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Modelling and Analysis of Rotary Air Lock Valve

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ABSTRACT

The Rotary Air-locks provide reliable service in high pressure, high temperature and other severe service conditions. The valves can be used in various industries such as food, plastics, chemical, asphalt, mining, baking, cement and paint. The main function of a Rotary Air- lock Valve is to regulate the flow of material from one chamber to another while maintaining a good airlock condition. The material or product being handled is usually dry free flowing powder, dust or granules.

Rotary Air-lock Valves are used at the bottom of Bins, Cyclones, Dust Collectors or Feed Hoppers to discharge materials at a controlled rate or act as an Airlock. A Rotary Feeder / Airlock Valve consists of a rotor which turns at a given RPM in close clearance to its casing thus maintaining a uniform rate of material flow and provides a seal.

In operation, a motor and drive chain turn the rotor shaft, spinning the rotor inside the housing and head plates. As the blades rotates a fixed volume of material passes through the material inlet to the spaces between adjacent blades (called rotor pockets) and is carried in the pockets toward the material outlet.

3D modelling of Rotary airlock valve is done in Pro-e. Theoretical calculations are performed for selecting bearing diameter and deflection of shaft as per beam analysis find out by using Ansys.

The analysis of shaft and rotor assembly done in pro-e/creo-2 and Ansys to find the deflection values from these values Factor of safety of selected diameter is calculated. In brief 3D models developed in pro-e & analyzed reports have been submitted while changing design and materials.

INTRODUCTION

The main function of a Rotary Air- lock Valve is to regulate the flow of material from one chamber to another while maintaining a good airlock condition. The material or product being handled is usually dry free flowing powder, dust or granules. In operation, a motor and drive chain turn the rotor shaft, spinning the rotor inside the housing and head plates. As the blades rotates a fixed volume of material passes through the material inlet to the spaces between adjacent blades (called rotor pockets) and is carried in the pockets toward the material outlet.

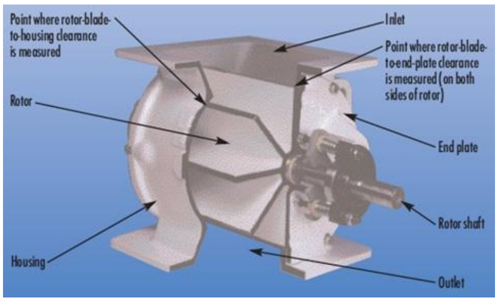
Rotary Air-lock Valves are used at the bottom of Bins, Cyclones, Dust Collectors or Feed Hoppers to discharge materials at a controlled rate or act as an Airlock. They are also used to introduce materials into positive or negative conveying systems. A Rotary Feeder / Airlock Valve consists of a rotor which turns at a given RPM in close clearance to its casing thus maintaining a uniform rate of material flow and provides a seal. The Rotary Air-locks provide reliable service in high pressure, high temperature and other severe service conditions. The valves can be used in various industries such as food, plastics, chemical, asphalt, mining, baking, cement and paint.

Rotary Air- Locks are usually used to accomplish 3 basic tasks:

a) To feed material from bins or hoppers.

b) To deliver fines from the collector while sealing against air loss.

c) And to feed material to pneumatic conveying line against pressure.



Rotary Air-lock valve cut way view

Rotary airlocks are referred to by many different names. Some are appropriate, and some are not. There are three appropriate names which are universally accepted when referring to this product. Technically, they all refer to a similar device in terms of design and appearance. These are:

1. Rotary Feeder
2. Rotary Valve
3. Rotary Airlock

Most suppliers and users are familiar with all these terms. We will focus on the term ‘rotary airlock’ for the purpose of this discussion. To further identify the name ‘rotary airlock’, we will define the two separate terms.

ROTARY

Refer to Illustration 1B and locate the vanes and pockets. The word ‘rotary’ refers to the fact that during operation of a rotary airlock, the vanes turn or rotate. As they turn, the pockets, which are formed between the vanes, become rotating pockets. The material being handled enters the pockets at the top, through the Inlet port, travels around in a rotating motion, and exits at the bottom, or through the Outlet port. As the vanes and

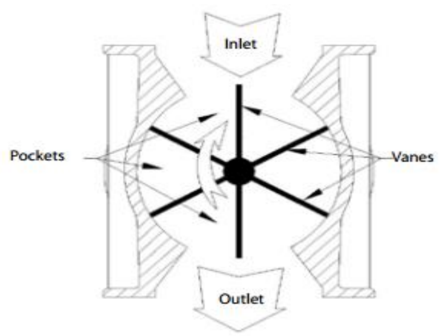
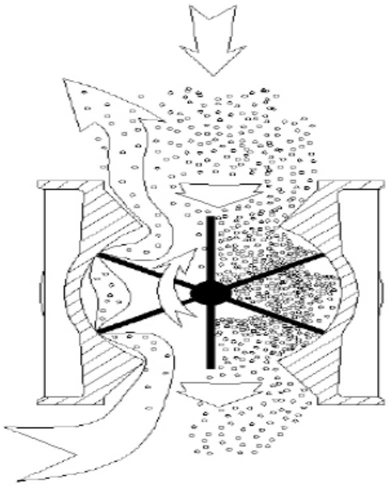


Illustration 1B



Airlock

AIRLOCK

Refer to Illustration 1C. The word ‘airlock’ means that this device is to act as a seal, or lock to the air, between the Inlet and Outlet ports, while moving material in a continuous rotating motion through its pockets. Material travels downward from Inlet port to Outlet port, but airflow is restricted. To provide a reference in discussing airflow through the rotary airlock, we have notated a 10 PSI air pressure on the Outlet port side. The air pressure, in this example, is trying to push airflow up through the rotary airlock. If the air were allowed to flow upwards, the material

Entering the Inlet port would be restricted and less material would be moved. Not all rotary valves or rotary feeders can be classified as ‘rotary airlocks’. But almost all rotary airlocks can be classified as both rotary valves and rotary feeders, depending on the interpretation. The term ‘airlock’ is very significant when used as a classification. The requirement of a rotary airlock to move material continually, and maintain a constant air pressure or vacuum difference between the Inlet and Outlet ports efficiently, presents one of the greatest challenges to most rotary airlocks. Consider the complications involved. A rotary airlock must be capable of moving various materials when there is an air pressure or vacuum on either the Inlet port or Outlet port, or both. The airlock application considerations are not to be taken lightly. While simple by design, airlocks are a very important element in

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material conveying and processing systems. An improperly applied airlock can lead to poor efficiency, extra maintenance and operator manpower, product degradation, equipment wear and replacement, and lost production due to process shutdowns. The annual cost of any of the deficiencies could easily exceed the cost of the equipment. To properly apply a rotary airlock, it's important to know and understand all of the variables related to rotary airlock performance.

POISON'S RATIO

Poisson's ratio, named after Siméon Poisson, is the negative ratio of transverse to axial strain. When a material is compressed in one direction, it usually tends to expand in the other two directions perpendicular to the direction of compression. This phenomenon is called the Poisson effect. Poisson's ratio ν (nu) is a measure of this effect. The Poisson ratio is the fraction (or percent) of expansion divided by the fraction (or percent) of compression, for small values of these changes.

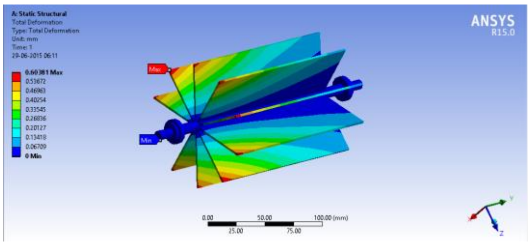
Conversely, if the material is stretched rather than compressed, it usually tends to contract in the directions transverse to the direction of stretching. This is a common observation when a rubber band is stretched, when it becomes noticeably thinner. Again, the Poisson ratio will be the ratio of relative contraction to relative expansion, and will have the same value as above. In certain rare cases, a material will actually shrink in the transverse direction when compressed (or expand when stretched) which will yield a negative value of the Poisson ratio.

The Poisson's ratio of a stable, isotropic, linear elastic material cannot be less than −1.0 nor greater than 0.5 due to the requirement that Young's modulus, the shear modulus and bulk modulus have positive values. Most materials have Poisson's ratio values ranging between 0.0 and 0.5. A perfectly incompressible material deformed elastically at small strains would have a Poisson's ratio of exactly 0.5. Most steels and rigid polymers when used within their design limits (before yield) exhibit values of about 0.3, increasing to 0.5 for post-yield deformation (Seismic Performance of Steel-Encased Concrete Piles by RJT Park) (which occurs largely at constant volume.) Rubber has a Poisson ratio of nearly 0.5. Cork's Poisson ratio is close to 0: showing very little lateral expansion when compressed. Some materials, mostly polymer foams, have a negative Poisson's ratio; if these auxetic materials are stretched in one direction, they become thicker in perpendicular direction. Some anisotropic materials have one or more Poisson ratios above 0.5 in some directions.

RESULTS

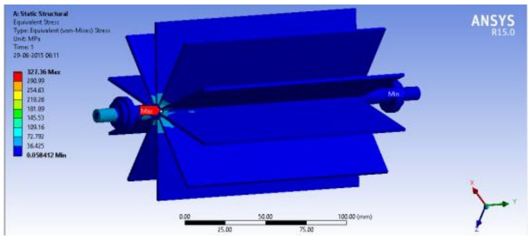
a. MATERIAL: CAST IRON

DEFORMATION



Deformation analysis on Cast Iron at pressure 5000 pa, load 25000 n-mm & Inertia 250 rpm

STRESS



Stress analysis on Cast Iron at pressure 5000 pa, load 25000 n-mm & Inertia 250 rpm

SAFETY FACTOR

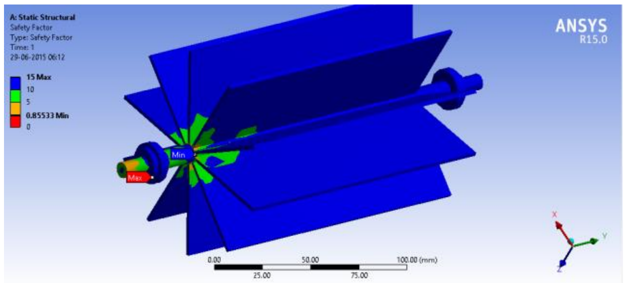


Fig. 4.7 (d) Safety factor analysis on Cast Iron at pressure 5000 pa, load 25000 n-mm & Inertia 250 rpm

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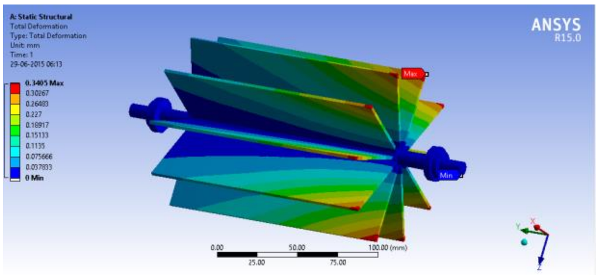
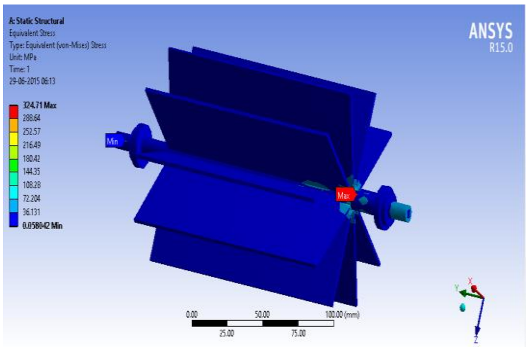
b. MATERIAL: 304 STAINLESS STEEL

DEFORMATION



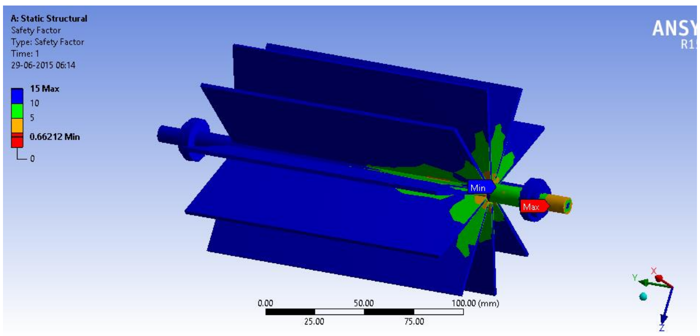
Deformation analysis on 304 Stainless steel at pressure 5000 pa, load 25000 n-mm & Inertia 250 rpm

STRESS



Stress analysis on 304 Stainless steel at pressure 5000 pa, load 25000 n-mm & Inertia 250 rpm

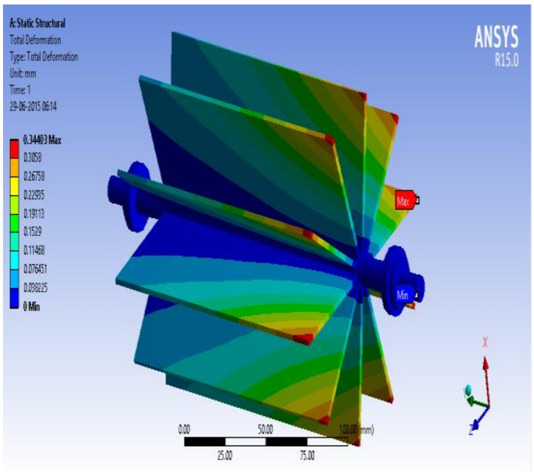
SAFETY FACTOR



Safety factor analysis on 304 Stainless steel at pressure 5000 pa, load 25000 n-mm & Inertia 250 rpm

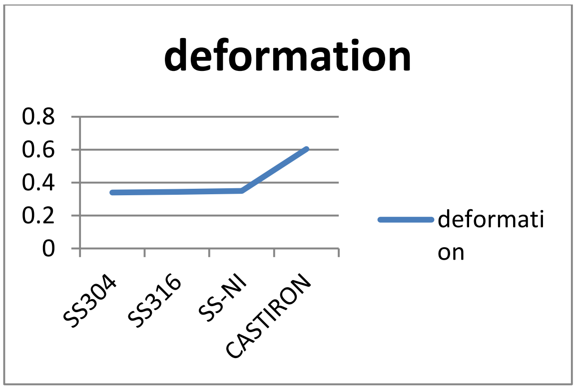
c. MATERIAL: 316 STAINLESS STEEL

DEFORMATION



Deformation analysis on 316 Stainless steel at pressure 5000 pa, load 25000 n-mm & Inertia 250 rpm

GRAPHS



Deformation at pressure 5000 pa, load 25000 n-mm & Inertia 250 rpm

Stress at pressure 5000 pa, load 25000 n-mm & Inertia 250 rpm

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CONCLUSION

In this project we designed one rotary air lock valve with 10 vanes by using creo-2 software and then imported this object into ANSYS. And we took cast-iron is a existing material then we analysing with real time boundary conditions to get better results we also took another 3 materials

In this project we decreasing the vanes from 10 to 8 and 6 and applying same boundary conditions for existing material and different materials from all these cases we will get one good object with good material

From the results we can say that when we decreasing the vanes the performance of the object is increasing i.e the stress values have been decreasing while decreasing vanes and also safety factor have been increased but when we checking deformation values 8 vanes model producing high deformations for Ss304 And Ss316 materials. Then after that slightly decreasing for Ss-Ni And Cast Iron

And finally the design with 6vanes with material Ss-Ni is more suitable model, and it is producing very less stress values and high safety factor values those results are 146 Mpa stress and 2.87 is safety factor

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