Design & Analysis of Dual Plate Check Valve

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Abstract - Dual plate check valve uses two half sphere discs and a connecting hinge to create a closure element that collapses when a positive flow exists and folds back to a full circular disc and reverse flow exist it is also known as split disc or wafer check valve. Dual plate check valves are used to balance the pressure flow in a line after a system pump has stopped or failed. Check valves may be requirement of secondary systems a pressure can exceed that of primary system. They also prevent any damage associated with reversal of rotary pump and compressor.

In this paper, the Dual Plate Check Valve is designed & then analyzed using Simulation software for agreeable results.

I. INTRODUCTION TO DUAL PLATE CHECK VALVE

Dual plate check valve are basically also known as double disk check valve. The double disk check valve uses two half sphere disks and a connecting hinge to create a closure element that exist. It is also known as split disk or wafer check valve.

Generally, dual plate check valves are popular because of their low cost and minimal size. The dual plate check valves are found in size 2 through 36 in (DN 50)

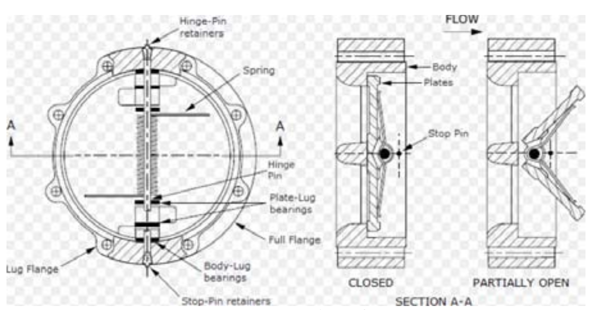


Image No.1: Drawing of DPCV

A. Features

- Spring ensures non slam action and avoids flap chatting also assists positive closure
- Suitable to mount between various Flange drillings
- Simplified design with only minimum parts
- Suitable to mount in any position
- Low opening pressure

- Optional soft seating for bubble tight shut-off

B. Advantages

- These check valves are stronger, lighter, compact and wafer type design with short overall length
  - Offers lower installation and maintenance cost and are most economical
- It improves valve response and performance in critical systems

C. Applications

- Chemical plant
- Heating lines
- Air conditioning
- Steam tracing system
- Food and pharmaceuticals
- Gas and air lines

II. DESIGN OF DUAL PLATE CHECK VALVE

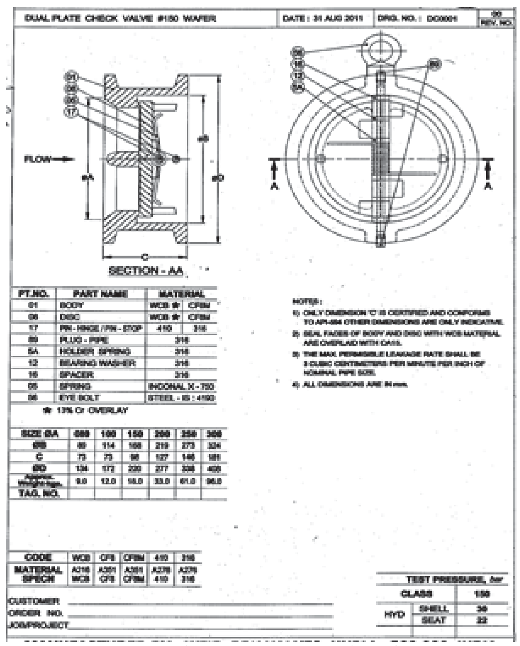


Image 2: General Arrangement Drawing of DPCV

A. Valve Specifications

Working pressure: Class 150 (PN 20) - 20 bar
Sizes: 80mm (3”) to 300mm (12”)
Type: Wafer type

B. Circumferential stress (Longitudinal joints)

When the thickness does not exceed one half of the inside radius, or ‘P’ does not exceed 1.25SE the following formulas shall apply

$$t = (P \times R) / (2 S E + 0.4 P)$$

or

$$P = 2 S E t / (R – 0.4 t)$$

C. Longitudinal stress (circumferential joints)

When the thickness does not exceed one half of the inside radius, or 'P' does not exceed 1.25SE the following formulas shall apply

$$t = (P \times R) / (2\,S\,E - 0.2\,P)$$

or

$$P = 2\,S\,E\,t / (R + 0.2\,t)$$

where,
E is Joint Efficiency
P is Internal design pressure
R is Inside radius of the shell course under consideration
S is Maximum allowable stress value
t is Minimum required thickness of shell

D. Thickness Calculation of Valve Body

Size = DN 300, Rating:
PN 20, D = 324 mm
#150

$$t = (P \times R) / (S \times E - 0.6P)$$

P = 20bar

$= 20 \times 10^5\ Nm^{-2}$

$= (20 \times 10^5 \times 10^{-4}) / 9.81$

$= 20.38\ kg/cm^2$

R = 162mm = 16.2cm

E = 1 for casting

S = 110.4 MPa for WCB = 1125.38

Therefore,

$t = (20.38 \times 16.2) / (110.4 \times 1 - 0.6 \times 20.38)$

Total Wall Thickness is calculated by adding the following allowances;

$$t_1 = t + C_1$$

Where,

t = Calculated Wall Thickness

C_1 = Manufacturer tolerance allowances

$$t_1 = 2.9 + 5$$

$$= 7.9mm$$

Actual Shell Thickness provided for CS & CR = 16.5mm

Verification:

$t = 0.0163 \times d + 4.7$

$t = 0.0163 \times 300 + 4.7$

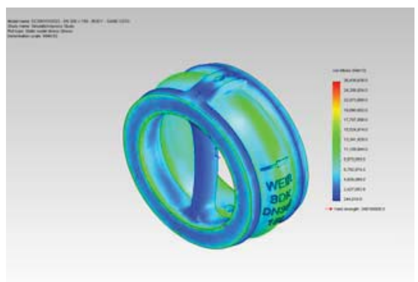
t = 9.6mm

Minimum Thickness should be 9.6mm However; we are considering 16.5mm as thickness in order to carry out effective machining operations in the workshop.

III. RESULTS AND DISCUSSIONS

A. Simulation of the Body:

Name	**Type**	**Min**	**Max**
Stress	VON: von Mises Stress	244019 N/m^2 Node: 99	2.64398e+007 N/m^2 Node: 22013



DC300101D023 - DN 300 x 150 - BODY - SAND

CSTG-SimulationXpress Study-Stress-Stress

Image 3: Study Results of Body Simulation

As per industry standards displacement must be within the 100 microns. The displacement obtained from analysis is 8 microns, hence it is within the permissible limit.

Factor of Safety = Yield Strength / Allowable stress (max. stress induced)

= 248168000 / 26439838

= 9.38

By considering above two conditions we can conclude that the part is safe for given working conditions.

B. Simulation of the Plate:

Name	**Type**	**Min**	**Max**
Displacement	URES: Resultant Displacement	0 mm Node: 1	0.00589033 mm Node: 10616

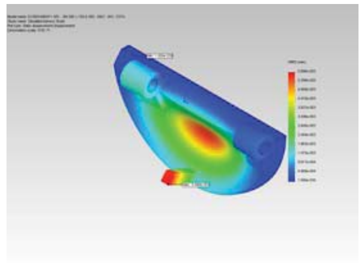
Name	Type	Min	Max
 DC300108D011-SPL - DN 300 x 150 & 300 - DISC - INV.			

Image 4: Study Results of Plate Simulation

As per industry standards displacement must be within the 100 microns. The displacement obtained from analysis is 5.89 microns, hence it is within the permissible limit.
Factor of Safety = Yield Strength / Allowable stress (max. stress induced)

= 248168000 / 51428464

= 4.81

By considering above two conditions we can conclude that the part is safe for given working conditions.

IV. CONCLUSION

The components used in dual plate check valves are modeled and analyzed for the given pressure, using software package solid works.

The summary of analysis procedure is as follows:

A. Modeling:
All the individual components of dual plate check valves are modeled for the given 2D diagrams. All the components are meshed using the solid works package.

B. Meshing:
All the components of DPCV are meshed, by using the solid works software package.

C. Analysis:
They are subjected to stress analysis to get the values of solid mechanics variables (i.e. displacement, von misses stress, FOS etc.).

By preferring the above results and discussions, all the components of DPCV suits best for given working conditions.

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