BLOW-DOWN VALVE FLOW COEFFICIENT TESTING

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ABSTRACT

Blow-down valves are playing a vital role in modern manufacturing process industries around the world. Properly selected Blow-down valves increases the efficiency, safety, profitability and ecology. The most common final Blow down element in the process Boiler industries is the Blow-down valves. Blow-down valves coefficient describes the relation between flow passage and pressure drop across valve (Flow Capacity). Blow-down valves flow test rig was designed in order to calculate practically the flow coefficient (KV) by standards ANSI/ISA-75.02-1996 and ANSI/ISA-75.01-2002. This flow test rig used to verify the designed KV. It was necessary to the KV equation for incompressible fluids to proceed with flow sensor selection. It is also described the electronic instrumentation for measuring flow, temperature and pressure difference. This work describes the operation of flow test rig, to determine KV of Blow-down valves with incompressible fluid under the regulations was established by standards. The results obtained are much encouraging and the accuracy of Blow-down valves coefficient is ±1%.

Keywords: - *Kv-Flow coefficient[1], BDV-Blow down Valve[2],*

1. INTRODUCTION

In any process line, the Blow-down valves is typically the final Blow down part used for controlling the process. The stem position of valve is controlled by actuators, which is operated by electric and pneumatic signals. There are different types of Blow-down valves which are used to Blow down process according to set points. To achieve the flow rate variation, various types of plugs and seats can be used, since Blow-down valves coefficient depends on seat area. In the year 1944, Masoneilan introduced the concept of Blow-down valves coefficient typically for liquid flows. Within a very short span of time this concept was accepted universally for determining valve capacity. Blow-down valves coefficient gives the flow capacity of Blow-down valves. The value of Blow-down valves coefficient depends on the difference in pressure across the valve and flow passing through it. Superior value of CV indicates the highest flow rate. Blow-down valves with different sizes but identical CV, have same flow capacity.

The KV is flow of water through Blow-down valves in m3/hr with differential pressure of 1 Bar across the valve. The Blow-down valves coefficient can also be confirmed practically for different valve openings by using international standards.

The Blow-down valves flow test rig is designed to measure Blow-down valves coefficient (KV), for various valve sizes having linear and equal percentage flow characteristics. Test rig conceived in order to determine experimentally flow coefficient. Process fluid is water (incompressible fluid). Design considerations are according to ANSI/ISA 75.02-1996 standard. It is necessary to select sensors properly. The measurement of KV values of the valves for various opening percentages. Butterfly valve used for upstream throttling valve to maintain specified pressure difference across the Blow-down valves. This used to determine flow characteristics.

In section II, the details of Blow-down valve are mentioned. In section III, the technical data are mentioned. In section IV, have features. In section V, flow coefficient definitions. In section VI, Blow down valve coefficient tests are mentioned. In section VIII, test procedure for BDV coefficient. In section IX, head losses in pipes. In section X and XI, have BDV testing observations. In section XII, the results are mentioned.

1.1 BLOW-DOWN VALVE

The primary function of a Blow-down valve is to Blow down the concentrations of suspended and total dissolved solids (TDS) in the boiler. Continuous Blow-down (CBD) valves are designed to operate in continuous open position by releasing water continuously, whereas Intermittent Blow-down (IBD) valves are designed to operate at predetermined intervals by

releasing water and accumulated sludge periodically. Boiler Blow-down is a severe service application owing to the high pressure drop in flashing water which results in rapid erosion and wearing out of conventional valves.

Fig 1: Types of Blow down valves

1.2 TECHNICAL DATA

1. Size – 1"/ 1½" / 2" / 2½"/ 3" NB
2. Pressure Rating - ANSI #300 / #600 / #900 / #1500 / #2500
3. End Connections - Flanged / Socket Weld / Butt Weld
4. Body Material - A105 / A182 F11 / A182 F22
5. Operation - Manual / Motorized
6. Orifice Size - 1/8" / 3/16" / 1/4" / 5/16" / 3/8" / 7/16" / 1/2"/ 5/8" / 3/4" / 7/8" / 1"
7. Bonnet - Standard Bolted / Pressure Seal
8. Types - 320-C, Continuous Blow-down Valve 320-I, Intermittent Blow-down Valve

1.3. FEATURES

1. Angle type design - Ensures that the blow down valve is practically entirely self-draining.
2. Separate trim for CBD and IBD – CBD has single step venturi diffuser, whereas IBD has multi step pressure reducing trim.
3. Pressure seal bonnet for ANSI #1500 and #2500 - Eliminates body-bonnet leakage at high pressures.
4. Satellite plug-spindle and seat – Provides maximum resistance against erosion, wire-drawing and ensures long service life.
5. Integral plug-spindle – Eliminates problem of vibration and chatter.
6. Extra long gland packing – Maintains tight seal even at high temperatures.
7. Roller burnished plug-spindle – Ensures minimum friction and zero gland leakage.
8. Online maintenance of gland packing – Facilitated by provision of back seat.
9. Quick and easy installation, dismantling and maintenance - Made possible by the modular design.

1.4. Flow Coefficient

CV: The valve flow coefficient is the number of U. S. gallons per minute of water passes through Blow down valve with a pressure drop of one psi.

KV: This is defined as the flow of water through a Blow down Valve in m3/hr with a differential pressure of 1 Bar through the Valve.

$$Kv = \frac{Q}{31.6}\sqrt{\frac{\rho}{\Delta P}}$$

CV = 1.17 KV
Q=Flow rate (m3/h) ρ = Density of the liquid (1000 kg/m3)
P=Pressure drop across Blow down valve (Bar).

2. BLOW DOWN VALVE COEFFICIENT TEST RIG

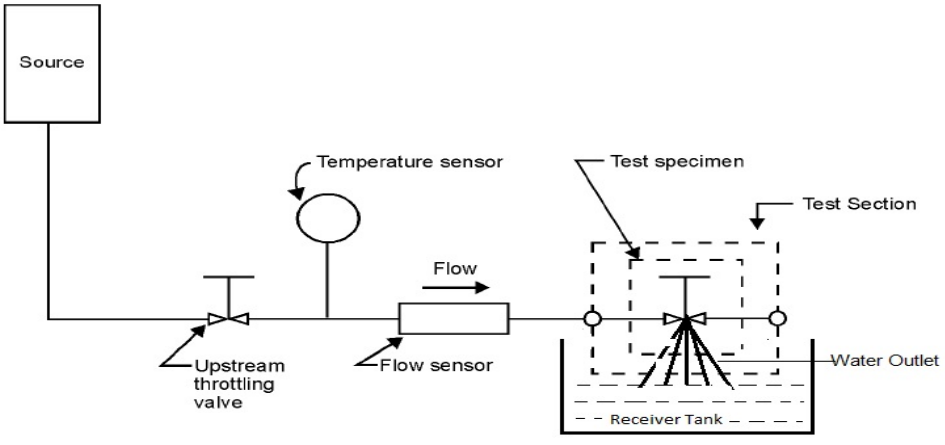

Fig 2: KV Test Rig

Fig 3: Actual Kv Test Rig

3. CALIBRATED INSTRUMENTS USED FOR TESTING

1. **Pressure gauge using for 1 bar:–**
   - Pr. Gauge range = 0 to 2.5 bar
   - Test pr. Min. 0.7 bar & max. 1.8 bar
   - Calibration date 4 April 2017
   - Next date of calibration 3 April 2018.

2. **Pressure gauge using for 4 bars:–**
   - Pr. Gauge range = 0 to 7 bar
   - Test pr. Min. 1.8 bar & max. 5 bar
   - Calibration date 8 July 2017
   - Next date of calibration 7 July 2018.

3. **Dial Gauge using for spindle lift (Stroke) :-**
   - Pr. Gauge range = 0 to 7 bar
   - Scale interval – 0.01 mm
   - Measuring range 50 mm
   - Calibration date 1 July 2017
   - Next date of calibration 31 June 2018

Fig 4: Dial gauge arrangement for lifting stem

4. BLOW DOWN VALVE COEFFICIENT TEST PROCEDURE:

1. Blow down Valve is installed without reducers. The flow velocity varies from 1 m/s deviation from standard requirement shall be recorded ANSI/ISA-S75.02-1996.
2. The variation of pressure is 1 to 4 bars.
3. Stem travel 0 % to 100 % to determine valve characteristics.
4. Fill water into the tank and maintain pressure of water at 1 bar & 4 bars with the help of air pressure.
5. Operate lever for opening and closing of the water flow. Close lever for after 1 minute of the flow by using stop watch.
6. Open valve to 10%, 20% till 100%.
7. Collected water from the outlet of the valves is next to measure the volume of the water on weighing machine.
8. Use same procedure for 1 bar and 4 bar pressure after every 10% of valve opening. And last in blow-off condition.
9. The following data shall be recorded:

- Valve travel is recorded.
- Pressure differential (Δp) across Blow down valve measure.
- Flow rate.
- Fluid inlet temperature
- Type and size of valve.
- Type of fluid

5. HEAD LOSSES IN PIPES

When velocity of flowing fluid changes. Either in magnitude or direction there is large scale turbulence generated in which a portion of the energy possessed by the flowing liquid is utilized which is ultimately dissipated as a heat and hence it is considered as loss. The change in magnitude of velocity of flow liquid due to change in crosses sectional area of the flow passage. The change in velocity of liquid may be either gradual or sudden and in both cases the energy is lost. But as compared with gradual change of velocity the loss of energy is much more when a sudden change of velocity takes place.

1. Losses due to sudden enlargement.
2. Losses due to sudden contraction.
3. Losses at the entrance of the pipe from large vessel.
4. Losses at exit from a pipe.
5. Losses due to obstructions in flow passage.
6. Losses due to gradual contraction and enlargement.
7. Losses in bends.
8. Losses in various pipe fittings.

6. BLOW DOWNVALVE TESTING

After assembly of the Blow down valve it under goes following testing:

1. Seat Leakage Testing.

2. Body Leakage Testing.
Seat leakage testing is done according to standard ANSI/FCI 70-2 as explained in Valve tested under leakage class IV, Body leakage test was done according to ANSI B 16.104. In this test valve is at full open state and water with high pressure through valve. Valve tested according to following pressure conditions. Table 2 shows the Body leakage testing details for materials CB/WC6/WC9/WCC/P11/P12.

7. TESTING OBSERVATION

Sr. No.	Lift		Flow (litre/min)	
	(%)	(mm)	1 bar	4 bar
1	10	1	6.7	13.4
2	20	2	8.1	16.1
3	30	3	8.8	17.6
4	40	4	9.3	19.4
5	50	5	10.4	22.7
6	60	6	11.3	23.7
7	70	7	12.2	28.2
8	80	8	13.6	29.5
9	90	9	14.9	29.8
10	100	10	15.7	29.9

Table-1: Observation readings for Valve Characteristics

8. RESULTS

Sr. No.	Kv Values (m^3/hrs)	
	1 bar	4 bar
1	0.409	0.409
2	0.494	0.491
3	0.537	0.537
4	0.567	0.592
5	0.634	0.692
6	0.689	0.723
7	0.744	0.860
8	0.830	0.900
9	0.909	0.909
10	0.958	0.912

Table-2: Result for Kv 1

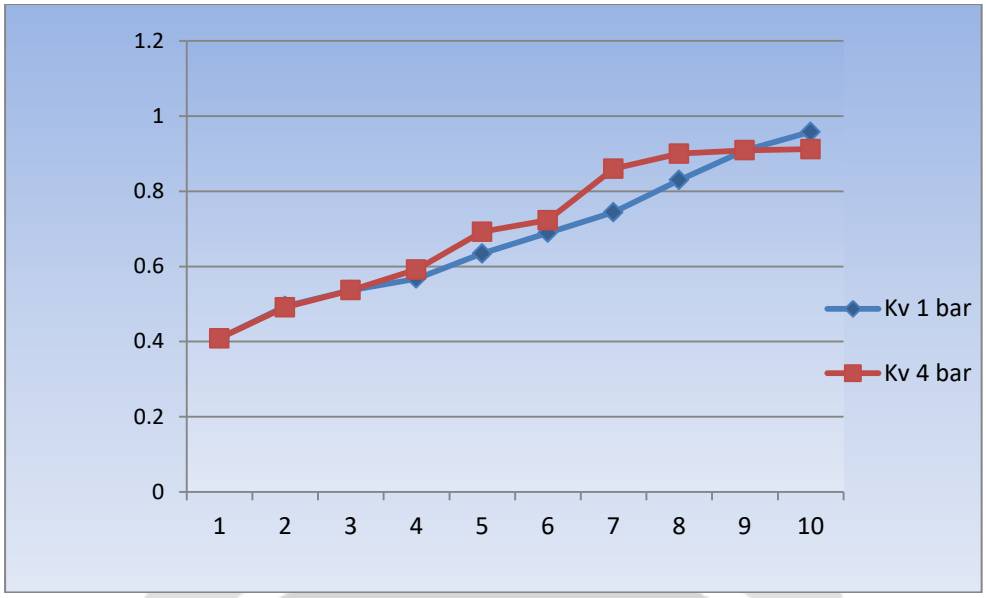

Chart-1: Equal Percentage and Linear Valve Characteristics for Kv=1

9. CONCLUSION

The flow capacity coefficient KV was calculated practically by measuring flow rate and pressure difference across a valve and temperature measurements and verified against the designed KV. The accuracy of obtained Blow down valve coefficient is ±1%. The measurement of Kv valve is at fully open position. In order to plot the characteristic curve, Blow down valves tested with variable openings. For this testing the water flow rate was maximum pressure 150 m3/hr with a pressure up to 2 bars considering these ranges the Blow down valve is tested.

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