# Spring-Less Non Return Valve using Diaphragm (with Stud) for Reciprocating Air Compressor

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*Abstract*— The project is on a non return valve also known as check valve. It is manually, pneumatically and hydraulically operated. Non return valve is a valve that normally allows a fluid (liquid or gas) to flow through it in only one direction. A non-return valve is fitted to ensure that a medium flows through a pipe in the right direction, where pressure conditions may otherwise cause reversed flow. We use a piston spring loaded check valve which has more components and also the design is complex. By applying the conceptive design we can reduce the components in the NRV and reduce the complexity of present valve. Initially the analysis is done by taking parameters like 10 bar pressure and 2000LPM flow.

***Key words:*** Spring-Less Non Return Valve, Reciprocating Air Compressor

## I. INTRODUCTION

Nowadays we use the valve everywhere, from tube of tyre to water supply valves. It has a wide range of application in domestic purpose to the industrial ones. Valve is a device for controlling the passage of fluid through a pipe or a duct, especially an automatic device allowing movement in only one direction. There are different types of valves used in various engineering fields like direction control valve, safety valve, non-return valve etc. From the above mentioned we are working on a non return valve also known as check valve. It is manually, pneumatically and hydraulically operated. Non return valve is a valve that normally allows a fluid (liquid or gas) to flow through it in only one direction. A non-return valve is fitted to ensure that a medium flows through a pipe in the right direction, where pressure conditions may otherwise cause reversed flow. We use a piston spring loaded check valve which has more components and also the design is complex. By applying the conceptive design we can reduce the components in the NRV and reduce the complexity of present valve. Initially the analysis is done by taking parameters like 10 bar pressure and 2000LPM flow.

## II. AIM AND OBJECTIVES OF PROJECT

This is a project regarding the changes in the Non return valve (check valve) of the reciprocating oil free compressor. By applying the conceptive design we can reduce the components in the NRV and reduce the complexity of present valve. Developing design for NRV in place of spring mechanism. We are going to develop a conceptive design of NRV which has less components which makes it cost effective and also easy maintenance. If further work and analysis is done we can also make it more efficient and easy working. The initial working pressure is taken as 10 bar.

### *A. Problem Specifications*

- Problem Criteria : Conceptive Design
- Machining Process : Casting, Turning, Shaping, Drilling, Boring
- Problem Work area : Non-Return Valve
- Problem part : Non-Return Valve
- Problem Phenomena : Spring loaded into spring-less
- Problem Effective part : Flexible plate
- Problem Effect : Sealing and fitting
- Pressure Limit : 10-15 bar
- Flow Rate : 80 CFM

### *B. Materials and Tools Required*

| Serial no. | Part Name | Material |
|---|---|---|
| 1 | Body | Aluminum (Al6061) |
| 2 | Body Seat | Aluminum (Al6061) |
| 3 | Flexible plate | Butyl rubber |
| 4 | Big stud | Aluminum (Al6061) |
| 5 | Small stud | Aluminum (Al6061) |
| 6 | Fix plate | Aluminum (Al6061) |

Table 1: Materials and Tools Required

### *C. Design Solution*

- According to the new design we are considering two plates one is fixed plate and the other is flexible plate.
- There is big hole at the center of the fixed plate and small studs on other side of fixed plate at circular periphery.
- Also there is big stud at the center of flexible plate and small holes on the circular periphery of the flexible plate.

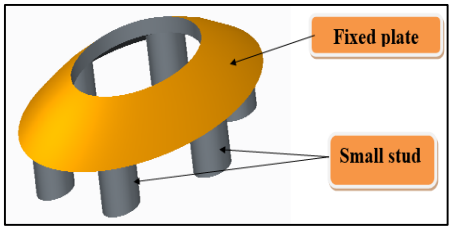

Fig. 1: Fixed plate with small stud

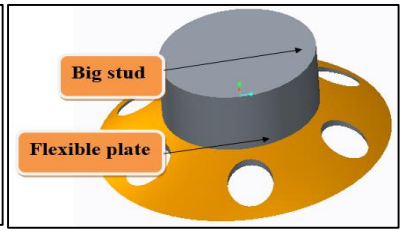

Fig. 2: Flexible plate with big stud

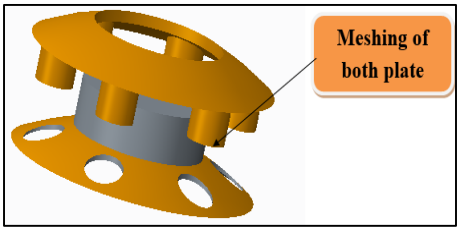

Fig. 3: Meshing of both plate

The fixed plate and the flexible plate are meshed together (locking position) like the big stud in big hole and small stud in small hole as shown below.

- The high pressure air from compressor will put force on the fixed plate.
- This pressure will directly be applied on the big stud which is in meshed condition with big hole and so this stud will be pushed downward due to flexibility of flexible plate.
- When the flexible plate is moved little downward due to pressure the lock on the circular periphery will open.
- The air flow will be passed out through the small holes at circular periphery and the air will be transmitted to tank.

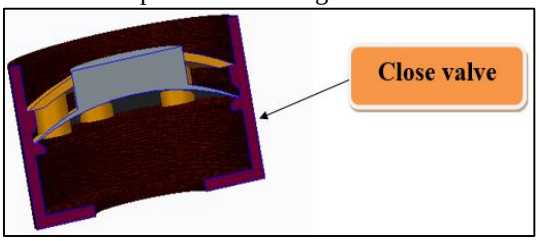

Fig. 4: Close valve

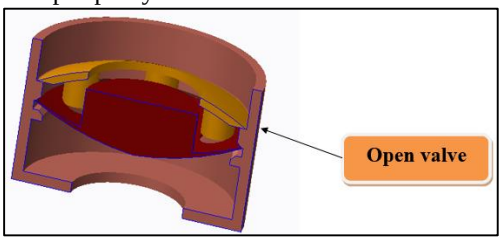

Fig. 5: Open valve

- Also the main working of NRV is to stop the back pressure flow.
- So during back pressure the force will be exerted on the flexible open plate and due to its flexibility it will be plate will automatically come in locking position and the back flow will be stopped.

*D. Design Calculations*

Considering the conditions 10 bar, 80 CFM valve

- Main diameter (D) = 45mm (taken)
- Big stud diameter (d) = 24mm (taken)
- Deflection = 9.32mm (upper/lower)
- Area remaining on disk $A_r$ = 1591.01 – 452.57 = 1138.44$mm^2$
- 6 small studs on remaining area $A_{6=}\frac{A_r}{6}=\frac{1138.44}{6}=189.74mm^2$
- For 6 studs $A_6=\frac{\pi}{4}{d_6}^2$
- Diameter of single stud $d_6$= 15.54/2 = 7.5mm

Now,

Considering the material specifications and needs Aluminum & Butyl rubber will be appropriate.

*1) Butyl rubber*

- Poisson's ratio: 0.3
- Density: 9.2e-10 tonne/$mm^3$
- Young's modulus: 2MPa
- Tensile yield stress: 3MPa
- Tensile ultimate stress: 10MPa

*2) Aluminum (AL6061)*

- Poisson's ratio: 0.3
- Young's modulus: 1e+07 psi
- Co-efficient Of Thermal Expansion: 1.3e-05 /F
- Density: 0.0002536 lbf sec^2/in^4
- Specific Heat Capacity: 829900 in^2/(sec^2 F)
- Thermal Conductivity: 22.49 lbf/(sec F)

*3) Stress, strain, displacement ANALYSIS: Creo Simulate*

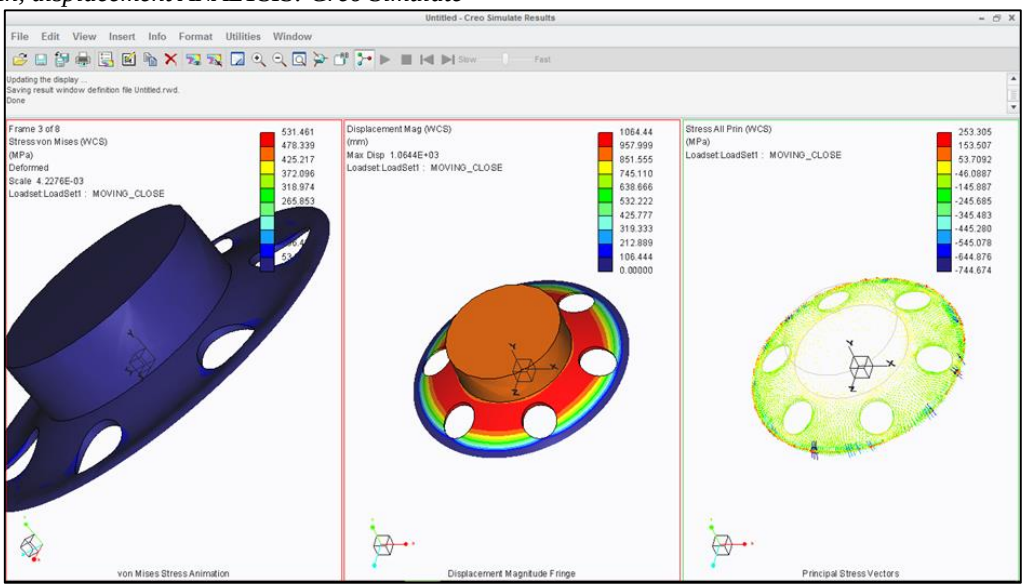


Fig. 1: Stress, strain, displacement ANALYSIS: Creo Simulate

## III. RESULTS

From above testings and analysis we can say that the proposed and designed plate cannot withstand at given pressure and flow. This design can be made working by reducing pressure and flow or by changing the material of flexible and fix plate.
Also design could be made useful in pipe line where back flow is controlled.

## REFERENCES

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