SRP Fluids Analysis:
Agua Fria Flow Measurement

ABDULLATEEF ALHUMAIDAN – *PROJECT MANAGER*

THOMAS HILL – *PROJECT MANAGER*

BRIANNA MOORE – DOCUMENTER

GALEN GEISLINGER – BUDGET LIAISON

CLAYTON SURRATT– CLIENT CONTACT

ABDULAZIZ ALANZI – WEB DEVELOPER

ME486C – SEC. 5 - Team 33

Project Sponsor: SRP

Faculty Advisor: DR. TREVAS

Sponsor Mentor: Vy Kieu

April 28 2017

Project Description

- Salt River Project (SRP)
- Fuel Measurement System
- 2% Error
- Collaborate with SRP technicians

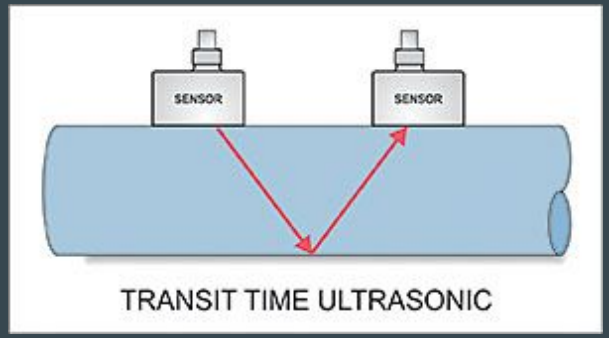
[1] Orifice Plate

[2] FloBoss

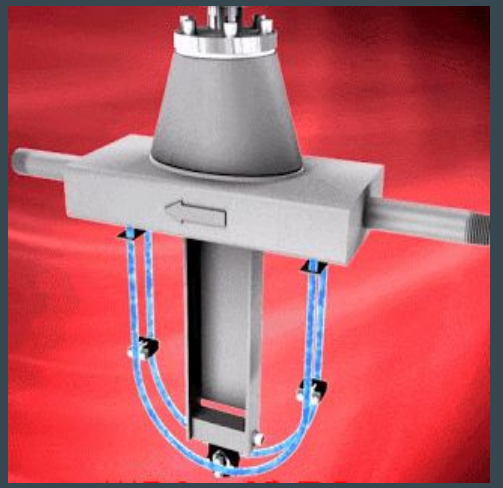
Process Overview - Research

Clayton Surratt - 4/28/2017
SRP Fluids Analysis Team 33

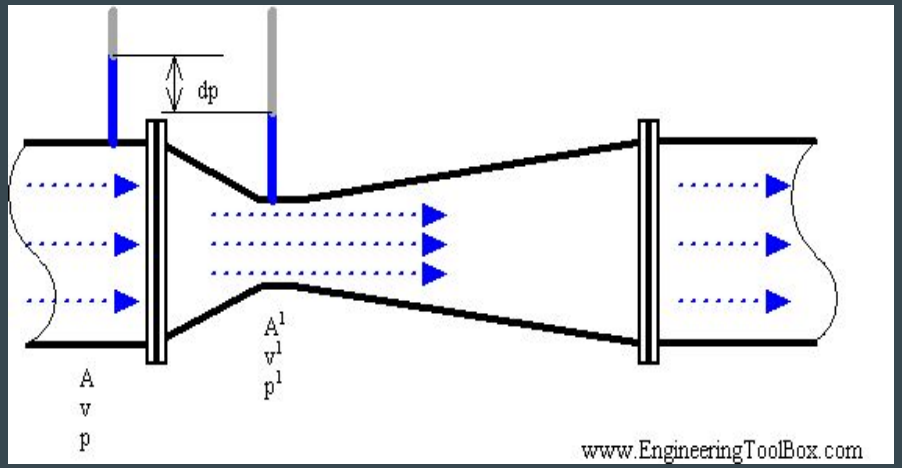
- Analyzed various flow meters
- Common sources of error
- Used Decision Matrix selection



[4] Ultrasonic Flow Meter



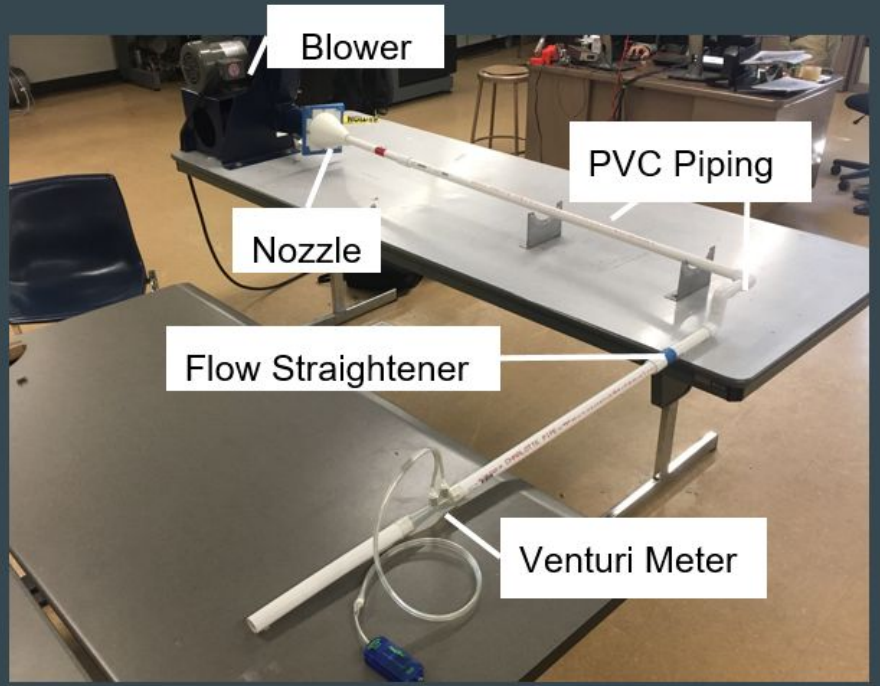
[5] Coriolis Flow Meter



[3] Venturi Tube

Process Overview - Experiment

- Replicated scaled Agua Fria geometry
- Replicated Reynold's number from Agua Fria
- Used air instead of natural gas for the medium

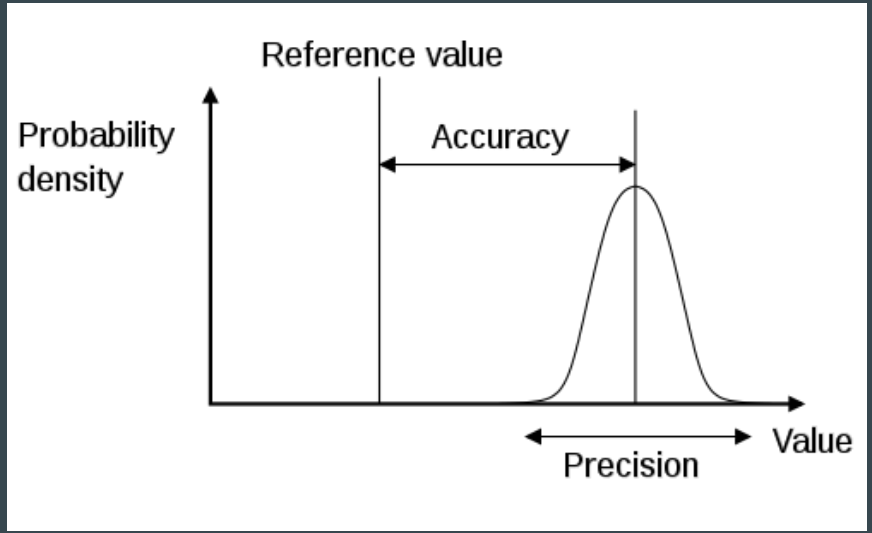


Proposed Solutions

- Change flow meter from orifice to Venturi tube
- Insert flow straightener after pipe bends
- Decrease beta coefficient of the orifice plate
- Increase upstream straight pipe length

Statistical Methods

- Analyzed how clustered the data are
- Calculated precision of data
- Higher precision correlates with higher measurement accuracy

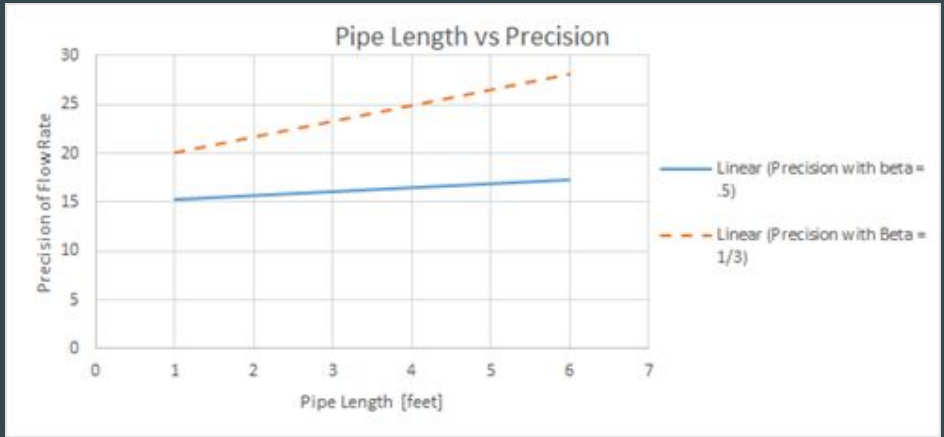


[6]

Altering Orifice Geometry

- Relationship of orifice diameter ratio to accuracy
- Beta coefficient at Agua fria currently between 0.63 and 0.65
- Lower beta corresponds with shorter necessary upstream length

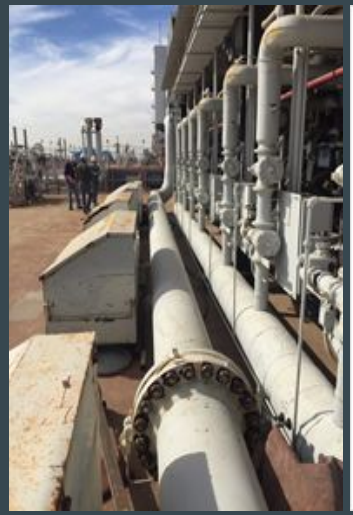
[7]

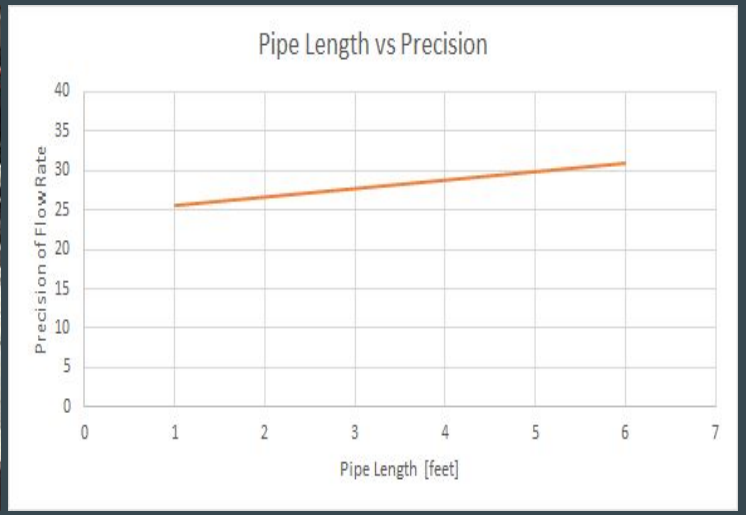


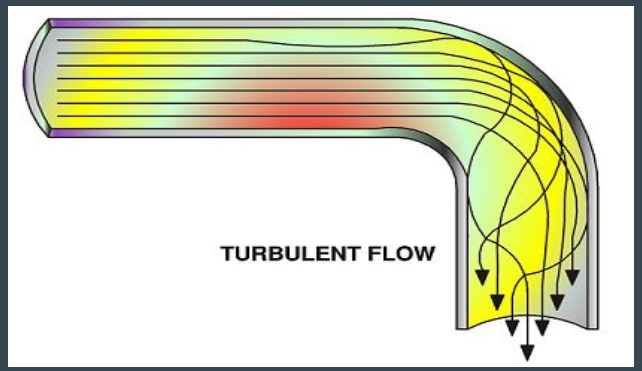
	Upstream Straight Lengths				
β	Single 90° Bend	Two 90° Bends in Perpendicular Planes	Reducer 2D to D Over 1.5D to 3D	Gate Valve Fully Open	Downstream
0.2	10(6)	34(17)	5	12(6)	4(2)
0.3	10(6)	34(17)	5	12(6)	5(2.5)
0.4	14(7)	36(18)	5	12(6)	6(3)
0.5	14(7)	40(20)	6(5)	12(6)	6(3)
0.6	18(9)	48(24)	9(5)	14(7)	7(3.5)
0.7	28(14)	62(31)	14(7)	20(10)	7(3.5)
0.75	36(18)	70(35)	22(11)	24(12)	8(4)

Pipe Length

- Longer pipe length allows flow to fully develop
- Longer pipe length correlates with higher precision
- Upstream distance increases with number of bends





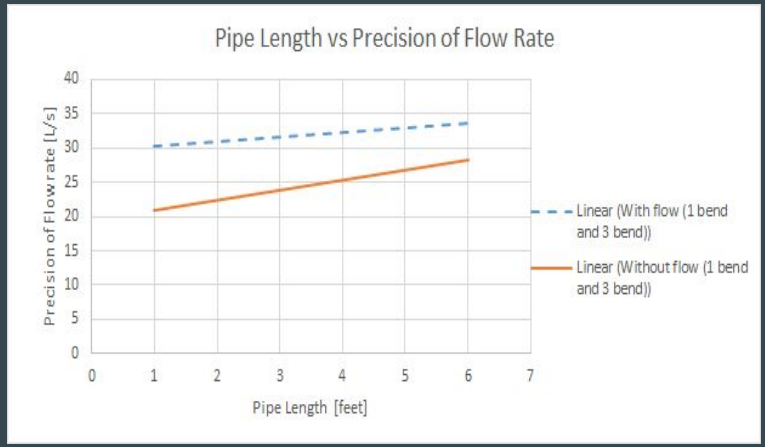


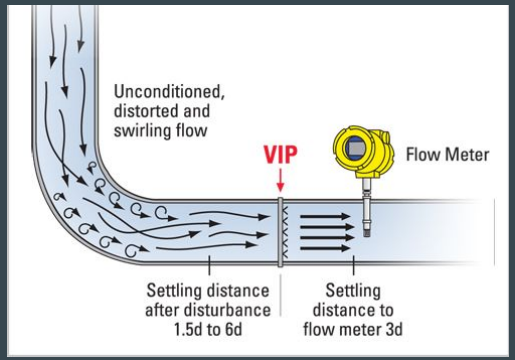
[8] Effect of Bends in Pipe

Abdullateef Alhumaidan - 4/28/2017
SRP Fluids Analysis Team 33

Flow Straightener

- Flow straightener allows flows to fully develop at a faster rate
- Adding flow straightener increases precision in flow rate measurement
- Flow straightener had the largest impact on precision in 3 bend scenario





[9] Effects of Flow Straightener

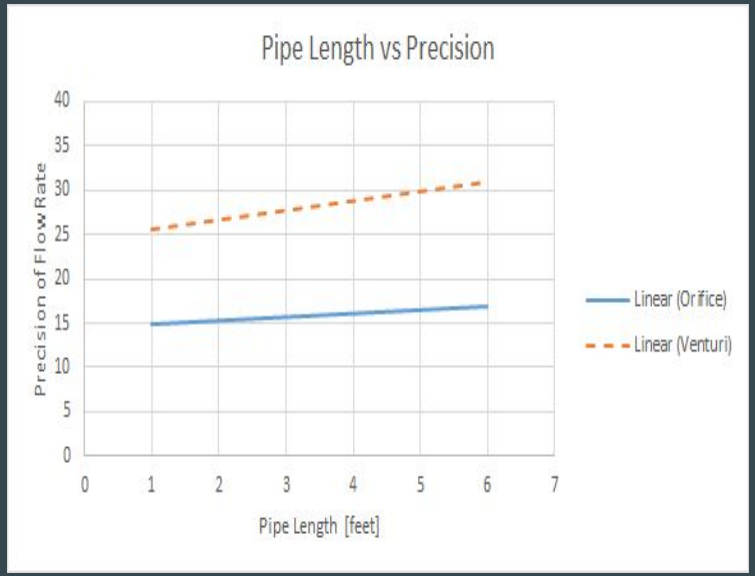
Abdullateef Alhumaidan- 4/28/2017
SRP Fluids Analysis Team 33

Flow Meter

- Compared the precision of orifice and Venturi

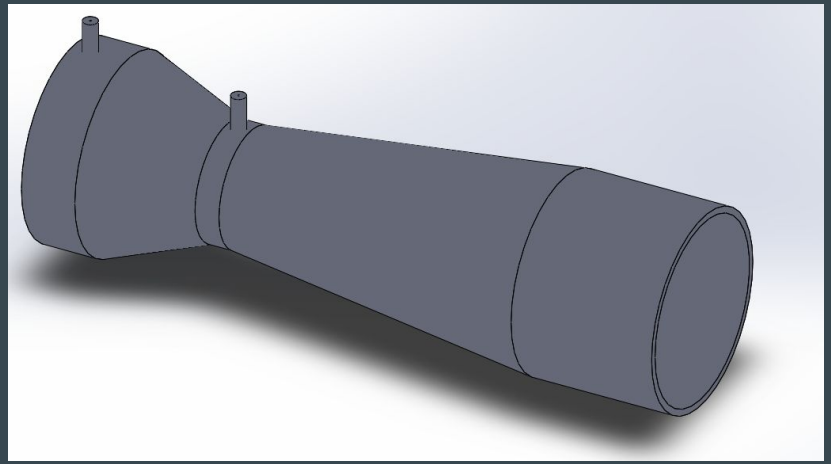
- Smooth transition with Venturi vs instantaneous transition with orifice

- Data showed that precision was greater for Venturi tube than orifice plate



Recommendations

- Either change from orifice to venturi, or change the orifice diameter
- Insert a flow straightener directly after the pipe bend before the measurement station
- Increase the upstream pipe length



Thank you

Acknowledgments

- Vy Kieu, SRP representative
- Sara McCoy, SRP plant manager
- Agua Fria operations staff
- Dr. David Trevas, NAU
- Dr. Sagnik Mazumdar
- Dr. Thomas Acker

References

[1]Indiamart, “”Orifice Plate - Restriction Orifice Plate.” [Online]. Available: http://www.indiamart.com/tansa/orifice-plate-assembly.html. [Accessed: 25-Oct-2016]

[2]Emerson, “FloBoss 107E Flow Manager” [Online} Available: http://www2.emersonprocess.com/en-US/brands/FloBoss/gasflowcomputers/107E/Pages/107E.aspx. [Accessed 25-Oct-2016]

[3]"Orifice, Nozzle And Venturi Flow Rate Meters". *Engineeringtoolbox.com*. N.p., 2017. Web. 21 Apr. 2017.

[4]"Two Technologies - Doppler And Transit Time Ultrasonic Flowmeter Technologies Explained". *Greyline.com*. N.p., 2017. Web. 21 Apr. 2017.

[5]"Coriolis Mass Flow Meter Working Animation Instrumentation Tools". *Instrumentation Tools*. N.p., 2017. Web. 21 Apr. 2017.

[6]"Understanding Accuracy And Precision For MEMS Pressure Sensors". *Design World*. N.p., 2017. Web. 21 Apr. 2017.

[7]J. P. Holman, Holman, and Search our Used & Out of... Holman, *Solutions manual to accompany experimental methods for engineers, sixth edition*, 6th ed. New York: McGraw Hill Higher Education, 1993

[8]”Cite A Website - Cite This For Me". *Gpmhydraulic.com*. N.p., 2017. Web. 21 Apr. 2017.

[9]"VIP - VORTAB Insertion Panel Flow Conditioner", *Vortab.com*, 2017. [Online]. Available: http://www.vortab.com/Flow-Conditioners/VIP-Flow-Conditioner.asp. [Accessed: 01- Feb- 2017].

[10] Emerson (2010). *Theoretical Uncertainty of Orifice Flow Measurement* [Online]. ETA Process Instrumentation.