets = potential for leakage
- Leaks can cause fire, explosions
- Potential for fire is always present in coker operations

Coker Feed Economics Maintenance Expenses



□ The issue as voiced by a refinery engineer in an online engineering discussion forum

Subject Heater Feed Pass Flow Measurement

Category: Reliability / Maintenance expenses

>>We currently use orifices with purge for measuring heater pass flow. ... We have reoccurring plugging problems and have been looking for an alternate technology. We looked at Vortex, but because we do get coke "chunks" occasionally in this service none of the vendors were comfortable with it. Any suggestion on what is the most reliable method for Htr Pass flow measurement?<<

Other case report :

>>.. Unstable readings...plugging lines and having to clean them...wasted labor...results in some \$ 50,000 p.a. maintenance costs<<

Feed Measurement Option Vortex Meter Technology





 Bluff body in flow stream causes vortices
 Frequency of vortices = measure for flow

Feed Measurement Option Vortex Meter & Coker Feed

Vortex Meter issues in coker feed

Pressure drop (= energy destroyer = costs)
 Turn down max. 1:20 (does not start at "0" flow)
 Turn down decrease with higher viscosity
 Danger of leakage (Health and Safety)
 Danger of clogging (Process availability)
 Danger of wear of bluff body due to abrasion
 Danger of bluff body breaking
 Sensitive to vibrations
 Maintenance intense



FI FXI/

Feed Measurement Option Differential Pressure Meters





Common to all...(or some)

□ Pressure loss = energy !

- □ Pressure lines = maintenance !
- □ Pressure lines = danger !
- □ Installation = shutting process down !
- □ Wear & tear = accuracy loss !

Turn down limited

Feed Measurement Option Ultra-Sonic Flow Meters (USFM)



Transit Time Operating Principle



... external measurement of internal flow¹⁰

Clamp-On USFM Operating Principle





Operational formula







Clamp-On USFM Flow Profile Compensation



$$Q = v_A \cdot A$$

$$v_A = \frac{1}{A} \iint_A \mathbf{v} \cdot d\mathbf{A} \qquad v_l = \frac{1}{l} \iint_{(l)} \mathbf{v} \cdot d\mathbf{I}$$

$$k_S = \frac{v_A}{v_l}$$

$$Q = v_l \cdot A k_S$$



Fully developed flow profile:

 $k_{\rm S}$ depends on Reynolds number and pipe roughness

Clamp-On USFM Accuracy & Uncertainty





Clamp-On USFM Applied to Hot Liquids





WaveInjector® Technology

Temperature to 400°C/ 750°F

□No contact with liquid

□Never a leak

□No mechanical wear & tear

□Minimal maintenance

□Very high turndown

□High safety

 \Box Line sizes > 1 ¹/₂"

USFM for Hot Liquids WaveInjector® Technology





Typical Applications
Coal Tar
Bitumen / Pitch
Feed Water

Heat Oils

Coker / FCC Feed

The toughest challenge ...



... lies in Alberta Canada



16

...and the "largest" in everything...



... can also be found in Alberta Canada



The Mother-Of-All Bitumen Coker Feed Lines



... is of course also in Alberta Canada



Coker feed flow 16" line @ 675°F

Customer states the issues for the test



The common method of flow measurement in bitumen service with high temperatures and pipe sizes > 8 inches is the DP / orifice plate transmitter...

The reliability of the DP instrument for this service is low because ... the instrument typically fails because of these impulse line problems

□ Impulse line plugging

□ Impulse line freezing

Impulse line fluid-voiding, which subsequently gets filled with bitumen

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WaveInjector® Installation done easily...

- Done in 1 hour
- No process shut down
- □ Installation outside of pipe
- No special tools







First Try : Flow Signal on 16" Bitumen Line



Signal quality with M transducers produce on-the-edge and unreliable readings for customer

Trend Chart - PHD Connect Key 57fc1171 (BPH) 21 00:00:00 03:12:00 06:24:00 09:36:00 12:48:00 07-Jan-2007 07-Jan-2007 07-Jan-2007 07-Jan-2007 07-Jan-2007

Flow Signal on 16" Bitumen Line Getting It Right !



Renewed test with G transducers (lower frequency = improved result on large pipe with high dampening media) produce stable signals



Signal Quality Examined & Compared

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.. Test results confirmed by customer. Red = Flexim, Blue and Green : DP

The red line is the Ultrasonic flow Meter. Very nice..



Signal reliability confirmed in winter performance



□ Test results for period March 15th to April 15th

□ Flow signal of orifice plates (red & green) improved on April 2nd due to > freezing temperatures

□ The USFM (blue) was more stable regardless of the temperature conditions



WaveInjector® Design Heat Tracing Issues



Coker feed: heat tracing lines stay intact



WaveInjector® Design Pipe Insulation Issues



Insulation stays intact



Reading the manual is important !



... an example of how NOT to do it...



Installation manual not read > disaster strikes

WaveInjector® Test Case: ExxonMobil California





The challenge:

Replace 44 DP meters on "resid" feed to coker @650F

Reason:DP maintenance issuesDP reliability issues

Measurement purpose: a safety reliable monitoring

Case: ExxonMobil Signal Reliability & Accuracy





Clamp-On USFM Economics ... vs in-line flow meters

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Competitor G

inline / wetted USFM special material for pipe and sensors cost per meter appr. **\$ 35 K** plus: process shut down expenses for installation

Competitor K

inline / wetted USFM special material for pipe and sensors cost per meter appr. **\$ 44 K** plus: process shut down expenses for installation

Flexim WaveInjector

clamp on USFM all standard materials and models cost per meter appr. \$ 12 K no process shut down / installation done in 1 hour no maintenance

FLEXIM – WaveInjector® Some Users



SUNCOR Flying J ExxonMobil BP TOTAL Shell Valero Chevron LUKOIL Husky Energy **Moose Jaw Refinery** DEVON Marathon

Diagnostics & Evaluation of Clamp-On USFM Flow Measurements



USFM Diagnostic Tools



All diagnostic values

- $\hfill\square$ are displayed and stored
- □ can drive process interface

Data logger

stores signal related and application diagnostic values for offline analysis



Diagnostics: Data Logging Software





Fluid sonic velocity Signal amplitude Fluid flow Channel A: blue B: black **Sonic Velocity** Channel A: green B: black

Diagnostics: Signal Analysis Software



Snap-Date fuid pipe SNR[dB] 30 travel time 608.426E-6 mode errors no errors 00:41:09.000 14.12.2006 material Carbon Steel Volt Hi variance[%] 3 Kanal Temperature d 406.400E-3 N Akkum 1 variance[%] 3 sensor name CDM1N52-0009 SCNR[dB] 29.7 SCNR[dB] 20.7 number of soundpath 1 testimated 584.96E-6 Filter 1 gnals Comments t1 path 495.45E-6 Filter 1 0.80 0.40 - - - -	
Inals Comments comments (first row) 1.00 - 0.80 - 0.60 - 0.60 - 0.40 - 0.40 -	FLEXIM
0.80 - 0.60 - 0.40 -	Signal+
0.20 - 0.00 - 0.20 - 0.40 - 0.40 - 0.60 - 0.80 - -1.00 - 570.000E-6 580.000E-6 600.000E-6 610.000E-6 620.000E-6 640.000E-6 650.000E-6 650.000E-6 670.000E-6 690.000E-6	Signal-

I parameters

JR

CNR

be signal

gnal ampitude

in

rrelation

Diagnostics Disturbed Flow Variation





Multi channel flow application

Diagnostics Example Time Variations





.. time & time difference variation are indicators for flow fluctuations such as turbulence, flow disturbances

Diagnostics Statistical Analysis

□ Average => main result

□ Standard deviation as an indicator of fluctuation



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