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Investigation of Performance of Twin Screw Compressor Using FEA

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ABSTRACT

A twin screw compressor with 5 teeth is designed, modeled and analyzed deformations, stresses, frequencies, directional deformations and shear stresses. The modeling and assembly is done in Creo 2.0. Static Structural analysis, Modal analysis are done on the twin screw compressor by varying rotational speeds 2000rpm, 4000rpm, 5000rpm to determine deformations, stresses and frequencies. Random Vibration analysis is done at speed 5000rpm to determine directional deformations and shear stresses. The analysis is done using materials Steel, Titanium alloy and Nickel Alloy. Analysis is performed in Ansys 14.5.

I.INTRODUCTION

A mechanical device that expands the gas pressure by lessening its volume is a compressor. A sort of gas compressor is an air compressor.

Rotary compressor

The refrigerant is compressed by a roller rotary motion ascended eccentrically with a cylinder enclosing it in this type of compressor. The function is similar to that of the reciprocating compressor that is refrigerant is compressed to high pressure (Condenser Pressure) & high temperature from low pressure(evaporator pressure), pressure difference is maintained between the evaporator & the condenser and refrigerant flow is created from evaporator to condenser.

Rotary Screw Compressor

It is a sort of gas compressor that utilizes a mechanism of rotary type positive displacement. They are normally utilized to supplant piston compressors where vast volumes of air with high-pressure are required, either for huge industrial applications or to work high-control air devices, for example, jackhammers.

The process of gas compression of a rotary screw is a ceaseless sweeping movement, so a very little flow surging or pulsation is present, as happens with piston compressors.

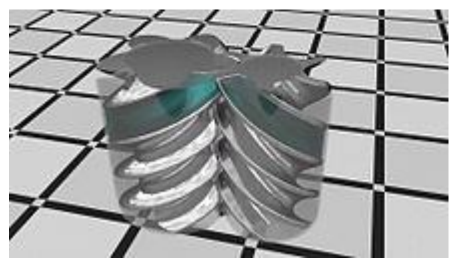

Fig 1: - The twin-screw compression action with a 6 lobe female screw & a 5 lobe male screw and one sets of cavities compression is featured: through intake port air is sucked in, compressed (appeared by the change from cyan to red) and discharged through the outlet port.

II.LITERATURE SURVEY

Nikhil M. Patel, Prof. B.B.Shah, Dr.A.Raman [1], studied an acceptable procedure for optimisation of the screw mechanical device form, size, and dimension is delineate here, which ends within the most applicable style. Compressors so designed deliver the goods higher delivery rates and higher efficiencies than those exploitation ancient approaches. **Huagen Wu [2]**, exhibited FEM for computation of compressor compression loads. 3D elements were mapped with every rotor. Chamber pressure was loaded on the elements

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corresponding to rotor surface. The compression loads are figured by incorporating the moment and force at every element node. To check the FEM, set up of a test rig was done, and each rotor axial forces were measured by the sensor which are placed between the bearings. The aftereffects of hypothetical computation by the FEM are in great concurrence with the measured data.

III.MODELING OF TWIN SCREW COMPRESSOR

The reference for the model is taken from the journal "Design and analysis for screw compressor", by Nikhil M. Patel, Prof. B.B.Shah, Dr.A.Raman, Journal of information, knowledge and research in mechanical engineering, ISSN 0975 – 668X| NOV 12 TO OCT 13 | VOLUME – 02, ISSUE – 02 specified as [1] in References chapter. In the model specified in the above journal paper, the teeth taken are 4. In this thesis, number of teeth taken are 5. The twin screw compressor with 5 teeth is done in 3D modeling software Creo 2.0.

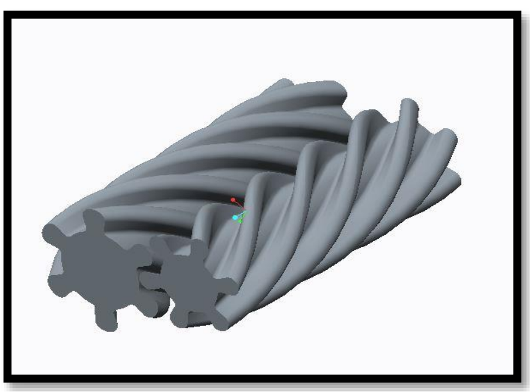

Fig 2 :- Final assembly of screw compressor

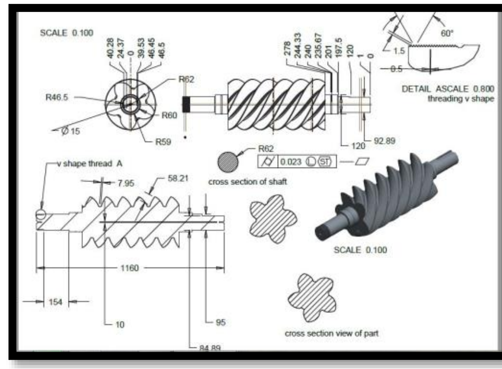

Fig 3:-2D drafting of screw compressor.

IV.ANALYSIS OF TWIN SCREW COMPRESSOR

Boundary conditions of static analysis are taken from the below journal paper

"Design and analysis for screw compressor", by Nikhil M. Patel, Prof. B.B.Shah, Dr.A.Raman, Journal of information, knowledge and research in mechanical engineering, ISSN 0975 – 668X| NOV 12 TO OCT 13 | VOLUME – 02, ISSUE – 02 specified as [1] in References chapter.

Static Structural analysis is performed on the twin screw compressor by varying the rotational speed 2000rpm, 4000rpm and 5000rpm using materials Steel, Titanium and Nickel to determine deformations, stresses and strains.

The meshing is done using fine mesh and triangular mesh is formed. Rotational velocity of 2000 rpm is applied in Z – axis of shaft.

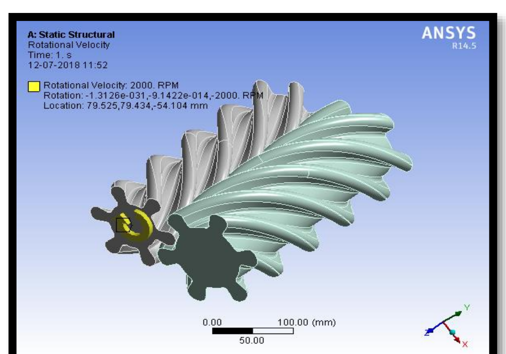

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Fig 4: - Rotation velocity applied on the shaft 2000 rpm

NICKEL ALLOY

ROTATIONAL SPEED – 5000rpm

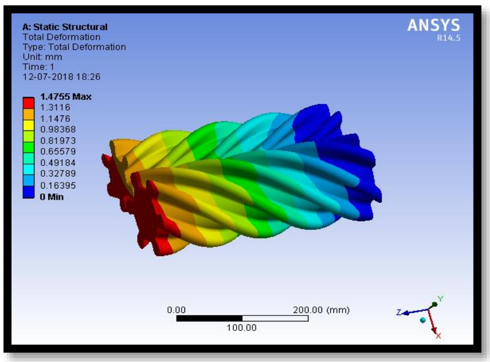

Fig 5:-Total deformation of twin screw compressor at 5000rpm using Nickel alloy

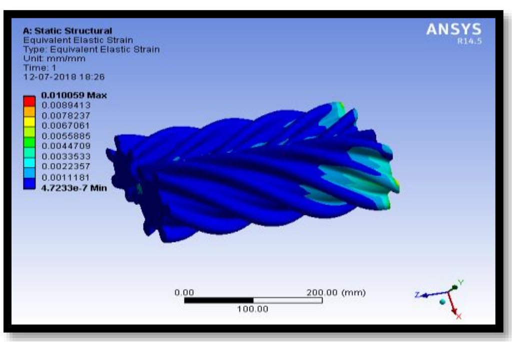

Fig 6:-Strain of twin screw compressor at 5000rpm using Nickel alloy

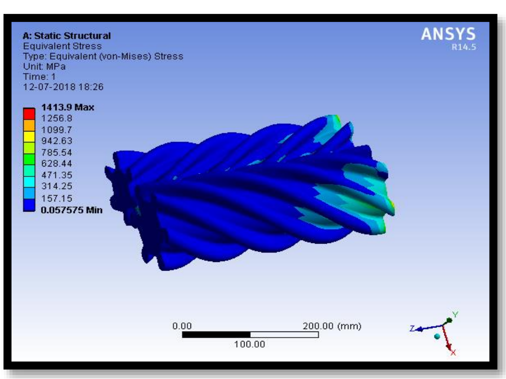

Fig 7:-Stress of twin screw compressor at 5000rpm using Nickel alloy

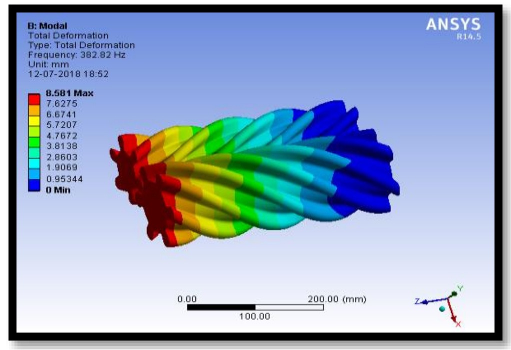

Fig 8:-Total deformation 1 of twin screw compressor at 5000rpm using Nickel alloy

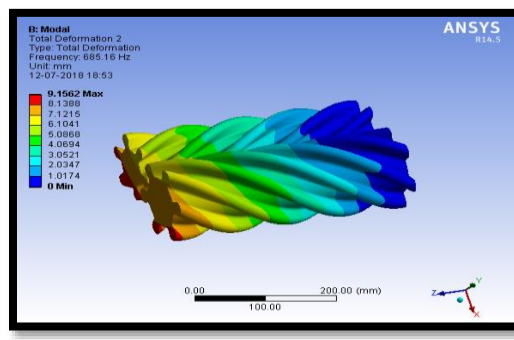

Fig 9:- Total deformation 2 of twin screw compressor at 5000rpm using Nickel alloy

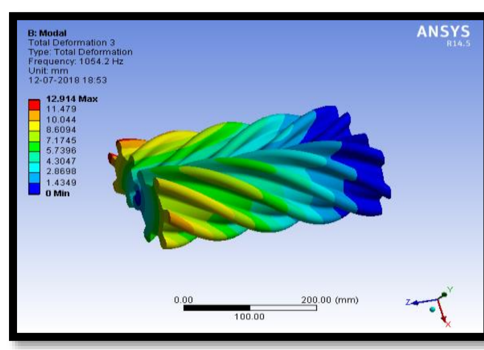

Fig 10:-Total deformation 3 of twin screw compressor at 5000rpm using Nickel alloy

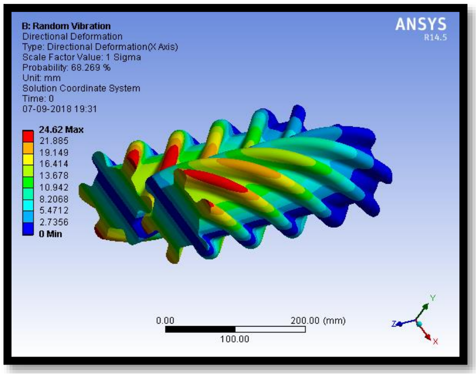

Fig 11:-Directional deformation of twin screw compressor at 5000rpm using Nickel alloy

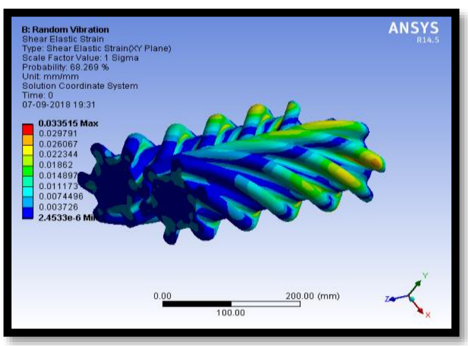

Fig 12:-Shear Strain of twin screw compressor at 5000rpm using Nickel alloy

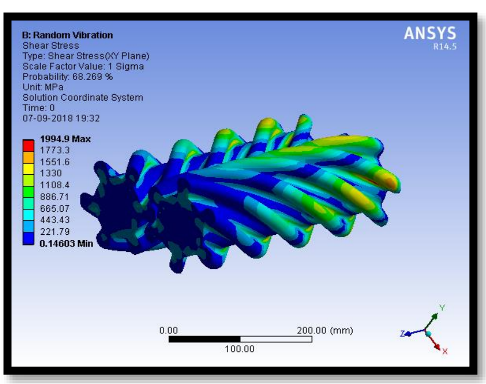

Fig 13:-Shear Stress of twin screw compressor at 5000rpm using Nickel alloy

V.RESULTS AND DISCUSSIONS

STATIC STRUCTURAL ANALYSIS

SPEED - 2000 rpm

	Steel	**Titanium**	**Nickel**
Total Deformation (mm)	0.001545	0.002022	0.0029321
Stress (MPa)	10.418	5.676	12.262
Strain	0.00068075	0.0006744	0.00096796

At 2000rpm, the deformation value is less when Steel is used and Stress value is less when Titanium alloy is used. The stress is reducing for Titanium alloy by about 45.5% when compared with that of Steel & by about 53.7% when compared with that of Nickel Alloy.

SPEED - 4000 rpm

	Steel	**Titanium**	**Nickel**
Total Deformation(mm)	0.0073802	0.0083082	0.011729
Stress (MPa)	41.672	22.704	49.048
Strain	0.00024323	0.00026979	0.00038718

At 4000rpm, the deformation value is less when Steel is used and Stress value is less when Titanium alloy is used. The stress is reducing for Titanium alloy by about 45.5% when compared with that of Steel & by about 53.7% when compared with that of Nickel Alloy.

SPEED – 5000 rpm

	Steel	Titanium	Nickel
Total Deformation (mm)	0.011532	0.012982	0.018326
Stress (MPa)	65.1133	34.475	79.637

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Strain	0.00038005	0.00042155	0.00060497

At 45000rpm, the deformation value is less when Steel is used and Stress value is less when Titanium alloy is used. The stress is reducing for Titanium alloy by about 47.05% when compared with that of Steel & by about 56.7% when compared with that of Nickel Alloy.

MODAL ANALYSIS

At 2000rpm, the deformation and frequency values are more when Steel is used and less when Nickel alloy is used. At mode 3, the frequency is reduced for Nickel alloy by about 18% when compared with that of Steel and by about 5.5% when compared with that of Titanium alloy. By reducing frequencies, vibrations in the component will decrease. At 4000rpm, the deformation and frequency values are more when Steel is used and less when Nickel alloy is used. At mode 3, the frequency is reduced for Nickel alloy by about 18% when compared with that of Steel and by about 5.5% when compared with that of Titanium alloy. By reducing frequencies, vibrations in the component will decrease. At 5000rpm, the deformation and frequency values are more when Steel is used and less when Nickel alloy is used. At mode 3, the frequency is reduced for Nickel alloy by about 18% when compared with that of Steel and by about 5.5% when compared with that of Titanium alloy. By reducing frequencies, vibrations in the component will decrease.

RANDOM VIBRATION ANALYSIS

The directional deformation value is less when Nickel alloy is used and Shear Stress is less when Titanium alloy is used. The stress value is decreasing for Titanium alloy by about 22.5% when compared with that of Steel and by about 29.35% when compared with that of Nickel alloy.

VI.CONCLUSION

Static Structural analysis, Modal analysis are done on the twin screw compressor by varying rotational speeds 2000rpm, 4000rpm, 5000rpm to determine deformations, stresses and frequencies. Random Vibration analysis is done at speed 5000rpm to determine directional deformations and shear stresses. The analysis is done using materials Steel, Titanium alloy and Nickel Alloy.

By observing static structural analysis results, at all speeds, the deformation value is less when Steel is used and Stress value is less when Titanium alloy is used. The stress is reducing for Titanium alloy by about 45.5% when compared with that of Steel & by about 53.7% when compared with that of Nickel Alloy.

By observing modal analysis results, at all speeds, the deformation and frequency values are more when Steel is used and less when Nickel alloy is used. At mode 3, the frequency is reduced for Nickel alloy by about 18% when compared with that of Steel and by about 5.5% when compared with that of Titanium alloy. By reducing frequencies, vibrations in the component will decrease when Nickel alloy is used.

By observing Random Vibration analysis results, the directional deformation value is less when Nickel alloy is used and Shear Stress is less when Titanium alloy is used. The stress value is decreasing for Titanium alloy by about 22.5% when compared with that of Steel and by about 29.35% when compared with that of Nickel alloy.

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