Multistage Orifice Assemblies

Standard as per R.W. Miller / ISO5167, AGA-3, B16.5, B16.36, B16.20, B16.47 Series B

Spraytech Systems manufactured multistage orifice assemblies are another type of measuring flow with high differential pressure meters effectively removing cavitation and flashing conditions. It also helps in killing pressure and thus effectively acting as a pressure reducing element. These are basically used to detect flow of fluids, gasses, steam, steam water, acids, alkalies, crudes, high viscous fluids, fluids with solid particles, condensation liquids. Spraytech Systems make of multistage assemblies lead to a precise measure of differential pressure leading to the most precise flow rate taking care of all factors of fluid cavitation related to its vapour pressure. The design is applicable from ½" to 64" of flow measurement. For higher sizes of impact and pressure reducing kindly do contact the design and engineering team of Spraytech Systems. It is measured at right angles to the flow direction, In a averaging Spraytech Systems make Multistage assemblies the kinetic energy of the flowing fluid is transformed into potential energy for measurement of fluid flow velocity by effectively abrupting to 40% recovery in between two stages and thus, effectively removing the choking content of the fluid in gas and steam and removing cavitation in especially liquid state thus essentially reducing industrial noise and restricting to below 80 decibels.

Applications

- Gas and Liquid Flows
- High Pressure Drops

Prevents

- Cavitation and Flashing in Liquid flows
- Choked flow in gases.
- Excessive Noise / Vibration

Restriction orifice plates have traditionally been used to reduce pressures in GAS AND LIQUID FLOWS by forcing the flow through a restricted bore. The precise pressure drop is produced by accurately calculating the orifice bore, having taken into account all the relevant process and flow conditions.

Where very HIGH PRESSURE DROPS in liquid flows are required MULTISTAGE RESTRICTION ORIFICE ASSEMBLIES may be required to achieve the desired pressure drop whilst preventing problems such as CAVITATION, FLASHING and high NOISE and VIBRATION levels.

CAVITATION is a potentially damaging, erosive condition which occurs when the internal pressure of the liquid passing through the orifice falls below its vapour pressure and vapour bubbles form. Further downstream from the orifice the pressure recovers sufficiently to collapse the bubbles with extreme violence. Cavitation calculations are performed during the design stage of a Multistage RO to calculate cavitation factors at each stage in the orifice assembly.

FLASHING is a similar phenomenon to cavitation except that the process pressure never recovers sufficiently to collapse the gas bubbles resulting in two phase flow - liquid and gas - downstream of the orifice. Erosion of pipe work and valves and other instrumentation can occur due to the impact of liquid droplets carried at high speed in the vapour flow.

CHOKED FLOW IN GASES - also know as critical flow - occurs when too large a pressure drop is attempted across a single orifice plate, or when too large flows are forced thru a lesser inlet pipe size. In such cases the flow through the orifice will become sonic, at which point no further increase in flow can be achieved by either increasing the upstream pressure or lowering the downstream pressure. Spraytech make multistage RO will enable staged reductions in pressure to prevent choked flow occurring.

Spraytech Systems make Multistage ROs are manufactured from a wide range of materials and are engineered to meet specific project process conditions and requirements. Plates are usually welded into pipe with a separation of one pipe diameter, the number of plates and orifice bores being determined by calculation. Process connections to existing pipe work can be either standard process flanges or machined ends suitable for butt welding.

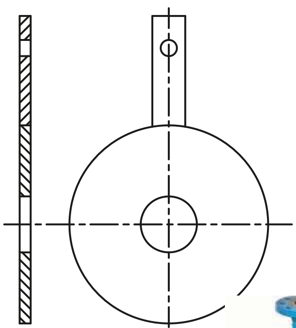

Fig 9.1

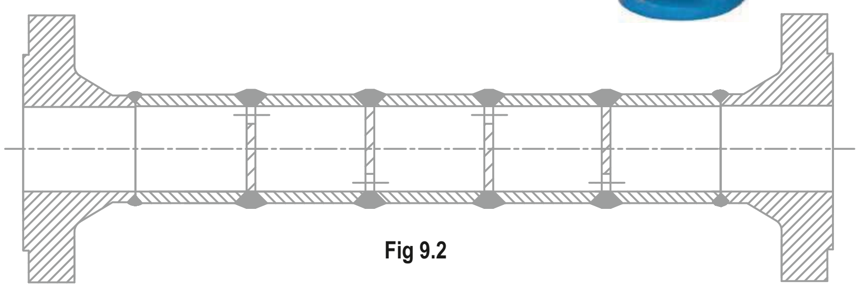

Fig 9.2

Multiple Restriction Orifice Assembly

The process of designing the multistage assemblies for flow measurements and reducing pressure

1. Check P1, inlet pressure, flow rate, and line size as the bare min parameter
2. Check for what application it is, either for flow measurements and or for pressure reducing
3. If for flow measurements, then check on what is the flow rate accounting to the velocity of the media as against pipe size and what is the drop of pressure required at the downstream
4. Here please use the basic formula for flow rate = 3.14 X R^2 X velocity of the media, Where R = Radius of the pipe
5. Now for all practical purpose, liquid is considered at 5 m/sec, gas at 40m/sec, steam at 40m/sec, mixed phase at 60m/sec as the velocity
6. Thus the R value, the radius of the pipe can be found out, double it and make the internal ID of the enquiry pipe check with your calculated value
7. Now if the conditions of the flow are as per the table below, then consider the pressure stages accordingly based on the calculations provided in the table, so that the final pressure drop at each stage when back calculated should match and all conditions of cavitation and flashing wherever applicable, in case will be considered and the best flow should result after the said pressure drop is completed
8. The total pressure drop is considered dividing the number of stages, which is now first decided depending on the table below. Thus each pressure drop is considered across each stage and then by multiplying the balance pressure drop by 1.6 times for subsequent calculations. This is done to take care of the 40% recovery and also thus to remove the relevant effect of choking and cavitation per stage. please refer to the example listed below for clarifications
9. Please note flow is not reduced or less end, please note it is a flow meter reading device while killing pressure and so on
10. The upstream and down stream length of the multistage assembly is also defined depending on the final stages applicable for flow measurements, please refer to the table below

For Pressure Temperature Considerations

Table 9.1

Line size	Max DP and or inlet pressure impact in bar g	Max temp applicability with max DP or at that inlet pressure in deg cent	Plate thickness applicable at that stage based on data of column 2 and 3	Pressure and temp differ than those column 2 and 3 but upto the max limit of	Plate thickness applicable at the condition of column 5	Pressure and temp differ than those column 5 but upto the max limit of	Plate thickness applicable at the condition of column 7
½”	Upto 20	Upto 150	3.18mm	30 bar g and 250 deg cent	6.35mm	45 bar and 350 deg cent	9.52mm
1”	Upto 20	Upto 150	3.18mm	30 bar g and 250 deg cent	6.35mm	45 bar and 350 deg cent	9.52mm
1 1/2”	Upto 20	Upto 150	3.18mm	30 bar g and 250 deg cent	6.35mm	45 bar and 350 deg cent	9.52mm
2’	Upto 20	Upto 150	3.18mm	30 bar g and 250 deg cent	6.35mm	45 bar and 350 deg cent	9.52mm
3”	Upto 16	Upto 150	3.18mm	25 bar g and 250 deg cent	6.35mm	40 bar and 350 deg cent	9.52mm
4”	Upto 16	Upto 150	3.18mm	25 bar g and 250 deg cent	6.35mm	40 bar and 350 deg cent	9.52mm
6”	Upto 15	Upto 150	3.18mm	24 bar g and 250 deg cent	6.35mm	38 bar and 350 deg cent	9.52mm
8”	XXXXX	XXXXX	XXXXX	24 bar g and 250 deg cent	6.35mm	38 bar and 350 deg cent	9.52mm
10”	XXXX	XXXXX	XXXXX	24 bar g and 250 deg cent	6.35mm	38 bar and 350 deg cent	9.52mm

Other temperature and pressure combinations and your solutions, please revert to Spraytech Systems Engineering and design team

For example

Line size is 3" and flow rate is at 500% consumption and the pressure drop is 120 bar g and temperature is 500 deg cent

Thus now to remove cavitation and effectively reduce noise within 80 decibles, for an application of steam water

Solution and how to proceed

Step 1: Since 500% consumption thus as per table above DP = $2^{(X/5)}$, therefore DP = 120 = $2^{(X/5)}$ thus X = 33.7 stages for a perfect noise to be within 70 decibels and choking is nil and thus increase the plant health bountifully and no external energy and more energy is utilized, thus saving plant energy cost. If not given then noise level is 200 decibels at say 7 stages and lot of energy is sapped and flow is lost and further plant life will reduce as more energy is required to drive the flow

Step 2: Thus 34 stages are noted

Step 3: Divide 120/34 this equals = 3.53 bar drop per stage

Step 4: As per above table, first impact of flow is 120 bar at 500 deg cent, plate thickness works out to be min 28mm for 3" thus

Step 5: Second stage inlet shall be 120 - (3.53x1.6) (since 40% recovery of press only at 1D distance of the second plate) =114.352 bar g but at 500 deg cent

Step 6: Thus second stage plate thickness shall be same as 28mm as stage 1

Step 7: This way onward calculations can be done and all stages of plate thickness can be calculated for all 34 stages

Step 8: After all calculations are completed the net result shall be ……..no choking, no cavitation, no noise beyond 70 decibels

Just for information the noise level for above calculation come down to 66decibels from a whopping 201 decibels. Such is the product applicability of Spraytech Systems Multistage design for measuring flow

Remember Multistage assembly of Spraytech Systems does measure flow and allows the maximum efficiency of the plant with very accuracy and no loss flow concept, thus increasing the life cycle of the assembly, the plant life.

Table 9:2

This table is achieved at 100% flow consumption. At lesser or more the ratio is multiplied at pressure column to have the resultant at that flow consumption.

Flow rate consumption	Differential pressure in bar g	No of stages to be recorded, X value	Plate thickness of each stage	Multistage material Selection
10%	DP	DP = $2^{(X/0.1)}$	As per above table	As per media compatability
20%	DP	DP = $2^{(X/0.2)}$	As per above table	As per media compatability
40%	DP	DP = $2^{(X/0.4)}$	As per above table	As per media compatability
50%	DP	DP = $2^{(X/0.5)}$	As per above table	As per media compatability
60%	DP	DP = $2^{(X/0.6)}$	As per above table	As per media compatability
70%	DP	DP = $2^{(X/0.7)}$	As per above table	As per media compatability
80%	DP	DP = $2^{(X/0.8)}$	As per above table	As per media compatability
90%	DP	DP = $2^{(X/0.9)}$	As per above table	As per media compatability
100%	DP	DP = $2^{(X/1)}$	As per above table	As per media compatability
150%	DP	DP = $2^{(X/1.5)}$	As per above table	As per media compatability
200%	DP	DP = $2^{(X/2)}$	As per above table	As per media compatability
300%	DP	DP = $2^{(X/3)}$	As per above table	As per media compatability
500%	DP	DP = $2^{(X/5)}$	As per above table	As per media compatability