xIlkogretim Online - Elementary Education Online,2021; Vol 20 (Issue 1): pp.2021-2030
http://ilkogretim-online.org
doi: 10.17051/ilkonline.2021.01.221

DESIGN AND ANALYSIS OF RADIAL IMPELLER WITH NYLON66 AND WHITE ACRYLIC

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Abstract- This study is carried out to predict and present the effects of a Radial fan impeller. Analyzing the features of a centrifugal pump is complicated and time-consuming. Pump activity is often highly based on a large number of interdependent variables. The aim of this project is to investigate the analysis of a radial impeller. Until performance testing and installation, the radial fan impeller is examined. Static primary investigation is performed to track down the greatest pressure esteems. These investigations are finished by ANSYS. In this venture contrasting the Nylon66 and white acrylic material properties of static primary examination have been performed during the investigation utilizing the product.

Key Words: Nylon66, Acrylic, Radial Impeller, Static structural analysis.

I. Introduction

This study has been done to foresee and give the consequences of a Radial fan impeller. The Radial fan impeller is examined before the exhibition testing and establishment. Stress examination is performed to track down the most extreme pressure esteems. These examinations are finished by ANSYS. In this task contrasting the nylon66 and white acrylic material properties of static primary investigation have been performed during the examination utilizing the product. A spiral impeller is an impeller at which the stream leaves the impeller outspread way, opposite to the siphon shaft. An impeller is a pivoting segment outfitted with vanes or edges utilized in super hardware (e. g. radiating siphons). An impeller is a pivoting part of a radiating siphon that speeds up liquid outward from the focal point of revolution, hence moving energy from the engine that drives the siphon to the liquid being siphoned ability to be changed over into siphon power yield.Impellers are fundamental segments in outward siphons and vacuum siphons, among other siphoning gadgets. Siphon impellers depend on Bernoulli's rule which expresses that an expansion in liquid speed is joined by a decline in pressing factor or likely energy (and the other way around) to work. At the point when liquid or gas media enters an impeller siphon, it gets caught between the impeller vanes and the siphon divider and expansions in speed as it moves from the impeller eye (focus) around the external measurement of the impeller. When the media arrives at a specific point closest the external breadth, it unexpectedly diminishes in speed and encounters an equivalent expansion in pressure (as per Bernoulli's standard). The media turns out to be much more compressed as it is released from the impeller and out of the siphon opening. In this investigation we will close the best material between the nylon66 and acrylic material.

II. Experimental Requirements

Processor	:	PENTIUM 4
CPU speed	:	2.7 GHZ
HDD	:	160GB
Main memory capacity	:	30GB
Software	:	ANSYS10

III. Material Properties and Applications

Material properties are the most important when we go for comparing the static structural analysis of different material with same applications. Here we are comparing the nylon66 material and acrylic material for the application of radial impeller.

3.1.1 Properties of Nylon66- PA66

Nylon66 may be a remarkably hard-wearing, sturdy material utilized in many applications. It is very often used as a replacement material for aluminum, steel and other materials. Nylon plastic is best suited in situations when a material's weight is often a priority also as when either low amount of impact our no impact to the material is expected. The material properties are detail shown in table:1 (Properties of nylon66 and Acrylic)

3.1.2 Application of Nylon66

Sleeve and slide bearings Wear pads, Support and guide wheels, Cable sheaves, Hammer heads, Scrapers, Gear wheels, Seal rings, Cutting boards, Track plates, etc

3.2.1 Properties of Acrylic materials

Solid and warm acrylic fiber is frequently utilized for sweaters and tracksuits and as linings for boots and gloves, just as in outfitting textures and rugs. It is fabricated as a fiber, at that point trim into short staple lengths like fleece hairs, and turned into yarn. Superb optical lucidity and straightforwardness. Exceptionally impervious to varieties in temperature. A large portion of the heaviness of glass and ideal for exactness machining. The material properties are detail appeared in table:1 (Properties of nylon66 and Acrylic)

3.2.2 Application of Acrylic (PMMA)

Indoor and outdoor signs, Architectural glazing, skylights, Transportation applications, Brochure holders Shelves and retail fixtures, transparent manifolds, Frames and display cases, etc.

S.NO	Property	White acrylic	Nylon 66
1	Hardness (HRC)	106.8	118-120
2	Tensile Strength (MPa)	67-70	85
3	Flexural Yield Strength (MPa)	40	145-310
4	Elongation at Break (%)	13	5-640
5	Melting Point (Celsius)	1470	260
6	Thermal Conductivity (w/m-k)	46	0.53
7	Tensile Modulus (MPa)	240	6500

Table:1(Properties of White Acrylic and Nylon66)

IV. CONSTRUCTIONAL FEATURES OF RADIAL IMPELLER DESIGN

A radial fan is a one in which the flow enters along the axis and leaves in the radial direction along the blades. It can be used for PA, FD and ID applications. Fig.1 shows the different types of radial fan.

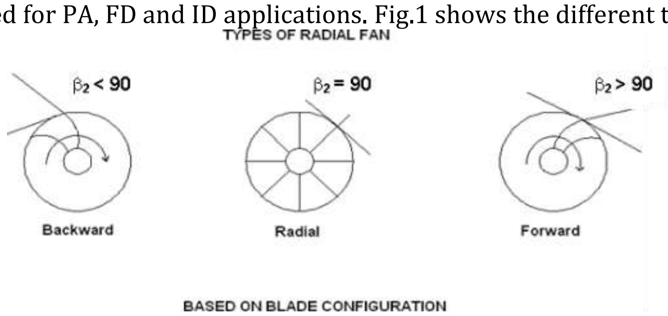

Fig.1: Types of radial fan

4.1 Aero foil bladed radial fan:

An aero foil bladed radial fan consists of blades, which are profiled, in an aero foil shape as shown in the fig.2.Since the aero foil is a profile curved body, it ensures a smoother flow than a blunt body and hence nonflow separation thereby minimized losses.

Fig 2. Aerofoil Impeller Blade.

4.2 Design of Radial Impeller

The impeller is a completely welded structure. It consists of a center plate (or) back plate, cover plate and blades. The blades are welded between the back plate and the cover plate. Proper welding sequence is followed to have minimum distortion. The impeller is the key component of centrifugal pump. The impeller, on the opposite side to the eye, is connected through a drive shaft to a motor and rotated at high speed. The rotational motion of the impeller vanes into the pump casing. The complete 2D sketch of radial impeller as per the company standards. Fig 3. Shows the 2D sketch of Radial Impeller.

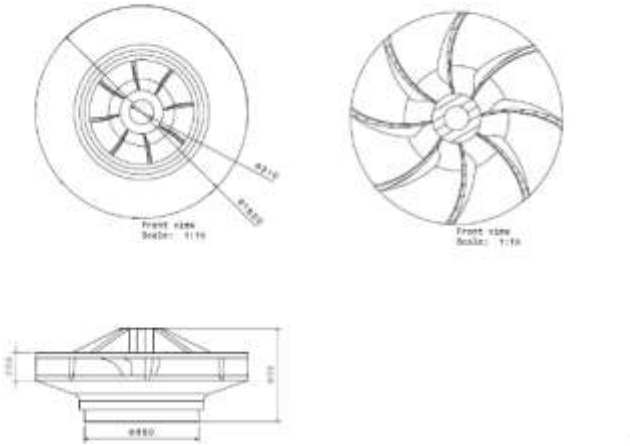

Fig.3: 2D sketch of Radial Impeller

V. EXPERIMENTAL PROCEDURE:

With the advent of hi-tech computers, the FEA solutions for complex problems are made easy and simple. The general procedure for the FEA is outlined in the form as below.

Pre –processor:

1. Read the input data and identify the design constraints.
2. Model the continuum.
3. Identify the element type and mesh the model.
4. Define the boundary conditions and load data.

Processor/solution:

1. Compute element stiffness matrices.
2. Assemble element equations.
3. Solve equations for the condition
4. Compute results.

Pre –processor:

1. Plot the results
2. Interpret the results

5.1 Creation of 3D Model:

Before doing analysis, the geometry of the model should be created as per standard dimensions with aero foil blade. Modeling is done in Catia V5. There we have lot of option through which the geometry of the model is created. The 3D model of radial impeller done with standard dimensions. Fig 4. Shows the analysis model of radial impeller.

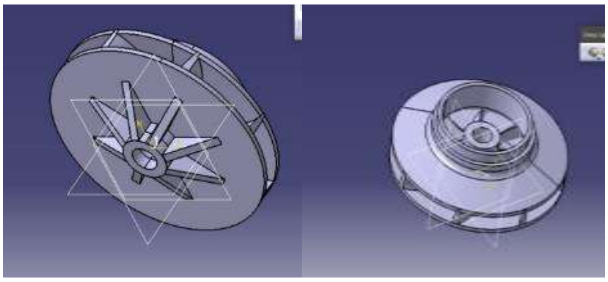

Fig 4. 3D Analysis model of radial impeller.

5.2 Meshing of 3D model in ANSYS:

The meshing is the more important part of analysis field it plays the vital role in result of analysis the element and node condition are satisfied along with design standard. Here the course meshing is done in Ansys software itself, the Fig 5. Shows that the free mesh of radial impeller. After generation of contours for proper meshing we should go for meshing of the model. There are two types of meshing. They are free mesh and mapped mesh. So, in free mesh we can solve it and get the results but it won't be accurate.
So, for accurate results, we have to go for mapped mesh. So, if we did line element sizing (resize) properly we get mapped mesh.

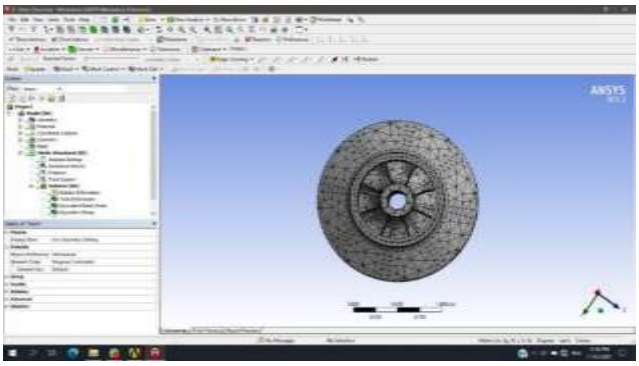

Fig 5. Free mesh of radial impeller

5.3 Boundary conditions:

Boundary conditions are most important and precious data to start the analysis, it must be related to the existing application of radial impeller conditions. The below following topics are explained detail about boundary conditions.

5.3.1 Displacement conditions

The rotating motor shaft is fixed in the impeller therefore the displacement on the impeller hole is zero in all degree of freedom, except rotation of Z-axis

5.3.2. Air pressure:

The air pressure is applied on impeller according to given company data of 100 mm of water.

5.3.3. Angular velocity:

The impeller rotates about the "z" axis at a speed of 276rpm. Therefore,
Angular velocity = (2πN)/60
= 28.888 rad/sec
The angular acceleration is also given as 43.17 rad/sec2. Fig 6. Shows the applying the boundary condition before solving the model.

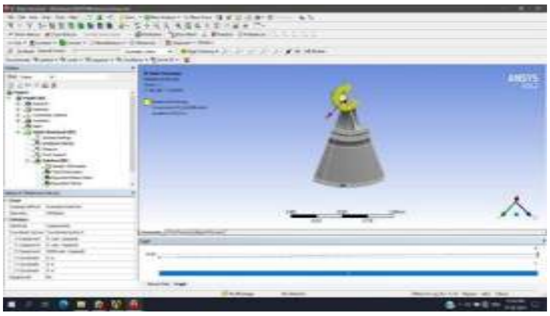

Fig 6. Boundary condition of Impeller.

5.4 Solution:

After completing modeling and giving boundary conditions the problem has to be solved using the ANSYS-SOLUTION utility. In the solution utility all the element matrices are formed and it is solved to find the stress and deflection for the applied boundary condition.

VI. RESULT AND DISCUSSION:

A static structural analysis determines the displacements, stresses, strains, and forces in structures or components caused by loads that do not induce significant inertia and damping effects. Structural analysis is thus a key part of the engineering design of structures.Structural analysis is the determination of the effects of loads on physical structures and their components. Structures subject to this type of analysis include all that must withstand loads. Now the all the criteria from the design to the boundary conditions are done with standard dimensions as per company data.

6.1 Types of Result in Static Structural Analysis:

The static structural analysis shows the different types of results, from that we are comparing the important results that helps to predict the suitable material for analysis, that following results are described.

6.1.1 Total Deformation:

The Cauchy strain or engineering strain is expressed as the ratio of total deformation to the initial dimension of the material body in which the forces are being applied. Based on the total deformation we should analysis the suitable material for our boundary conditions.

6.1.2 Von mises stress:

Von Mises stress is a value used to determine if a given material will yield or fracture. The von Mises yield criterion states that if the von Mises stress of a material under load is equal or greater than the yield limit of the same material under simple tension then the material will yield.

6.1.3 Equivalent Elastic Strain

The equivalent elastic strain is defined as the limit for the values of strain up to which the object will rebound and come back to the original shape upon the removal of the load.

6.1.4 Maximum Principle Elastic strain:

That the material or component fails when the strain energy stored inside it per unit volume in a bi-axial system reaches the strain energy per unit volume at the yield point (In the stress- strain curve).

6.1.5 Maximum Principal Stress:

The maximum-principal-stress criterion postulates that the growth of the crack will occur in a direction perpendicular to the maximum principal stress. As a continuous criterion, the criterion does not take into account the discreteness of the numerical modeling of the crack-extension procedure.

6.2 Static Structural Analysis of NYLON66 PA-66

After applying all the boundary conditions with suitable data as per company the meshed model is ready to solve and it take some running time for analysis of processing stage, the after analysis the software shows the accurate result for the given data with material properties. All results of static analysis of Nylon66 material for radial impeller are shown as Fig 7 given below.

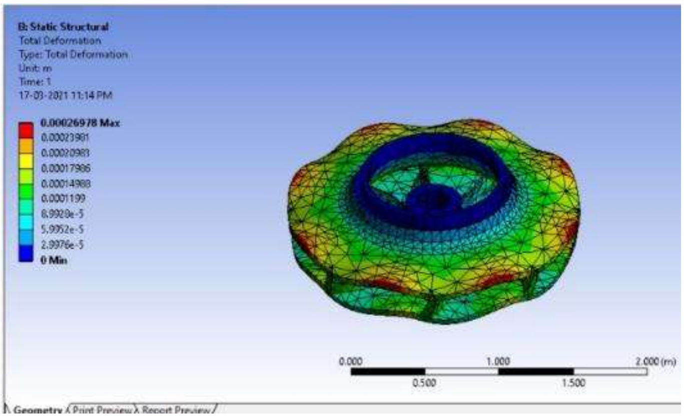

Fig 7. Total Deformation of Nylon66 PA-66

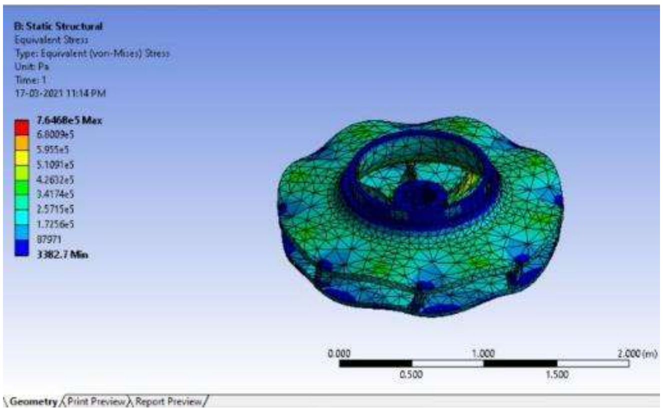

Fig 8. Vonmises stress of Nylon66 PA-66

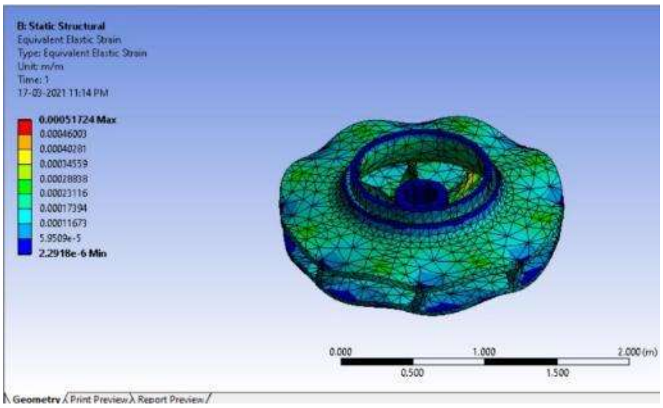

Fig.9. Equivalent Elastic Strain of Nylon66 PA-66

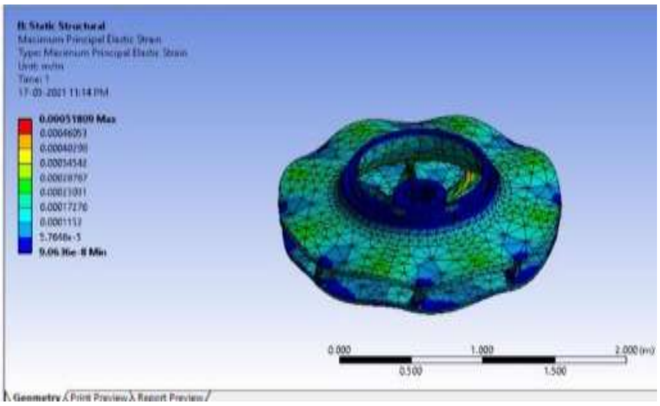

Fig 10. Maximum Principle Elastic Strain of Nylon66 PA-66

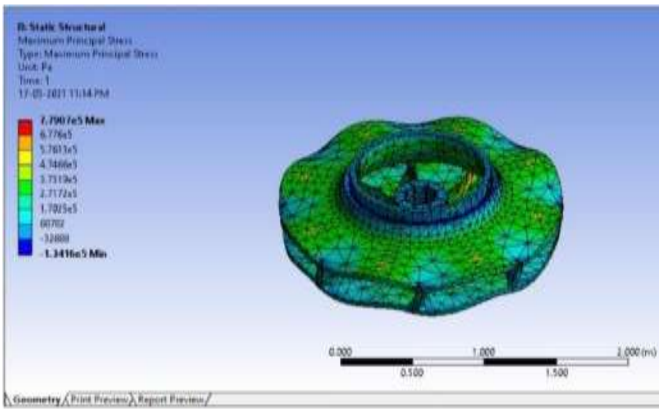

Fig 11. Maximum Principal stress of Nylon66 PA-66.

6.3 Static Structural Analysis of ACRYLIC (PMMA):

Static structural analysis of white acrylic (PMMA) also follows the same procedure followed y nylon66, after applying the same boundary conditions the solver takes time for analysis and the following results are shown below.

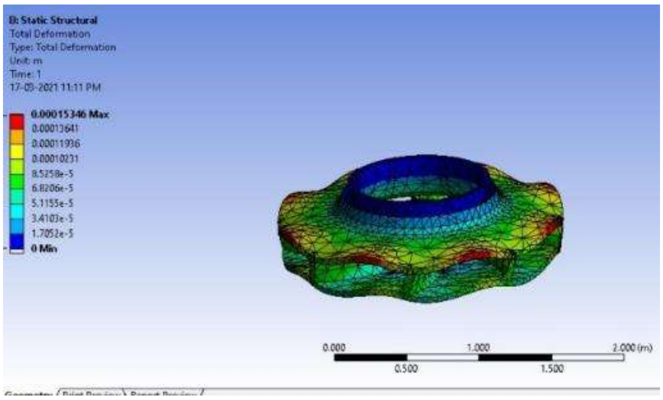

Fig 12. Total Deformation of Acrylic (PMMA)

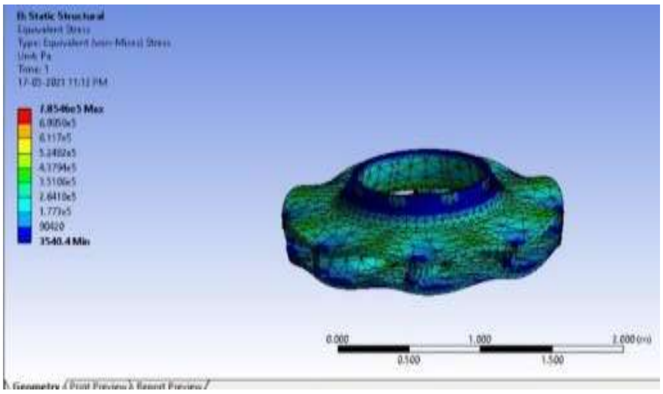

Fig 13. Vonmises Stress of Acrylic (PMMA)

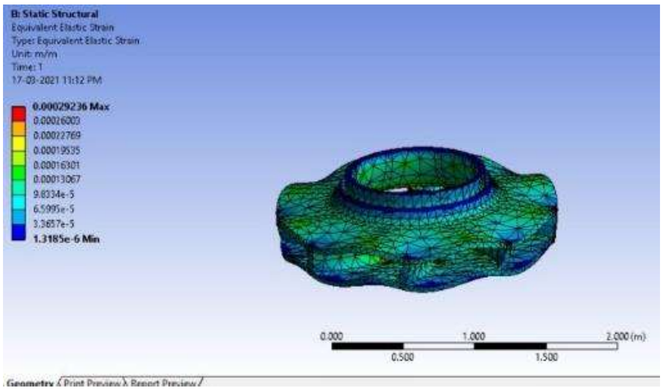

Fig 14. Equivalent Elastic Strain of Acrylic (PMMA)

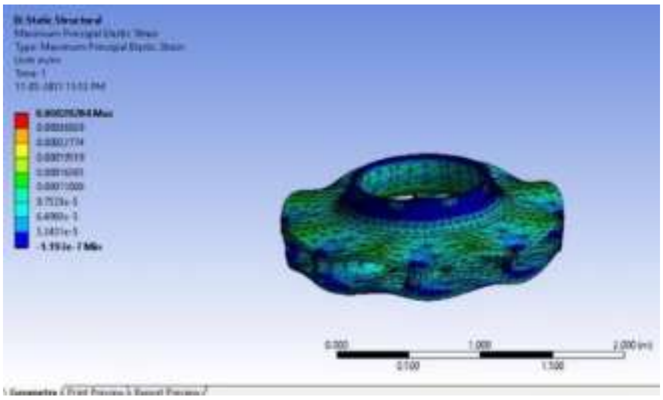

Fig 15. Maximum Principle Elastic Strain

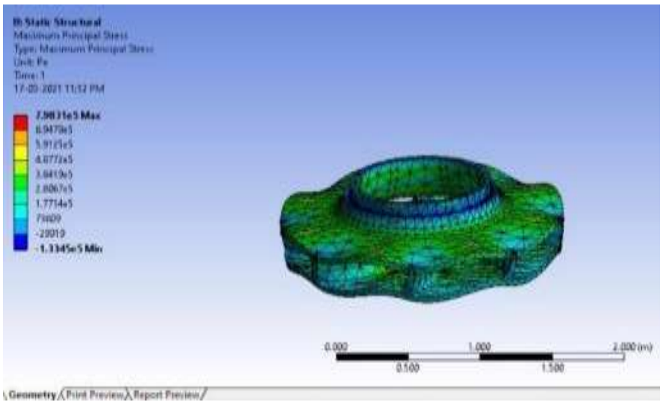

Fig 16. Maximum Principal Stress

That above fig shows the result of white acrylic (pmma)
material behavior based on the radial impeller of given boundary conditions. The result of both materials is satisfied its own characteristic properties. The comparison of nylon66 and white acrylic material are followed below.

6.4 Comparison of Nylon66 and White Acrylic

In the correlation of Nylon66 PA-66 and White Acrylic materials dependent on the conduct qualities applied on the outspread stream impeller. There are such countless applications are comparable for both material properties due to its syntheses. plastic in assembling machine parts Conveyer and safety belts, parachutes, airbags, nets and ropes, coverings, string, and tents. Crinkled nylon strands are utilized for making versatile hosiery. Presently a day the both nylon and white acrylic materials are supplanted with steel, aluminums, and so forth Principally the nylon materials are utilized and most appropriate for outspread impeller with numerous benefits. Henceforth the examination should be possible with the static underlying investigation, the accompanying table 2, shows the correlation of nylon66 and acrylic material for spiral impeller.

Table2. Comparison of Nylon66 (PA-66) and Acrylic (PMMA) results.

S. No	**Static Structural Analysis**	**Nylon66 (PA-66)**	**White Acrylic (PMMA)**
1	Total Deformation(m)	2.6s978e-004	1.5346e-004
2	Von mises stress (Pa)	7.6468e+005	7.8546e+005
3	Equivalent Elastic Strain (m/m)	5.1724e-004	2.9236e-004

4	Maximum Principle Elastic Strain (m/m)	5.1809e-004	2.9284e-004
5	Maximum PrincipalStress (Pa)	7.7907e+005	7.983e+005

The above table2 shows the result of both Nylon 66 and White Acrylic materials.

VII. CONCLUSION

The table2 shows the final output result of Nylon66 (pA-66)and White Acrylic (PMMA). The result is purely based on the geometry and boundary conditions of Radial Impeller with the standard company data. Here, when we compare the static structural behavior between Nylon and White Acrylic material are:

1) Total deformation of Nylon66 (PA-66) are lower than the Acrylic (PMMA) material
2) Von mises stress of Nylon66 (PA-66) are lower than the Acrylic (PMMA) material
3) Equivalent Elastic Strain of Nylon66 (PA-66) higher than the Acrylic (PMMA) material
4) Maximum principle Elastic strain of Nylon66 (PA-66) higher than the Acrylic (PMMA) material
5) Maximum Principal Stress of Nylon66 (PA-66) are lower than the Acrylic (PMMA) material

That the above discussed five points are most important when we conclude the best material. Here Nylon66 PA-66 material have more strain and stress so it gives the higher deformation. In Acrylic (PMMA) material having the lower stress and strain so the deformation is comparatively lower than Nylon66. At last, we conclude, according to the deformation of Radial impeller the White Acrylic material is best suited. When we focus the stress and strain of radial impeller Nylon66 AP-66 are best.

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