

# BVT-U

# TECHbrief

Wyatt Badger Venturi Tubes  
Fabricated Primary Elements



## FEATURES:

- High Accuracy
- Low Pressure Loss
- Custom Designed
- Low Signal-to-Noise Ratio
- Documented Performance

## Description

Wyatt's Badger Venturi Tubes are available as a fabricated series of modified Venturi flow elements that can be used to measure the flow of gases and liquids over a wide range of temperatures and pressures in full pipes. The fabricated **BVT-U** maintains its accuracy over a greater range of flow rates and incurs lower permanent pressure loss than either the ISO or ASME Venturi designs. Wyatt's fabricated BVT series can be manufactured from practically any metal or alloy. Each unit, therefore, is designed specifically for your application.

## Application

The **BVT-U** series of fabricated Venturis (**BVT-U**, **BVT-F**, **BVT-B**, and **BVT-IL**) are often used in applications where the flow stream demands specific material selection due to pressure and/or temperature, or the corrosive/erosive properties of the fluid being measured. **BVT-U** installations are found in:

Power Plants  
Refineries  
Petrochemical Plants  
Cryogenic Processes  
Water and Sewage Plants  
Steam Custody Transfer  
Fiscal Metering

## Low Uncertainty

For pipe Reynolds numbers greater than 75 000, and with a normalized piping configuration, the Wyatt **BVT-U** provides a flow measurement accuracy of  $\pm 0.50\%$  without flow calibration. With independent flow calibration, Wyatt Engineering's Badger Venturi Tubes provide the user with an uncertainty band of  $\pm 0.25\%$  or better.

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## Accuracy

For pipe Reynolds numbers greater than 75 000 and normalized piping, the Wyatt **BVT-U** Venturi tube provides a flow measurement uncertainty of:

- ± 0.50% for standard QS9001 calibrated meters and
- ± 0.25% for flow calibrated meters.

## Pressure Loss

The permanent pressure loss of the fabricated BVT product line is significantly lower than that of short-form Venturis, and, for most beta ratios, lower than that of long-form Venturis as well. Call Wyatt Engineering for detailed headloss information on the design and process data for your application.

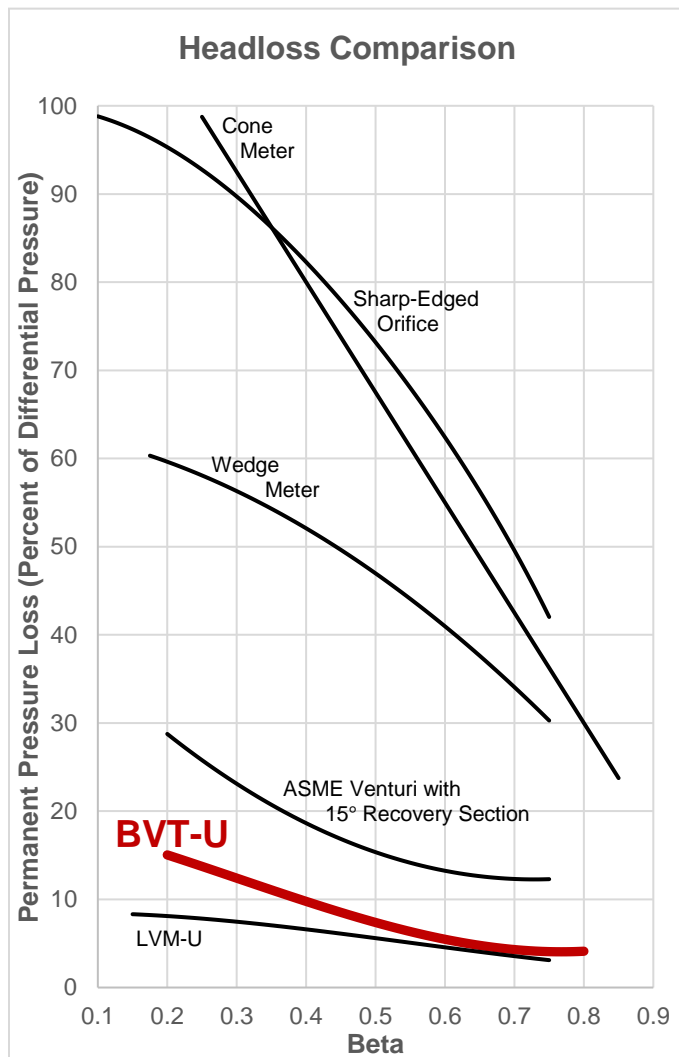


Figure 1

## Beta Ratio

Wyatt can furnish fabricated BVT products with any diameter ratio (d/D). This provides users with accurate flow measurement over a broad range of flow rates for a given line size.

## Temperature Range

Depending on the materials of construction, the fabricated **BVT-U** can operate over a fluid temperature range of -425 °F to +1200 °F (-250 °C and +650 °C).

## Pressure Range / End Connections

Flanged end connections, per ANSI B16.5 or 16.47 for 150 PSIG through 2500 PSIG service, are available. Various end connections are also available, including plate, slip-on, weld neck, Van Stone, RTJ, or beveled for butt-welding.

## Piping Requirements

Designed for full-pipe flow, BVT flow meters may be mounted either horizontally, at an angle, or vertically. For recommended upstream piping, refer to Wyatt Engineering TECHspec for the BVT design.

## Energy Considerations

Figure 1 compares the headloss of the **BVT-U** with that of other primary flow elements. The pressure recovery of Wyatt's **BVT-U** will lead to reduced pumping costs. The Wyatt **BVT-U** has a shorter laying length and exhibits better recovery than standard classical Venturi meters and most modified Venturis.

## Design Concepts

The BVT hydraulic design produces a predictable and stable discharge coefficient. The pressure taps and smooth transition section minimize flow noise and lessen the effects of aging, corrosion, and/or erosion. Flow measurement of compressible fluids is performed accurately and reliably.

## Signal-to-Noise Ratio

Within the specified flow range and piping conditions, the **BVT-U** will produce signal-to-noise ratios greater than 98%. This level of performance is essential for sensitive process control and reactive rate-of-flow control applications.

# BVT-U Sizing Table

Inlet Diameter		Throat Diameter		Beta Ratio	Overall Length		Outlet Diameter		ΔP = Differential Pressure of 100.00" wc (24.864 kPaD)						
									Water Flow at 60° F (16° C)					ΔH = Headloss	
(inches)	(mm)	(inches)	(mm)		(inches)	(mm)	(inches)	(mm)	US GPM	US MGD	LPS	m <sup>3</sup> /d	R <sub>D</sub> (10 <sup>-3</sup> )	in. wc	kPa
3.068	78	1.500	38.1	0.4889	7.60	193	2.30	58	130.06	0.187	8.205	708.94	120	9.8	2.43
3.068	78	1.800	45.72	0.5867	7.70	196	2.60	66	193.56	0.279	12.212	1055.1	178	7.1	1.76
3.068	78	2.100	53.34	0.6845	7.70	196	2.80	71	279.79	0.403	17.652	1525.2	258	4.5	1.12
4.026	102	2.000	50.80	0.4968	10.10	257	3.00	76	231.66	0.334	14.616	1262.8	163	9.2	2.30
4.026	102	2.400	60.96	0.5961	10.20	259	3.40	86	345.61	0.498	21.805	1883.9	243	6.6	1.64
4.026	102	2.800	71.12	0.6955	10.30	262	3.80	97	502.04	0.723	31.674	2736.6	352	4.1	1.03
6.065	154	3.000	76.20	0.4946	15.20	386	4.60	117	520.96	0.750	32.868	2839.8	243	8.8	2.20
6.065	154	3.600	91.44	0.5936	15.30	389	5.20	132	776.69	1.118	49.001	4233.7	362	6.3	1.57
6.065	154	4.200	106.68	0.6925	15.40	391	5.70	145	1126.7	1.622	71.083	6141.6	525	4.0	0.99
7.981	203	4.000	101.60	0.5012	20.20	513	6.10	155	927.71	1.336	58.529	5056.9	328	8.4	2.09
7.981	203	4.800	121.92	0.6014	20.40	518	6.90	175	1386.0	1.996	87.444	7555.2	491	5.9	1.47
7.981	203	5.600	142.24	0.7017	20.60	523	7.60	193	2019.2	2.908	127.39	11006.8	715	3.7	0.92
10.02	255	5.000	127.00	0.4990	25.20	640	7.70	196	1448.7	2.086	91.400	7897.0	408	8.2	2.05
10.02	255	6.000	152.40	0.5988	25.50	648	8.70	221	2162.9	3.115	136.46	11789.8	610	5.8	1.45
10.02	255	7.000	177.80	0.6986	25.70	653	9.50	241	3146.4	4.531	198.51	17151.0	887	3.6	0.91
12.00	305	6.000	152.40	0.5000	30.30	770	9.20	234	2086.7	3.005	131.65	11374.6	491	8.0	2.00
12.00	305	7.200	182.88	0.6000	30.60	777	10.40	264	3116.3	4.488	196.61	16987.2	734	5.7	1.41
12.00	305	8.400	213.36	0.7000	30.80	782	11.40	290	4536.5	6.532	286.21	24728.2	1068	3.5	0.88
13.25	337	7.000	177.80	0.5283	35.30	897	10.80	274	2863.3	4.123	180.65	15607.7	611	7.3	1.81
13.25	337	8.400	213.36	0.6340	35.70	907	12.10	307	4320.7	6.222	272.59	23552.0	921	4.8	1.20
13.25	337	9.800	248.92	0.7396	36.00	914	13.30	338	6428.2	9.257	405.56	35040.0	1371	3.0	0.76
15.25	387	8.000	203.20	0.5246	40.30	1024	12.30	312	3735.5	5.379	235.67	20362.2	692	7.3	1.80
15.25	387	9.600	243.84	0.6295	40.80	1036	13.90	353	5628.5	8.105	355.10	30680.7	1043	4.8	1.20
15.25	387	11.200	284.48	0.7344	41.10	1044	15.30	389	8346.9	12.02	526.61	45498.8	1546	3.0	0.76
17.25	438	9.000	228.60	0.5217	45.40	1153	13.80	351	4723.7	6.802	298.02	25748.7	774	7.2	1.79
17.25	438	10.800	274.32	0.6261	45.90	1166	15.60	396	7109.4	10.24	448.53	38753.4	1164	4.8	1.20
17.25	438	12.600	320.04	0.7304	46.20	1173	17.20	437	10518	15.15	663.58	57332.9	1723	3.0	0.75
19.25	489	10.000	254.00	0.5195	50.40	1280	15.40	391	5827.8	8.392	367.68	31767.2	855	7.2	1.78
19.25	489	12.000	304.80	0.6234	51.00	1295	17.40	442	8763.5	12.62	552.89	47770.0	1286	4.8	1.20
19.25	489	14.000	355.60	0.7273	51.30	1303	19.10	485	12941	18.64	816.46	70541.9	1899	3.0	0.75
23.25	591	12.000	304.80	0.5161	60.50	1537	18.50	470	8383.8	12.07	528.94	45700.0	1019	7.1	1.76
23.25	591	14.400	365.76	0.6194	61.20	1554	20.90	531	12591	18.13	794.39	68635.0	1530	4.8	1.20
23.25	591	16.800	426.72	0.7226	61.60	1565	22.90	582	18544	26.70	1169.9	101083	2253	3.0	0.74
29.25	743	15.000	381.00	0.5128	75.60	1920	23.10	587	13087	18.85	825.68	71338.8	1264	7.0	1.73
29.25	743	18.000	457.20	0.6154	76.50	1943	26.10	663	19631	28.27	1238.6	107011	1896	4.8	1.19
29.25	743	21.000	533.40	0.7179	77.00	1956	28.70	729	28839	41.53	1819.5	157201	2786	3.0	0.74
35.25	895	18.000	457.20	0.5106	90.70	2304	27.70	704	18834	27.12	1188.3	102665	1510	6.8	1.70
35.25	895	21.600	548.64	0.6128	91.80	2332	31.30	795	28230	40.65	1781.0	153881	2263	4.7	1.17
35.25	895	25.200	640.08	0.7149	92.40	2347	34.40	874	41403	59.62	2612.1	225685	3318	2.9	0.73
41.25	1048	21.000	533.40	0.5091	105.80	2687	32.40	823	25624	36.90	1616.6	139678	1755	6.7	1.68
41.25	1048	25.200	640.08	0.6109	107.10	2720	36.50	927	38387	55.28	2421.8	209245	2629	4.7	1.16
41.25	1048	29.400	746.76	0.7127	107.80	2738	40.10	1019	56235	80.98	3547.8	306534	3852	2.9	0.72
47.25	1200	24.000	609.60	0.5079	120.90	3071	37.00	940	33458	48.18	2110.9	182379	2001	6.7	1.65
47.25	1200	28.800	731.52	0.6095	122.40	3109	41.80	1062	50101	72.15	3160.9	273102	2996	4.6	1.15
47.25	1200	33.600	853.44	0.7111	123.10	3127	45.90	1166	73335	105.6	4626.7	399748	4385	2.9	0.71

This sizing table can be used as a guide to aid the user in choosing the proper **BVT-U** for a given application and reflects the most commonly used sizes. Other sizes and special geometries are available, often at no additional cost. Depending on the details of your application, a more appropriate selection, or a more accurate estimation of the performance of a given selection, may be available. Wyatt Engineering encourages users to contact their local Wyatt representatives, or call us directly, for definitive sizing information.

### Incompressible Flow Relationships:

$$\Delta P_N = 100 (Q_N / Q)^2$$

$$\Delta H_N = \Delta H (Q_N / Q)^{1.88}$$

$$Q_N = Q (\Delta P / 100)^{0.5}$$

### Examples:

For a 19.25" x 14.000" BVT-U, find  
 ΔP at 20 000 US GPM  
 ΔH at 20 000 US GPM  
 Q<sub>N</sub> at 750" wc

### Solutions:

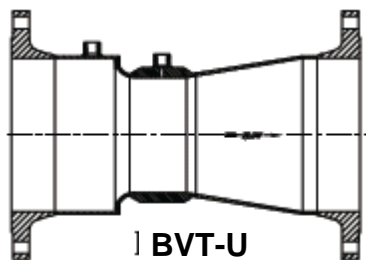
Found using the "Incompressible Flow Relationships"  
 ΔP<sub>N</sub> = 100 (20 000 / 12 941)<sup>2</sup> = 238.85" wc  
 ΔH<sub>N</sub> = 3.0 (20 000 / 12 941)<sup>1.88</sup> = 6.8" wc  
 Q<sub>N</sub> = 12 941 (750 / 100)<sup>0.5</sup> = 35 440 US GPM

# Available Options

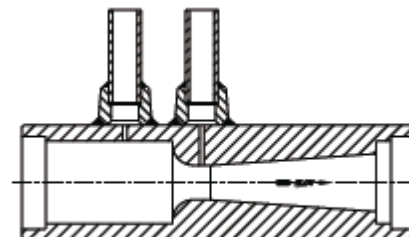
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## Fabricated BVT units are available in four styles:

**Model BVT-U** is designed to the ASME Boiler and Pressure Vessel Code. It is typically used at operating pressures less than 6 000 PSIG (41 350 kPaG) and temperatures less than +1 000 °F (+535 °C). The unique construction of the **BVT-U** allows for custom designs. For example, the throat can be manufactured from the correct alloy for maximum abrasion resistance, while the exit cone can be constructed with a different material for corrosion resistance. For flexibility, multiple pressure connections are available.



**Model BVT-B** is designed for service in which demanding process conditions require a uniquely rugged design. Machined from forged bar material, it is ideally suited for applications in which extreme temperature cycling and/or pressure cycling is encountered, such as the power industry. While the most common sizes are 12 inches (300mm) and less, the Wyatt Badger bar stock design has been made from 26" (660mm) diameter bar stock material.



**Model BVT-F** is used for more demanding process temperatures and pressures. Its pipe-shell design can be constructed and certified to meet the requirements of B31.1 and B31.3. The **BVT-F** is available in flanged and plain-end designs.

**Model BVT-IF** is designed for insertion within the interior of a pipeline and can be secured by companion flanges or welded directly into your pipeline. For more information on fabricated insert BVTs, see the Wyatt Engineering **BVT-IF** TechBrief.

## Materials of Construction

The versatile **BVT-U** design can be constructed from almost any material, including:

Carbon Steel  
300-Series Stainless Steel  
400-Series Stainless Steel  
Duplex and Super Duplex

Inconel  
Hastelloy B & C  
Monel  
Titanium

Cr-Mo Alloy  
Nickel  
Tantalum  
Zirconium

*Consult your local representative or Wyatt Engineering for information on other materials of construction.*



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