



BALANCED FLOW METERS



- The balanced flow meter technology was conceived, created and tested through the Marshall Center's Technology Investment Program
- Licensed in August 2003, the technology was developed by NASA and A+Flowtek.
- Originally designed for potential use in space shuttle main engines
- Further development made this invention suitable for commercial applications

A+ FLOWTEK

Balanced Flow Meter

- **Patent No. US 7,051,765 B1**
- **AWARDED 2007 NASA/MSFC INVENTION OF THE YEAR**
- **Balanced Flow Meter Inventors**
 - **Paul Van Buskirk, MSChE - QMC
Technical Director**
 - **Anthony R. Kelley, MSEE, MSIT - NASA
Avionics**

BFM Advantages Over Orifice Plates

- **Ten times improvement in accuracy**
- **100% increase in pressure recovery**
- **No need for strait pipe runs before of after the plate**
- **Extreme resistance to Scaling**
- **15 times reduction in noise energy/vibration**
- **Permanent pressure loss, accuracy and discharge coefficient comparable with a venturi meter**

About Graftel



- **Graftel is a specialized products and services company located outside of Chicago Illinois.**
- **For over 16 years, Graftel has serviced the nuclear power community.**
- **We currently work with most of the Nuclear Facilities in the continental United States as well as plants in Korea, Japan, Brazil, and England.**

QUALITY ASSURANCE

- **Graftel's QA program meets the requirements of 10CFR50 Appendix B, 10 CFR 50 Part 21**
- **All calibrations are performed in compliance with both ANSI/NCSL Z540-1-1994 and ISO 17025-2005.**
- **Graftel in the NUPIC database as supplier of calibration, software and engineering services**

Graftel is Certified by L.A.B. as an ISO/IEC 17025:2005 Compliant Calibration Laboratory



Laboratory Accreditation Bureau

Certificate of Accreditation

ISO/IEC 17025:1999

Certificate Number L2115

Graftel, Inc.
5050 Newport Drive, Suite 7
Rolling Meadows, IL 60008

has been accredited for technical competence in the major fields and related disciplines on the approved scope of accreditation. They have met the requirements set forth in L-A-B's policies and procedures, and all requirements of ISO/IEC 17025:1999 "General Requirements for the competence of Testing and Calibration Laboratories."

Accreditation effective March 28, 2005 and valid through March 28, 2008

Peter B. Lake
Executive Director

R. Douglas Leonard, Jr., Chief Technical Officer
Laboratory Accreditation Bureau

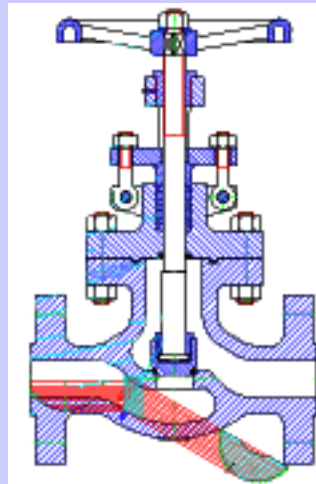
Graftel's Scope of Accreditation

- Liquid Flow
- Gas Flow
- Gas Velocity
- Temperature
- Relative Humidity
- Dew Point Temperature



NUCLEAR INDUSTRY HISTORY

- Graftel is a supplier, designer and manufacturer of instrumentation and software.



The following plants are a few of those in the US and Korea that have used Graftel's instruments:

- Surry
- North Anna
- Dresden
- Quad Cities
- LaSalle
- Byron
- Braidwood
- TVA - All Sites
- Duke Energy – All Sites
- River Bend
- Omaha Public Power District
- Pacific Gas & Electric
- Southern California Edison
- Public Service Gas & Electric
- Texas Utilities
- Union Electric
- Nebraska Power & Light
- Calvert Cliffs
- Turkey Point 3 & 4
- All KEPCO nuclear plants in South Korea



Technical Background

- **QMC established in 1996 for advanced monitoring & control (health management, sensor validation, etc.)**
- **Founders developed ABB Instrumentation and DuPont's flow meter sizing programs**
- **A+ FlowTek established in 2002 for commercialization of several co-patents with NASA and QMC**
- **First commercial Balanced Flow Meter sale in 2004**

Graftel and A+ Flowtek

- **Balanced flowmeter technology is owned by NASA under patent 10 / 750,628**
- **A+ Flowtek has exclusive rights to this patent.**
- **Graftel, Inc. has exclusive rights to distribute BFMs to the nuclear power industry**

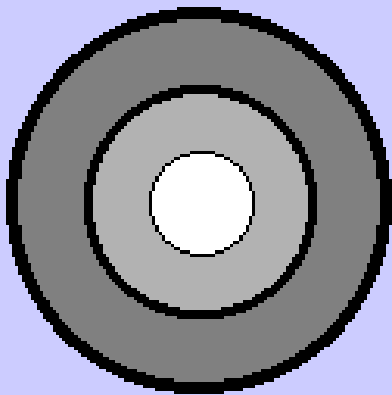
Balanced Flow Meters

- **Accuracies of 0.25% of Reading**
- **Accuracy Unaffected by Entrance and Exit Lengths**
- **Reduced System Pressure Drop**
- **Reduced Vibration**
- **Direct Drop-in Replacement to an Orifice**

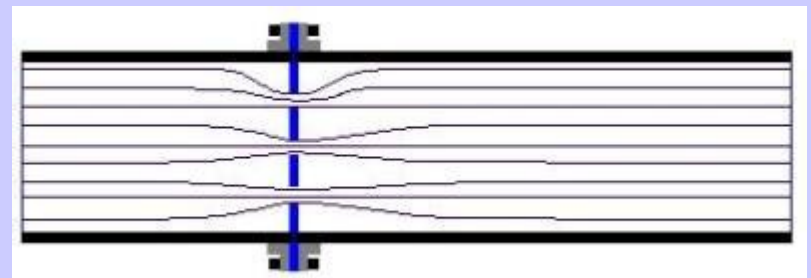
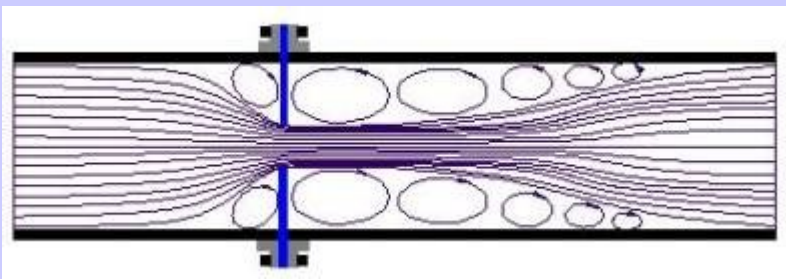
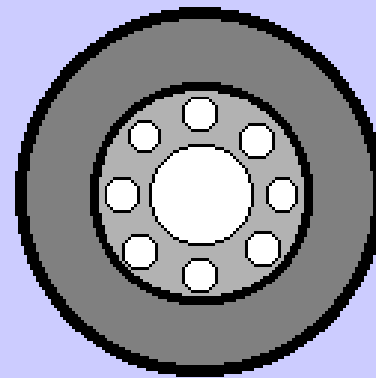


Orifice Plate and BFM Flow Patterns

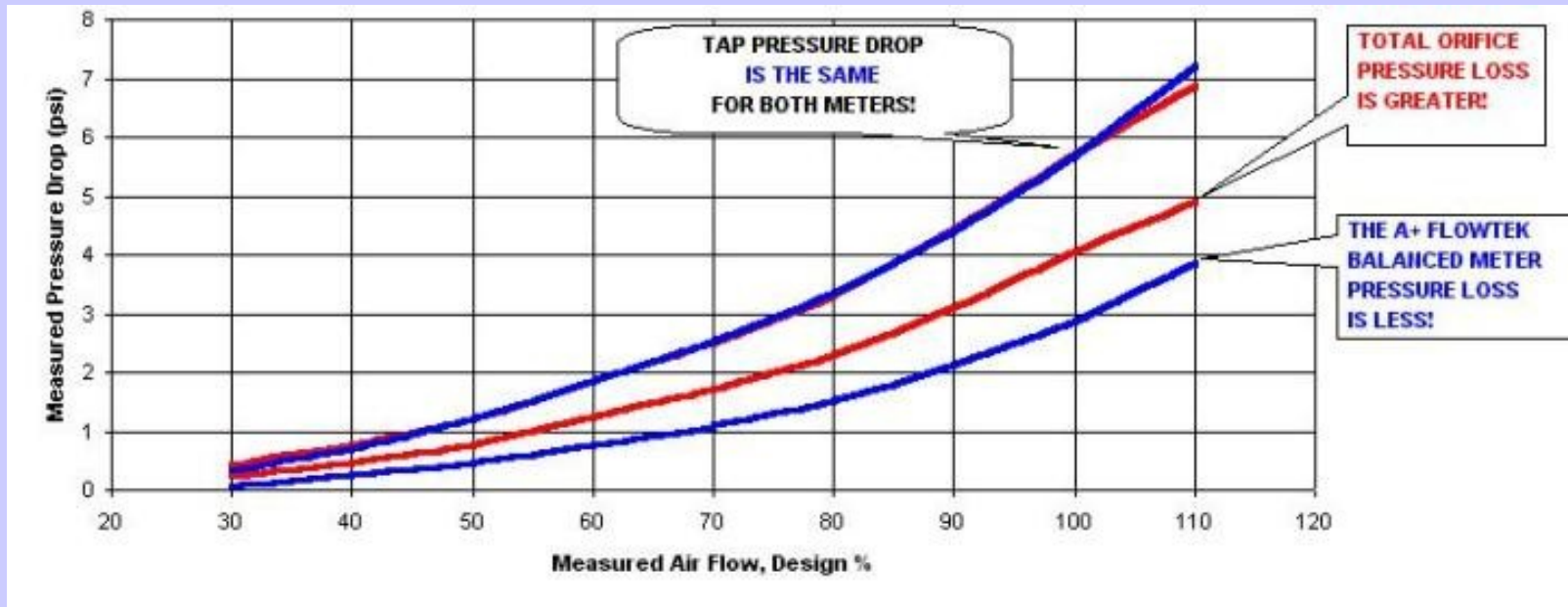
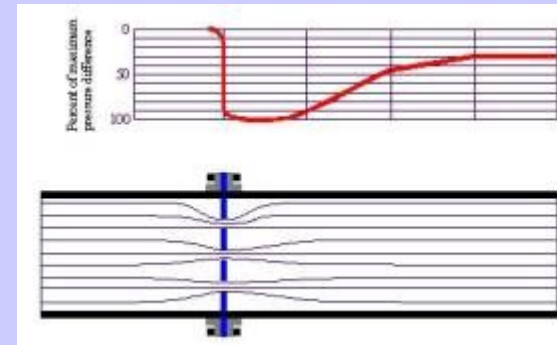
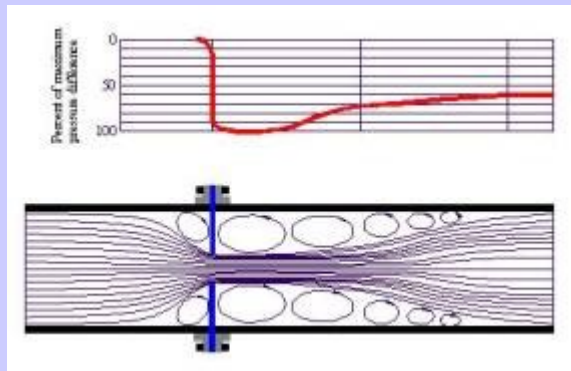
Single Hole Orifice



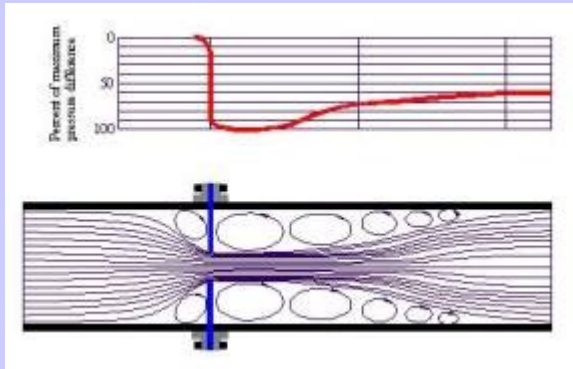
Multi Hole BFM



BFM and Orifice Plate Pressure Drops

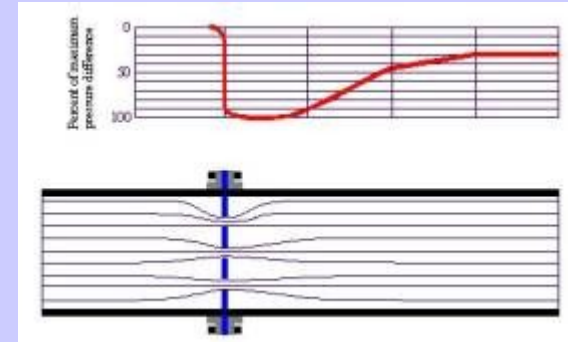


Orifice Plate and BFM Scaling



Orifice plates have dead flow zones before and after the plate

These zones allow scale to form on the plate, effecting accuracy



BFMs minimizes eddy current formations

Both sides of the plate are washed with flowing liquid

This does not allow the formation of scale

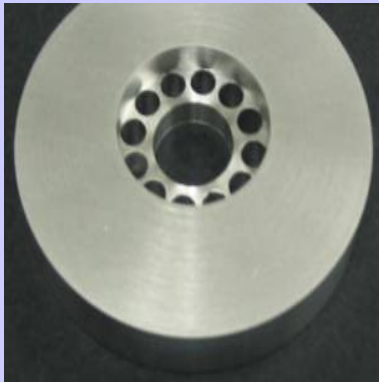
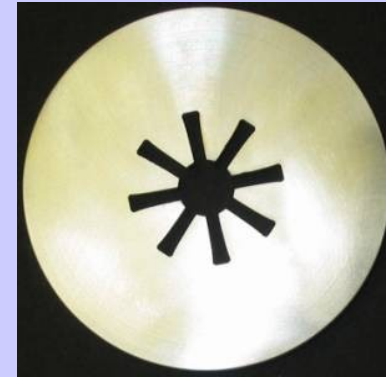
SELF CHECKING FEATURE

- **BFMs allow for self checking of accuracy during operation**
- **Pressure drop taps may be located in two or three locations rather than just one**
- **By independent calibration of each tap, two or three measurements may be made of the same flow rate**
- **Each tap should yield the same flow rate, any difference would indicate any loss of accuracy**
- **These readings may be constantly monitored during operation**

BFM Tapped for Self Checking



Balanced Flow Meter Designs



Permanent pressure loss, accuracy and discharge coefficient comparable with a Venturi meter!

SN 50410002

6 inch, 0.25" thick, Beta 0.752400

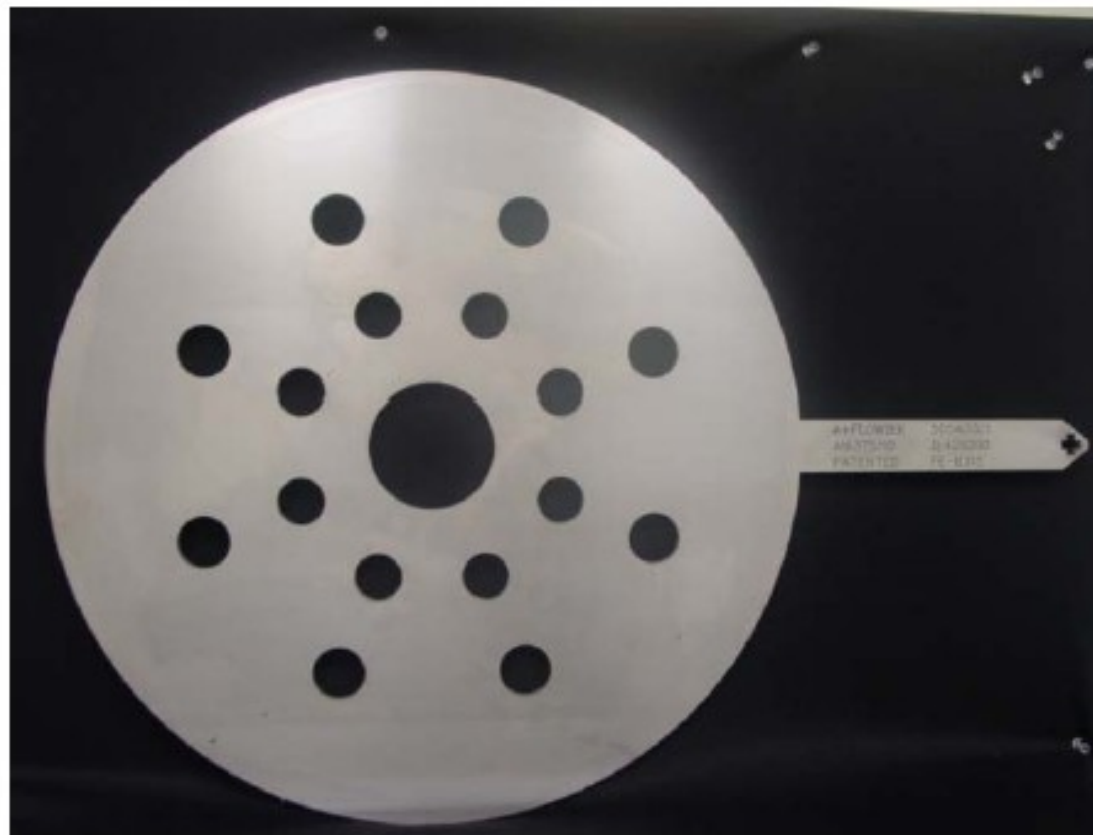
Application: Chilled cooling water loop and silencer



SN 50540001

16 inch, 0.25" thick, Beta 0.426200

Application: Steam



SN 51380001-2

8 inch, 0.25" thick, Beta 0.593

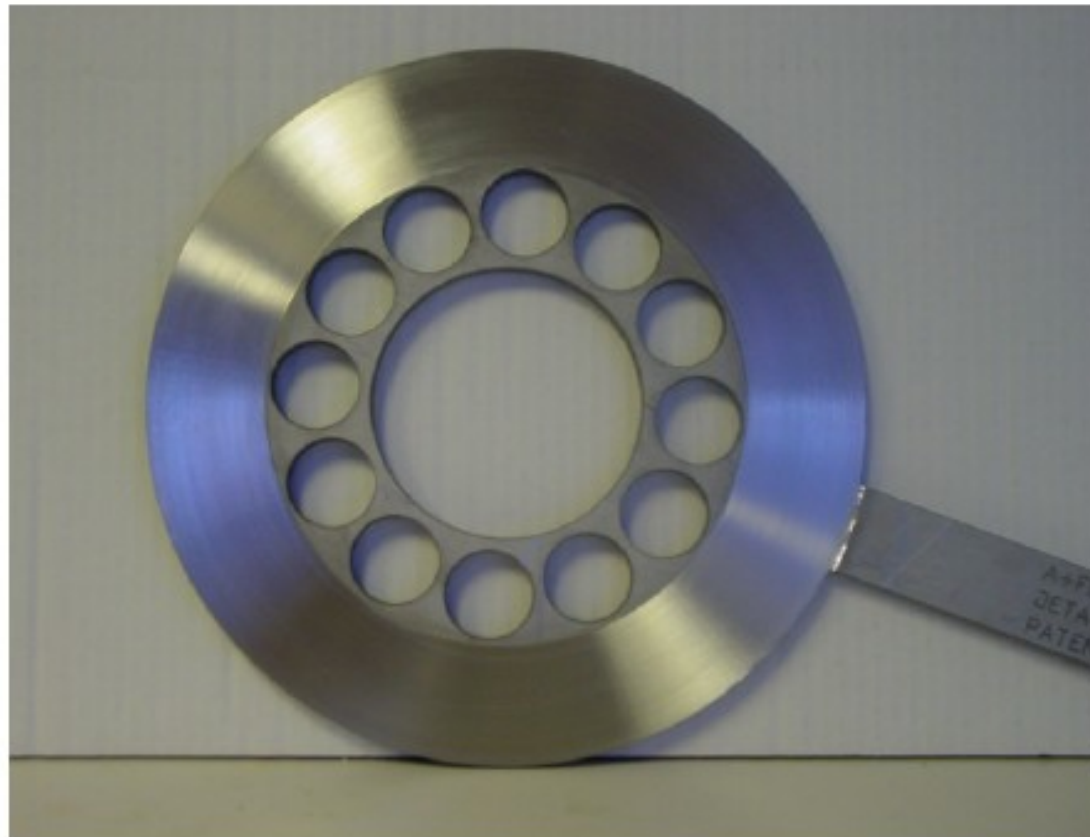
Application: Refinery hydrocarbon liquid



SN 52420001

8 inch, 0.375" thick, Beta 0.85

Application: High pressure steam



SN 60530001-5

8 inch, 0.5" thick, Beta 0.77318

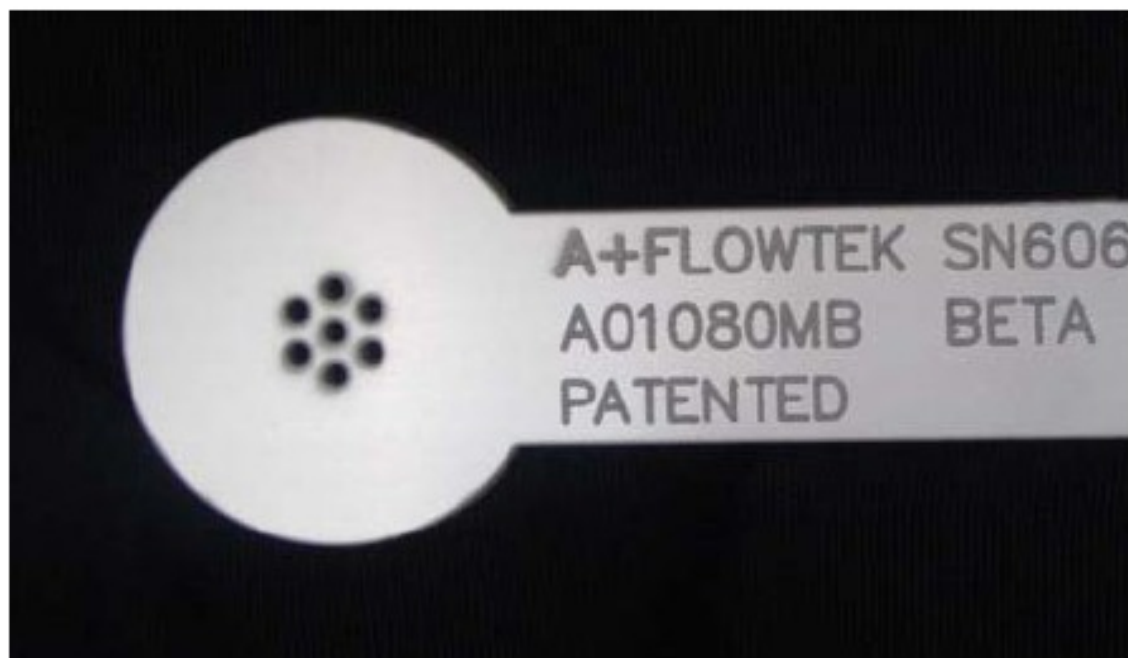
**Application: Well head gas and condensate flow
(high pressure 2-phase flow)**



SN 60650001-2

1 inch, 0.25" thick, Beta 0.34553

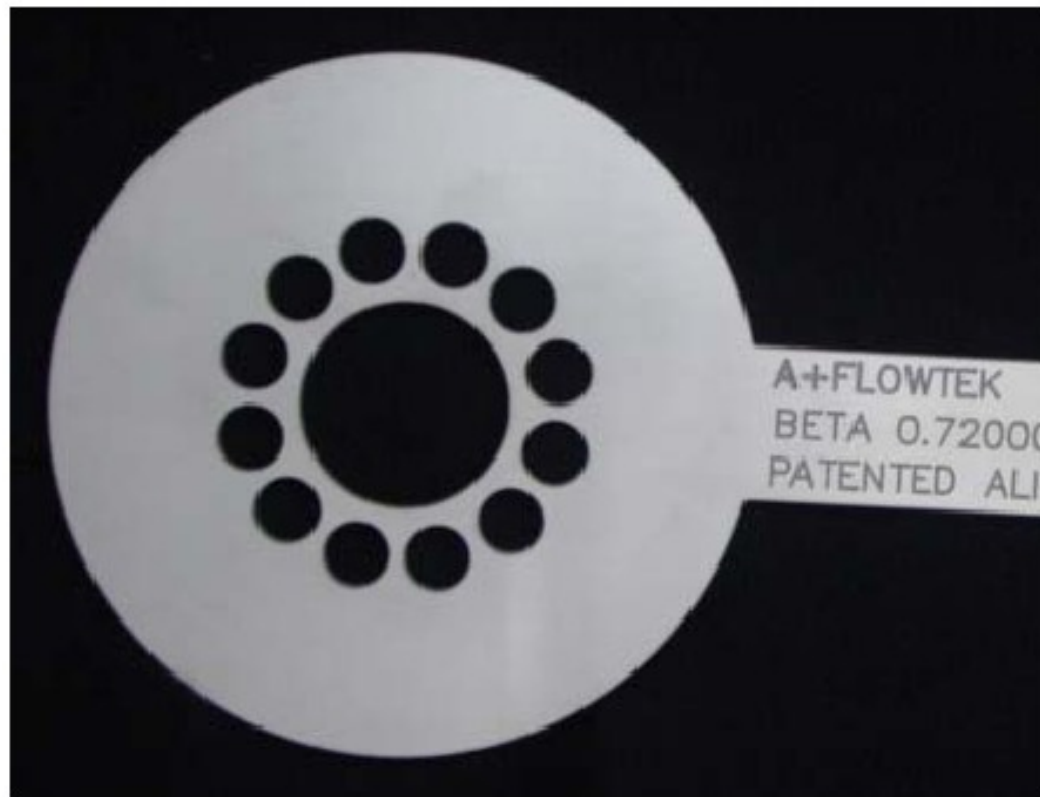
Application: Nitrogen utility stream



SN 60890002-3

4 inch, 0.25" thick, Beta 0.72000

Application: Air compressor stream



SN 60970001

4 inch, 0.25" thick, Beta 0.66213

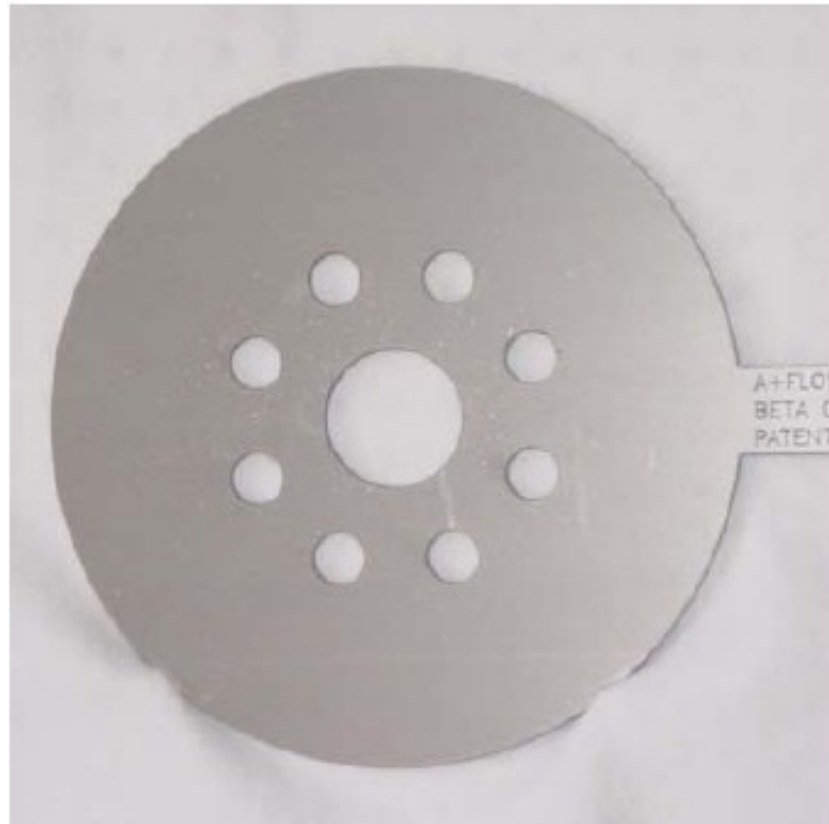
Application: Water cooler



SN 61580001

4 inch, 0.25" thick, Beta 0.43910

Application: High Pressure Air



Feedwater Flow Rate Measurement

- **BFM orifice plates can be supplied by Graftel custom sized to an accuracy of 0.25 % of reading**
- **Associated DP instruments, temperature sensor and programmed processor to output a scaled analog signal can also be supplied**

Feedwater Flow Rate Measurement

- **Appendix B, Part 21 calibrations for all instruments can be provided by Graftel**
- **Equipment can be provided safety related Part 21 by Graftel working in conjunction with Ecker-Erhardt Company and their Appendix B program**