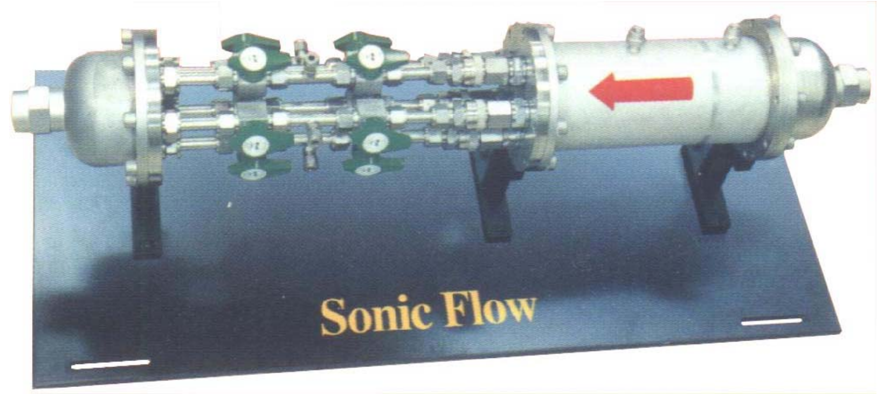
JAIN TECHNOLOGY

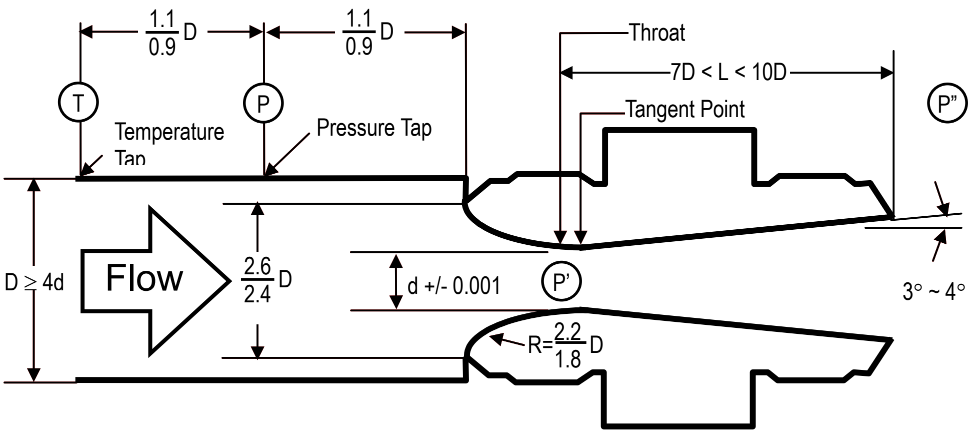
Sonic Nozzle Bank

Primary Element that Replaces Bell Provers and Piston Provers



What is Sonic Nozzle Bank and What does it do?

Our Sonic Nozzle Bank is composed of, from upstream to downstream, the stagnation temperature measuring tap, the stagnation pressure measuring tap, the nozzle holder plate, the sonic nozzle array, the precision ball valves, leakage checking port and the downstream holder plate. And each nozzle consists of a Bell Mouth converging inlet section, a minimum area throat followed by a conical diverging diffuser section(as sown in the diagram below).



Schematic Diagram of a Sonic Nozzle

The nozzles are designed and manufactured to the ISO standard and as such the gas is accelerated along the Bell Mouth converging section and then is expanded in a conical diverging section, which is designed for pressure recovery. In the throat, or minimum area point of the Sonic Nozzle, the gas velocity becomes equal to the speed of sound. At this point, gas velocity and density are maximized, and the mass flow rate is a function of the inlet pressure, inlet temperature, and the type of gas. So, you only need to measure the inlet pressure and temperature to determine the flow rate. The flow rate varies linearly with the upstream pressure and is not affected by downstream pressure fluctuation or changes by virtue of sonic velocity existing at the throat. The diffuser provides efficient recovery allowing critical flow to be maintained at inlet to exit pressure ratios (P/P”) as low as 1.2. There are no moving parts to affect reliability.

Our sonic nozzle bank is designed with a one-touch connection concept for the ease of connection and disconnection of the nozzles. Several nozzles are combined to adjust the flow rate and there's a test port between vales, which is designed for the testing of the valve leakage.

The material used meets surface property requirement for the precision machining, provides anti-corrosiveness and allows an accurate estimation of the nozzle throat diameter varied by the heat expansion.

- ✓ **Compact and Portable Design**
- ✓ **No Moving Parts - Low Maintenance Cost**
- ✓ **High Accuracy ±0.2% of Reading**
- ✓ **Wide Measuring Range (1:25000)**
- ✓ **Automated Measurement, Short Measurement Time and Easy to Use and Maintain**
- ✓ **Full Instrumentation with Flow Computer Option Possible**

Digital Wet Gas Meter

Leak Rate Monitor

Viscosity Fluid

Nozzle Specifications

Nozzle	Flow Range(Liter/Hour)
No. 1	6~39
No. 2	12~78
No. 3	24~158
No. 4	48~316
No. 5	96~624
No. 6	192~1248
No. 7	384~2496
No. 8	768~4992
No. 9	1536~9984
No. 10	3072~19968
No. 11	6144~39936
No. 12	12288~79872

Note:
Individual sonic nozzles, not a complete nozzle bank, are also available. And sizes that are not listed as standard sizes can be available. So, please contact us with your specific requirements.

Designed Flow Rate for Each Nozzle

Throat Diameter (mm)	1 bar Nℓ /h	2 bar Nℓ /h	3 bar Nℓ /h	4 bar Nℓ /h	5 bar Nℓ /h	6 bar Nℓ /h	6.5 bar Nℓ /h
0.1	6	12	18	24	30	36	39
0.14	12	24	36	48	60	72	78
0.2	24	48	71	96	120	144	158
0.28	48	96	144	192	240	288	316
0.4	96	192	288	384	480	576	624
0.56	192	384	576	768	960	1152	1248
0.8	384	768	1152	1536	1920	2304	2496
1.12	768	1536	2304	3072	3840	4608	4992
1.6	1536	3072	4608	6144	7680	9216	9984
2.24	3072	6144	9216	12288	15360	18432	19968
3.2	6144	12288	18432	24576	30720	36864	39936
4.48	12288	24576	36864	49152	61440	73728	79872

Accuracy(Design Standard for Critical Sonic Nozzles as per ISO 9300)

When gas flows through the critical sonic nozzle, where the pressure difference between the upstream and the downstream of the nozzle is greater than 0.8 bar, the flow speed of the gas at the nozzle throat is increased to a sonic speed and the flow rate is defined as below;

$$q_m = \frac{A * CC * P_0}{\sqrt{(\frac{R}{M})T_0}}$$

or

$$Q_m = A * CC_R \sqrt{P_0 \rho_0}$$

where

$$C_R = C * \sqrt{Z}$$

In the above equation, A* is the section area of the throat of the sonic nozzle, P_0 is the static pressure, ρ_0 is the static density and Z is compressibility factor. C* is a critical flow function in an isentropic one-dimensional flow between the throat and inlet of the nozzle and is a function of the stagnation pressure and the stagnation temperature. The ISO standard specifies the value of C* in various gases. C_d is 'discharge coefficient', which is the rate of the real flow to the isentropic ideal flow.

The discharge coefficient is affected by the kinematic viscosity and the flow field, especially, the swirl, but in a given condition, it is a function of the Reynold's number. The Reynold's number at the throat of the nozzle is defined by the density(ρ), the flow velocity(sonic, V), the diameter of the throat and the viscosity(μ) at the static temperature and the static pressure. An the relation between the Reynald's number and the discharge coefficient is defined as below;

$$C = a - bRe^{-n}$$

$$Re = \frac{\rho V d}{\mu}$$

where, the values of a, b and n are the same as those provided in Table 1. Table 2 provides the discharge coefficient by nozzle shape for each Reynold's number. The uncertainty of value C in the table is ±0.5%. The discharge coefficient differs by the shape of the nozzle and if the nozzle throat should be small, it is difficult to make the shape of the nozzle to the ISO standard and to measure the dimensions.

Table 1. Values of a, b and n

Toroidal-Throat Venturi Nozzle		Cylindrical-Throat Venturi Nozzle	
$10^5 < Re_d < 10^7$	a = 0.9935 b = 1.525 n = 0.5	$3.5x10^5 < Red < 2.5x10^6$	a = 0.9887 b=n=0
		$3.5x10^6 < Re_d < 2.5x10^7$	a = 1 b = 0.2165 n = 0.2

Table 2. Discharge Coefficient of Critical Sonic Nozzle(Toroidal Throat)

Reynold's Number(Re_d)	Discharge Coefficient(C_d)
1×10^5	0.9887
2×10^5	0.9901
3×10^5	0.9907
5×10^5	0.9913
7×10^5	0.9917
1×10^6	0.992
2×10^6	0.9924
3×10^6	0.9926
5×10^6	0.9928
7×10^6	0.9929
1×10^7	0.993

ISO/IEC 17025 Certified

For Inquiries, please contact our agent or authorized dealer in your area:

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