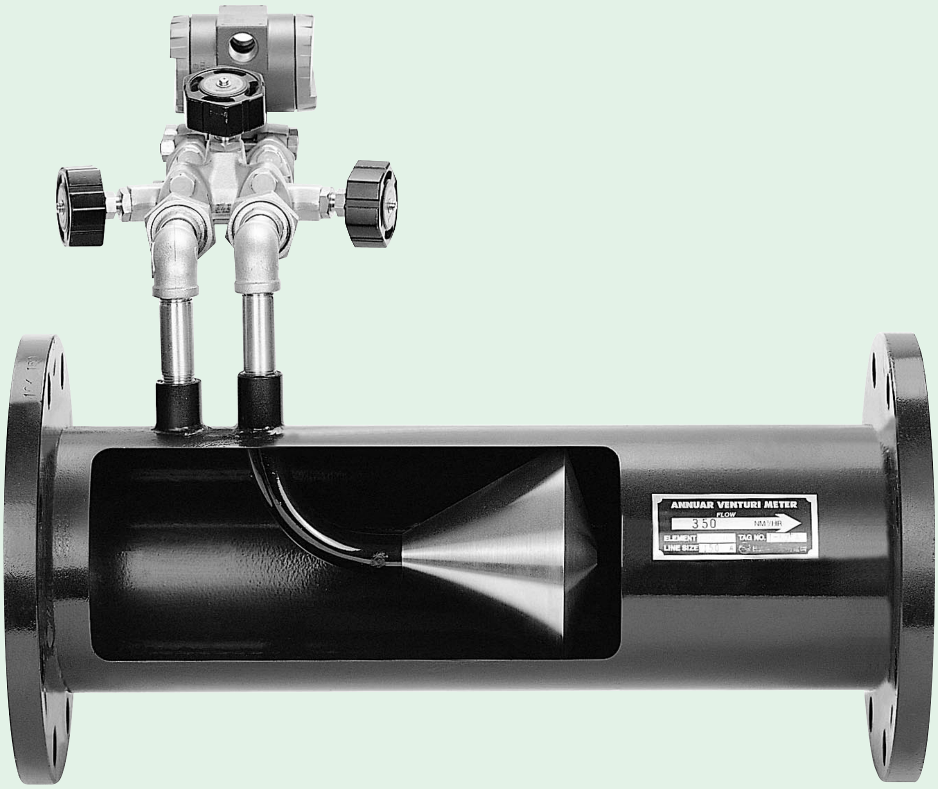
ANNULAR VENTURI METER



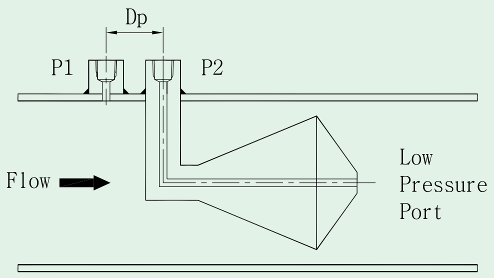
1.0 / General

1.1 Introduction

The Annular venturi meter is a patented technology that accurately measures flow over a wide range of Reynolds numbers, under all kinds of conditions and for a variety of fluids, It operates on the same physical principle as other differential pressure-type flowmeters, using the theorem of conservation of energy in fluid flow through a pipe. The Annular venturi meter remarkable performance characteristics, however, are the result of Its unique design, It features a centrally-located cone inside the tube. The cone interacts with the fluid flow, reshaping the fluid's velocity profile and creating a region of lower pressure immediately downstream of itself. The pressure difference, exhibited between the static line pressure and the low pressure created downstream of the cone, can be measured via two pressure sensing taps, One tap is placed slightly upstream of the cone, the other is located in the downstream face of the cone itself. The pressure difference can then be incorporated into a derivation of the Bernoulli equation to determine the fluid flow rate. The cone's central position in the line optimizes the velocity profile of the flow at the point of measurement, assuring highly accurate, reliable flow measurement regardless of the condition of the flow upstream of the meter.

1.2 Principles of Operation

The Annular venturi meter is a differential pressure type flowmeter. Basic theories behind differential pressure type flowmeters have existed for over a century. The principal theory among these is Bernoulli's theorem for the conservation of energy in a closed pipe. This says that for a constant flow, the pressure in a pipe is inversely proportional to the square of the velocity in the pipe. Simply, the pressure decreases as the velocity increases. For instance, as the fluid approaches the Annular venturi meter, it will have a pressureof P1, As the fluid velocity increases at the constricted area of the Annular venturi meter, the pressure drops to P2, as shown in figure 1. Both P1 and P2 are measured at the Annular venturi meter's taps using a variety of differential pressure transducers. The Dp created by Annular venturi meter will increase and decrease exponentially with the flow velocity. As the constriction takes up more of the pipe cross-sectional area, more differential pressure will be created at the same flowrates. The beta ratio equals the flow area at the largest cross section of the cone (converted to an equivalent diameter) divided by the meter's inside diameter.

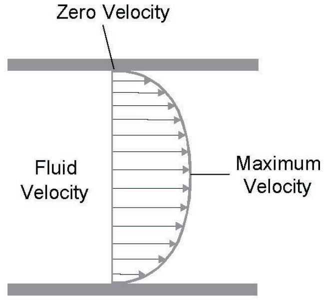


High and Low Ports
Figure 1

1.3 Reshaping the Velocity Profile

The Annular venturi meter is similar to other differential pressure (Dp) meters in the equations of flow that it uses. Annular venturi meter geometry, however, is quite different from traditional Dp meters, The Annular venturi meter constricts the flow by positioning a cone in the center of the pipe.

This forces the flow in the center of the pipe to flow around the cone. This geometry presents many advantages over the traditional concentric Dp meter. The actual shape of the cone has been continuously evaluated and tested for over ten years to provide the best performance under differing circumstances.

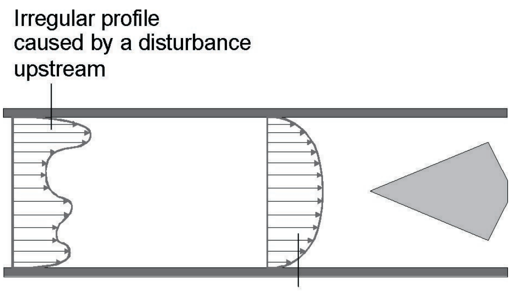


Velocity Profile
Figure 2

One must understand the idea of a flow profile in a pipe to understand the performance of the Annular venturi meter. If the flow in a long pipe is not subject to any obstructions or disturbances, it is well-developed flow. If a line passes across the diameter of this well-developed flow, the velocity at each point on that line would be different. The velocity would be zero at the wall of the pipe, maximum at the center of the pipe. and zero again at the opposite wall. This is due to friction at the pipe walls that slows the fluid as it passes. Since the cone is suspended in the center of the pipe, it interacts directly with the "high velocity core" of the flow. The cone forces the high velocity core to mix with the lower velocity flows closer to the pipe walls. Other Dp meters have centrally located openings and do not interact with this high velocity core.

This is an important advantage to the Annular venturi meter at lower flowrates. As the flowrate decreases, the Annular venturi meter continues to interact with the highest velocity in the pipe. Other Dp meters may lose their useful Dp signal at flows where the Annular venturi meter can still produce one.

The pipe flow profile in actual installations is rarely ideal. There are many insallations where a flowmeter exists in flow that is not well developed. Practically any changes to the piping, such as elbows, valves, reductions, expansions, pumps, and tees can disturb well-developed flow. Trying to measure disturbed flow can create a substantial problem for other flowmeter technologies. The Annular venturi meter overcomes this by reshaping the velocity profile upstream of the cone. This is a benefit derived from the cone's contoured shape and position in the line. As the flow approaches the cone, the flow profile "flattens" toward the shape of a well-developed profile.



Flattened Velocity Profile Figure 3

The Annular venturi meter can flatten the flow profile under even conditions, such as single elbows or double elbows out-of-plane positioned closely upstream of the meter. This means that as different flow profiles approach the cone, there will always be a predictable flow profile at the cone. This ensures accurate measurements even in non-ideal conditions.

2.0 / Features

2.1 High Accuracy

The Annular venturi meter primary element can be accurate to ±0.5% of reading. The level of accuracy is dependent to a degree on application parameters and secondary instrumentation.

2.2 Repeatabity

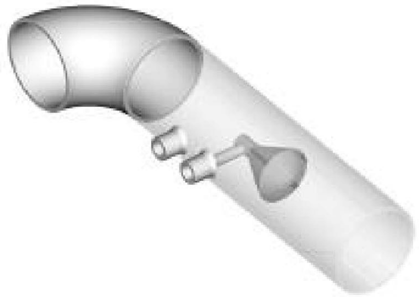
The Annular venturi meter primary element exhibits excellent repeatability of +0.1% or better

2.3 Turndown

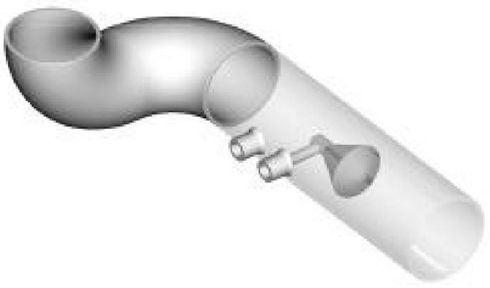
The turndown of the Annular venturi meter can reach far beyond traditional Dp meters. A typical turndown for a Annular venturi meter is 10 to 1. Greater turndowns are attainable. Flows with Reynolds numbers as low as 8000 will produce a linear signal. Lower Reynolds numer ranges are measurable and are repeatable by a curve fit to the measured Dp.

2.4 Installation Requirements

Since the Annular venturi meter can flatten the velocity profile, it can function much closer to upstream disturbances than other Dp meters. The recommended installation for the Annular venturi meter is zero to three diameters of straight run upstream and zero to one diameters downstream. This can be a major benefit to users with larger, more expensive line sizes or users with small run lengths available. Dae Han instrument conducted performance tests of the Annular venturi meter downstream of a single 90° elbow and two close coupled 90 elbows out of plane. These tests show that the Annular venturi meter can be installed adjacent to either single elbows or two elbows out of plane without sacrificing accuracy.



Single Elbow and Annular Venturi Meter
Figure 4



Double Elbow and Annular Venturi Meter
Figure 5

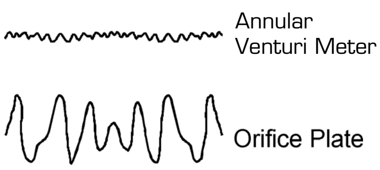
2.5 Long Term Performance

The contoured shape of the cone constricts the flow without impacting it against an abrupt surface. A boundary layer forms along the cone and directs the fluid away from the beta edge. This means the beta edge will not be as subject to the usual wear by unclean fluids. The beta ratio will then remain unchanged and the calibration of the meter will be accurate for a much longer time.

2.6 Signal Stability

Every Dp meter has a “signal bounce”. This means that even in steady flow, the signal generated by the primary

element will fluctuate a certain amount. On a typical orifice plate, the vortices that form just after the plate are long. These long vortices create a high amplitude, low frequency signal form the orifice plate. This could disturb the Dp readings from the meter. The Annular venturi meter forms very short vortices as the flow passes the cone.
These short vortices create a low amplitude, high frequency signal. This translates into a signal with high stability from the Annular venturi meter. Representative signals from a Annular venturi meter and from a typical orifice plate are shown in figure 6.



Singlnal Stability
Figure 2

2.7 Low Permanent Pressure Loss

Without the impact of an abrupt surface, the permanent pressure loss is lower than a typical orifice plate meter. Also, the signal stability of the Annular venturi meter allows the recommended full scale Dp signal to be lower for the Annular venturi meter than other Dp meters. This will lower the permanent pressure loss.

2.8 Sizing

The unique geometry of the Annular venturi meter allows for a wide range of beta ratios.
Standard beta ratios range from 0.45, 0.55, 0.65, 0.75, and 0.85.

2.9 No Areas of Stagnation

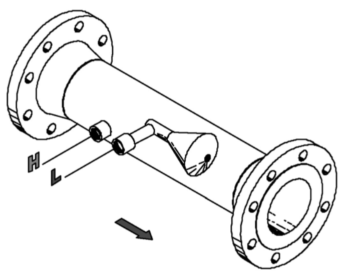
The "swept through" design of the cone does not allow for areas of stagnation where debris, condensation or particles from the fluid could accumulate.

2.10 Mixing

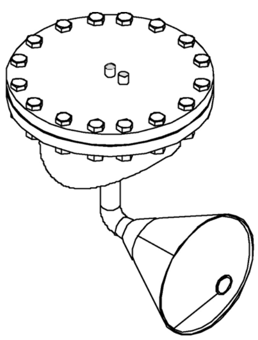
The short vortices described above mix the fluid thoroughly just downstream of the cone. The Annular venturi meter is currently in many applications as a static mixer where instant and complete mixing are necessary.

2.11 Two Models

Dae-han instrument offers two types of Annular venturi meter primary elements, the precision tube Annular venturi meter and the insertion top-plate Annular venturi meter. Precision tube Annular venturi meter range in line sizes from 15A to 600A and larger; and insertion top-plateAnnular venturi meter range in line size from 150A" to 1800A and larger.



Precision Tube Annular Venturi Meter
Figure 7



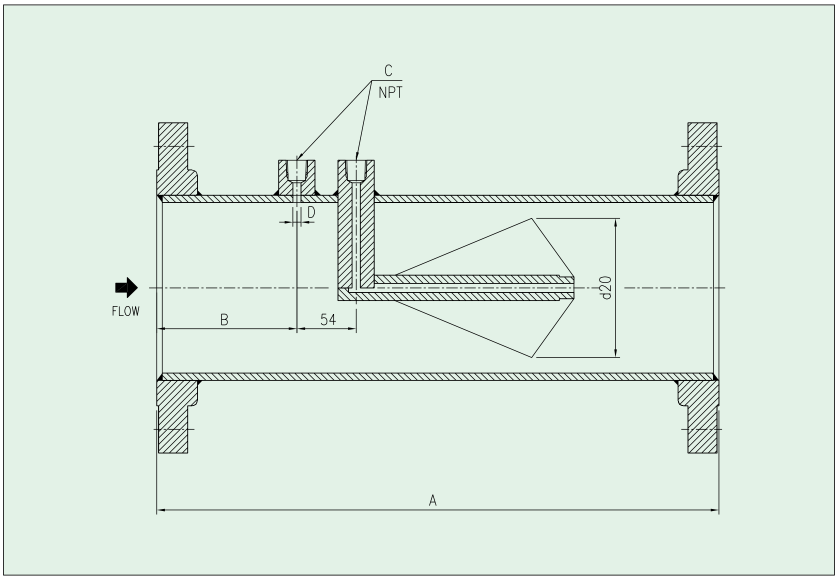
Insertion Top-plate Annular Venturi Meter
Figure 8

3.0 / Ordering informating

3.1 ANNULAR VENTURI METER STANDARD DIMENSIONS

(MODEL : DHAV-CC01)

FLANGE VERSION ▶



SIZE(mm)	A(mm)	B(mm)	C(PT)	C ϕ	REMARKS
15	203	64	1/4	6	150#, 300# ANSI, RF FLANGE
20	203	64	1/4	6	
25	203	64	1/4	6	
40	254	76	1/4	6	
50	305	89	1/2	6	
65	305	89	1/2	6	
80	356	89	1/2	6	
100	406	102	1/2	8	
150	559	108	1/2	8	
200	660	127	1/2	8	
250	711	127	1/2	8	
300	762	133	1/2	8	
350	762	152	1/2	8	
400	762	152	1/2	8	
500	914	152	1/2	8	
600	1219	254	1/2	8	
1800	4000	254	1/2	12	

LARGER ANNULAR VENTURI METER ON SPECIAL ORDER

* FLUID NAME

FLOW RATE (kg/hr, m3/hr)

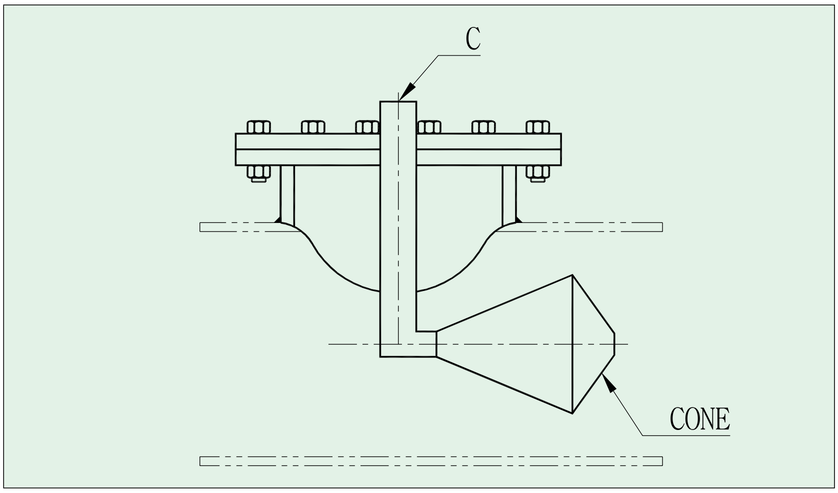
PRESSURE (kpa)

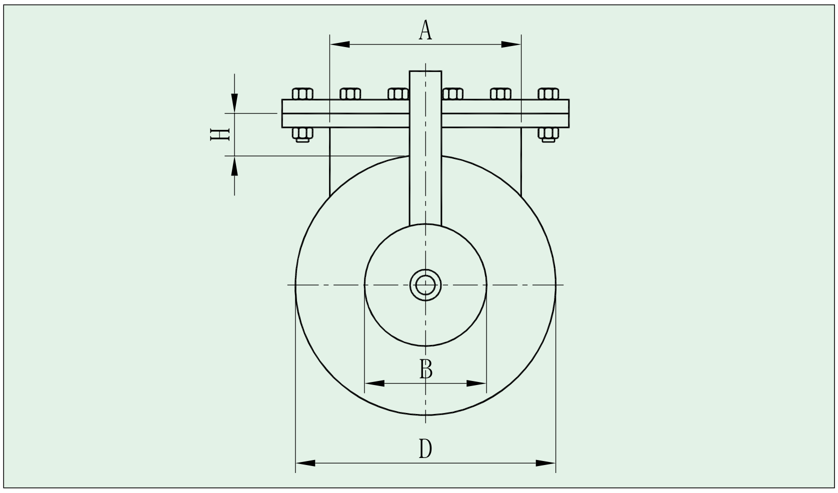
MATERIAL (304SS, 316SS, etc)

LINE SIZE (3B sch20. sch40, etc)

3.2 ANNULAR VENTURI METER WELDED TYPE

(MODEL : DHAV-CC02)





A		B	D	H		C	REMARKS
TOP PLATE SIZE(mm)	sch.	CON SIZE (mm)	LINE SIZE (mm)	150# (mm)	300# (mm)	NPT	ANSI RF FLANGE
150	40	~140	150~350	125	150	1/2	
200	40	~190	200~500	125	150	1/2	
250	40	~241	250~600	125	150	1/2	
300	40	~292	300~750	125	150	1/2	
350	40	~324	350~750	125	150	1/2	
400	40	~375	400~900	125	150	1/2	
450	std	~425	450~1000	175	200	1/2	
500	std	~476	500~1200	175	200	1/2	
600	std	~578	600~1400	175	200	1/2	
750	std	~730	750~1700	175	200	1/2	
900	std	~883	900~2250	175	200	1/2	

3.3 How To Order

STANDARD TYPE

(Model : DHAV-CC01)

LINE SIZE		MATERIAL				PIPE SCHEDULE		FLANGE CLASS	
			CONE	PIPE	FLANGE				
015A	15	Z	SS316	SS316	SS316	A	10	M	ANSI 150#
020A	20					B	20		RF/SO
025A	25	Y	SS304	SS304	SS304	C	40 Bored		
040A	40						(15A~150A)		
050A	50	X	SS304	CS	CS	D	std	N	ANSI 300#
065A	65						(400A 以上)		RF/SO
080A	80	W	Option	Option	Option	E	40		
100A	100						(200A~350A)		
150A	150					F	80	O	ANSI 600#
200A	200					G	160		RF/SO
250A	250								
300A	300								
350A	350							P	ANSI 900#
400A	400								RF/SO
500A	500								
600A	600								
750A	750								
900A	900								

Ex : DHAV-CC01-100AYCM

WELDED TYPE

(Model : DHAV-CC02)

LINE SIZE		MATERIAL				PIPE SCHEDULE		FLANGE CLASS	
			CONE	PIPE	FLANGE				
0400A	400	Z	SS316	SS316	SS316	A	10	M	ANSI 150#
0450A	450					B	20		RF/SO
0500A	500	Y	SS304	SS304	SS304	C	40 Bored		
0600A	600					D	std		
0750A	750	X	SS304	CS	CS		(400A 以上)		
0900A	900					E	40		
1000A	1000	W	Option	Option	Option	F	80		
1200A	1200					G	160		
1500A	1500								
1800A	1800								

Ex : DHAV-CC02-0600AXDM