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# MODELING AND ANALYSIS OF PVC MIXTURE BLADE

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***Abstract: PVC (polyvinyl chloride) is a solid plastic made from vinyl chloride. It is made softer and more flexible by the addition of phthalates and bisphenol-A PVC is used to make pipes, sliding, medical devices and automobiles parts etc. The PVC mixtures are used for mixing, drying, stirring and cooling of plastics for a daily usage. The temperature of the PVC mixture is maintained around 120ºC and mixing the different chemical powders uniformly. The high speed stainless steel mixer blades are used in PVC mixer. These blades are arranged in 3 series with different angles. Blades angle play an important role for uniform mixing. The aim of this project work is to increase blade efficiency by designing a mixture blade with new profile and material. In this work, the modeling of the blade will done using CATIA software package and analysis viz., static, dynamic and model analysis will be carried out using ANSYS software package. The proposed new design ensures longer life and uniform mixing of PVC elements in lesser time.***

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## I INTRODUCTION

### 1.1 INTRODUCTION

Mixtures are one product of mechanically blending or mixing chemical substances such as elements and compounds, without chemical bonding or other chemical change, so that each ingredient substance retains its own chemical properties and makeup. Despite the fact that there are no chemical changes to its constituents, the physical properties of a mixture, such as its melting point, may differ from those of the components. Some mixtures can be separated into their components by using physical (mechanical or thermal) means. Azeotropes are one kind of mixture that usually poses considerable difficulties regarding the separation processes required to obtain their constituents (physical or chemical processes or, even a blend of them).In chemistry, a mixture is a material made up of two or more different substances which are physically combined. A mixture is the physical combination of two or more substances in which the identities are retained and are mixed in the form of solutions, suspensions and colloids.

**Figure 1.1: PVC powder mixing**

### 1.2 CHARACTERISTICS OF MIXTURES:

Mixtures can be either homogeneous or heterogeneous. A mixture in which its constituents are distributed uniformly is called homogeneous mixture, such as salt in water. A mixture in which its constituents are not distributed uniformly is called heterogeneous mixture, such as sand in water.

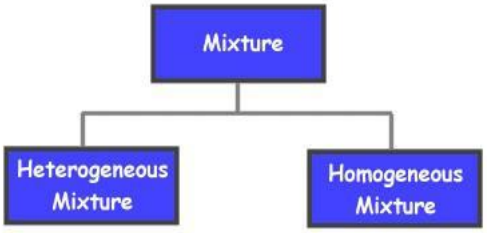


**Figure 1.2 Types of mixture**

One example of a mixture is air. Air is a homogeneous mixture of the gaseous substances nitrogen, oxygen, and smaller amounts of other substances. Salt, sugar, and many other substances dissolve in water to form homogeneous mixtures. A homogeneous mixture in which there is both a solute and solvent present is also a solution. Mixtures can have any amounts of ingredients.

Mixtures are unlike chemical compounds, because:

The substances in a mixture can be separated using physical methods such as filtration, freezing, and distillation. There is little or no energy change when a mixture forms.

Mixtures have variable compositions, while compounds have a fixed, definite formula.

When mixed, individual substances keep their properties in a mixture, while if they form a compound their properties can change.

**1.3 MIXTURES CAN BE CLASSIFIED INTO TWO METHODS:**

**Suspension mixture colloidal mixture**

**1.3.1 Suspension mixture:**

A suspension mixture is usually created by stirring together two or more ingredients, where the particles are typically large enough to be seen by the unaided eye or a magnifying glass. The ingredients of a suspension mixture are heterogeneous, meaning that they are not evening distributed throughout. Most mixtures are suspension mixtures.

**1.3.2 Solid-solid mix:**

Many suspension mixtures consist of solids mixed with solids. Cake mix is an example of visible solid particles mixed together by a means of stirring. Dirt or soil is another example of a solid-solid suspension mixture.

These mixtures can be separated by sifting. Sometimes shaking will cause the heavier particles to settle to the bottom.

**1.3.3 Colloidal mixture:**

A colloidal mixture is a homogeneous combination of solid or liquid particles mixed within a liquid or gas solvent.

Size of particles:

The size of solute particles in a colloidal mixture is much smaller than the particles in a suspension, but they are not as small as those in a solution. The particles in a colloidal mixture are typically as small as a clump of molecules that may not even be visible with a common microscope.

What makes a colloidal mixture unusual is that the solute particles do not break down any further to be single molecules-thus forming a solution. Instead, "something" coats the particles and prevents them from completely dissolving in the solvent.

**1.4 MIXING QUALITY:**

The quality of a mixture is improved by reducing both the scale and intensity of segregation. As they are reduced the mixture will pass through a critical quality where it can be deemed satisfactory or well mixed. Further mixing is unnecessary. This concept of a critical mixture quality was described by danckwerts in terms of a scale of scrutiny for the mixture. This is the quantity of mixture on which the customer will base a judgment of quality. Thus, in the case of dispersing a pigment in a face powder the judgment would be based on the ability of an eye to detect any patchiness when the powder is spread on the skin and the scale of scrutiny would be measured in fractions of a gram of powder.

## II PVC MIXER BLADES

**MECHANIS MS OF MIXING:**

Mechanisms of mixing: Mixing of solids can be achieved by any one of the following three mechanisms. Mixing by diffusion blending is characterized by the random motion of soli d particles. Diffusion blending occurs where the particles are distributed over a freshly developed interface. Tumbler blenders like the double cone blenders and v-blenders function by diffusion mixing.

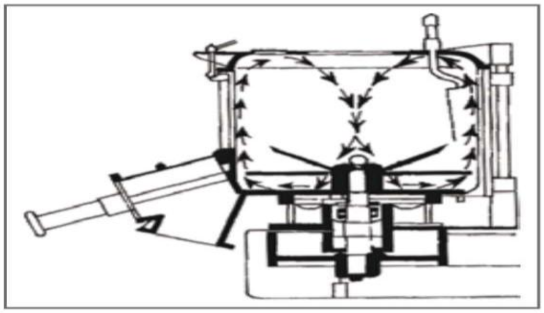

**Figure 2 Mixing Mechanism**

**2.1.1 Mixing by convection:**

Mixing by convection blending is characterized by the random motion of solid particles. In convection blending groups of particles are rapidly moved from one position to another due to the action of a rotating agitator. The blending of solids in ribbon blenders, and paddle mixers is mainly a result of convection mixing.

**2.2 MIXING BY SHEAR:**

Here mixing is achieved due to the removal of force of attraction between the particles. Shear blending as the development of slip planes or shearing strains within a bed of material. Blenders with high s peed chopper blades and intensifiers are examples of shear blending.

**2.2.1Low Shear Mixing Blades:**

Mixer directs low shear impellers are designed wit h the intention of imparting motion to the mix while utilizing the least amount of energy possible. For this to occur, our low shear mixing blades are designed specifically for low drag and smooth flow. A helpful example of this would be to picture a large stainless steel tank filled with a mixed product that needs to be kept stable while preventing any separation by rotating it over periodically. This is an ideal application for a low shear impeller.

**Figure 3** **Low Shear Mixing Blade**

**2.2.2 Medium Shear Mixing Blades:**

Mixer Directs medium shear mixing blades are the perfect choice for the middle ground of mixing found between low and high shear applications. Medium shear mixing blades are meant for mixing moderately viscous materials that do not require high shear dispersion, but require more shear and movement than a low shear application. Medium shear mixing blades can often be found in use in the food industry, distil ling, and where tote mixing applies

**2.3 MIXING TEC HNIQUES:**

This is used both to reduce the particle size and mix powder. A glass mortar-pastel may be preferred for chemicals.

Spatulation: Mixing of powder is done by movement of a spatula throughout the powders on the sheet of paper. Sifting: The powder i s mixed by passing through sifters. This processes result in a light fluffy pro duct.

**III MIXER BLADE MATERIALS**

A material is a substance or mixture of substances that constitutes an object. Materials can be pure or impure, living or non-living matter. Materials can be classified based on their physical and chemical properties, or on their geological origin or biological function. Materials science is the study of materials and their applications.

Raw materials can be processed in different ways to influence their properties, by purification, shaping or the introduction of other materials. New materials can be produced from raw materials by synthesis.

In industry, materials are inputs to manufacturing processes to produce products or more complex materials.

**3.1 CLASSIFICATION BY USE:**

Materials can be broadly categorized in terms of their use, for example:

Building materials are used for construction

Building insulation materials are used to retain heat within buildings Refractory materials are used for high-temperature applications

Nuclear materials are used for nuclear power and weapons

Aerospace materials are used in aircraft and other aerospace applications Biomaterials are used for applications interacting with living systems

Material selection is a process to determine which material should be used for a given application**.**

**3.2 CLASSIFICATION BY STRUCTURE:**

His relevant structure of materials has a different length scale depending on the material. The structure and composition of a material can be determined by microscopy or spectroscopy.

**3.2.1 Microstructure**

In engineering, materials can be categorized according to their microscopic structure

Ceramics: non-metal, inorganic solids

Glasses: amorphous solids

Metals: pure or combined chemical elements with specific chemical bonding behavior

Polymers: materials based on long carbon or silicon chains

Hybrids: combinations of multiple materials, for example composites.

**3.2.3 LARGER-SCALE STRUCTURE**

In foams and textiles, the chemical structure is less relevant to immediately observable properties than larger-scale material features: the holes in foams, and the weave in materials.

**3.3 CLASSIFICATION BY PROPERTIES:**

Materials can be compared and classified by their large-scale physical properties.

**3.3.1 Mechanical properties**

Mechanical properties determine how a material responds to applied forces.

**Examples include:**

**Stiffness Strength Toughness Hardness**

### 3.3.2 Thermal properties

Materials may degrade or undergo changes of properties at different temperatures. Thermal properties also include the material's thermal conductivity and heat capacity, relating to the transfer and storage of thermal energy by the material.

### 3.3.3 Other properties

Materials can be compared and categorized by any quantitative measure of their behavior under various conditions. Notable additional properties include the optical, electrical and magnetic behavior of materials.

### 3.3.4 CHEMICAL PROPERTIES

These describe what chemical reactions are likely to occur. We can observe how a sample reacts when mixed with other chemicals (water, acid). A material that can burn is described as flammable. Some materials rust (a type of oxidation reaction). Some materials dissolve in water or other liquids. Usually a chemical reaction involves a transformation of the sample into a different substance, and it may be difficult to reverse the process. For example, wood is flammable. When it burns it combines with oxygen from the air. The reaction produces ashes, smoke and water; it cannot be reversed to make wood. The products of the reaction have quite different properties from the original wood.

## 3.4 DESIGN AND CUSTOMIZATION:

### MATERIALS

Most mixers are made from stainless steel, due to the material’s sanitary and corrosion-resistant nature. Other materials that may be used are aluminum, cast iron, steel, titanium, or thermoplastic.

### MICRO STRUCTURE OF STAINLESS STEEL AND TITANIUM

### CONSIDERATIONS

When designing a mixer, manufacturers must make decisions about details like: the materials, the type, the design of the blades and the power level of the motor. They make these decisions based on application specifications like: the thickness and viscosity of the material to be mixed, the volume of material to be mixed, the corrosive of the material to be mixed, the space available to the customer and required levels of sanitation.

A manufacturers’ goal is to assemble the mixer with precision and and select high quality materials that will last as long as possible. Typically, they use materials that are corrosion resistant and have a frictionless surface, like those we’ve already mentioned.

### CUSTOMIZATION

While it is possible for mixer manufacturers to customize mix equipment, it is not super common. However, custom mixers do offer some advantages worth considering. Namely, custom-built and specialized machines enable their operators to have more control over the mixing process. Also, because they are specialized custom machines wear down less quickly than standard models. Some of the most common specializations include: using high velocities to mix multiple materials and modifying the mixer to be able to handle drastic drops in pressure.

## 3.5 SAFETY & COMPLIANCE STANDARDS:

Mixers must be reliable and have an exceptional amount of durability. To that end, we recommend you only purchase mixers that have been certified by a reputable and widely accepted standards organization. In the US, the best example of this is ASME, or the American Society of Mechanical Engineers.

Depending on your application, industry and location, other standards may be of interest to you as well. Some of the most common include: API, UL, USFDA, BISC and ABS. To find out more, talk to your industry leaders and applicable governmental offices.

## 3.6 CHOOSE THE RIGHT MANUFACTURS

Though it’s easy to find and order standard processing equipment sight unseen online, if you care about your business, you’ll work with an experienced mixer supplier instead. That’s not to say you won’t look at their company online; it just means that you’ll do more than read a description and click “add to cart.” For the best results, you want to talk with a professional who can make sure what you’re getting is right for your application and customize the product if it’s not. Find a supplier like that by checking out the mixer manufacturers we’ve detailed on this page. All of those whom we’ve listed have proven themselves with their customers time and time again. They are all known for their quality work and customer service.

To choose from among them, we recommend you take some time to compile a specifications list, and then browse the manufacturers here. Consult your list frequently as you browse. Who looks like they might service you best? Pick three or four to whom you’d like to speak, and then reach out to each of them for a quote. Don’t forget to discuss your standard requirements, budget, timeline and delivery preferences.

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## IV ANALYSIS IN ANSYS SOFTWARE

### 4.1 INTRODUCTION:

ANSYS Mechanical provides solutions for many types of analyses including structural, thermal, modal, linear buckling and shape optimization studies. ANSYS Mechanical is an intuitive mechanical analysis tool that allows geometry to be imported from a number of different CAD systems. It can be used to verify product performance and integrity from the concept phase through the various product design and development phases. The use of ANSYS Mechanical accelerates product development by providing rapid Feedback on multiple design scenarios, which reduces the need for multiple prototypes and product testing iterations.

Founded in 1970, ANSYS employs more than 2,700 professionals, and many of them are engineers, expert in fields such as finite element analysis, computational fluid dynamics, electronics and electromagnetic, and design optimization. Our staff includes more master’s and Ph.D.-level engineers than any other simulation provider. ANSYS is passionate about pushing the limits of world-class technology, all so our customers can turn their design concepts into successful, innovative products.

### 4.1.1 PRODUCTS OVERVIEW:

ANSYS offers engineering simulation solution sets in engineering simulation that a design process requires. Companies in a wide variety of industries use ANSYS software. The tools put a virtual product through a rigorous testing procedure such as crashing a car into a brick wall, or running for several years on a tarmac road before it becomes a physical object.

### 4.1.2 ENERGY:

Columbia Power wave energy device shape optimization to reduce maintenance costs and breakdowns. Indar Electric permanent magnet wind turbine generator optimization for reliable operation**.**

### 4.1.3 ELECTRONICS:

University of Arizona antenna performance optimization. Fujitsu Semiconductor Limited integrated circuit (IC) design optimization.

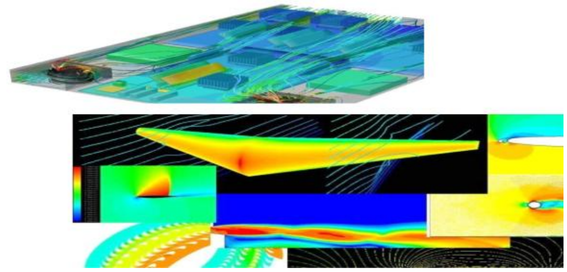


**Figure 4 Integrated circuit (IC) design optimization**

Consumer products Dyson blade less fan airflow performance optimization. Speedo FASTSKIN3 Racing System drags reduction.

### 4.1.4 PRODUCTS:

Simulation Technology: Structural Mechanics, Multiphasic, Fluid Dynamics, Explicit Dynamics, Electromagnetic, Hydrodynamics (AQWA**).**Workflow Technology:

ANSYS Workbench Platform, High- Performance Computing, Geometry Interfaces, Simulation Process & Data Management**.**

### 4.1.5HISTORY:

The company was founded in 1970,by Dr. John, Swanson Analysis Systems, Inc (SASI) Its primary purpose was to develop and market finite element analysis software for structural physics that could simulate static (stationary), dynamic (moving) and thermal (heat transfer) problems. SASI developed its business in parallel with the growth in computer technology and engineering needs. The company grew by 10 percent to 20 percent each year, and in 1994 it was sold to TA Associates. The new owners took SASI’s leading software, called ANSYS®, as their flagship product and designated ANSYS, Inc. as the new company name**.**

### 4.2 TYPES OF ANALYSIS:

In its simplest terms, design analysis is a powerful software technology for simulating physical behaviour on the computer. Will it break? Will it deform? Will it get too hot? These are the types of questions for which design analysis provides accurate answers. Instead of building a prototype and developing elaborate testing regimens to analyze the physical behaviour of a product, engineers can elicit this information quickly and accurately on the computer. Because design analysis can minimize or even eliminate the need for physical prototyping and testing, the technology has gone main stream in the manufacturing world over the past decade as a valuable product development tool and has become omnipresent in almost all fields of engineering.

### 4.3 FINITE ELEMENT ANALYSIS (FEA):

Design Analysis employs the finite element analysis (FEA) method to simulate physical behaviour of a product design.

The FEA process consists of subdividing all systems into individual components or “elements” whose behaviour is easily understood and then reconstructing the original system from these components. This is a natural way of performing analysis in engineering and even in other analytical fields, such as economics. For example, a control arm on a car suspension is one continuous shape. An analysis application will test the control arm by dividing the geometry into ‘elements,’ analyzing them, and then simulating what happens between the elements. The application displays the results as colour-coded 3D images, red usually denoting an area of failure, and blue denoting areas that maintain their integrity under the load applied.

In the field of mechanical engineering, design analysis can solve a wide range of product development problems. Engineers can use design analysis to predict the physical behaviour of just about any part or assembly under any loading conditions: from a simple beam under a bending load to car crash simulations and vibration analysis of aircraft. The true power of design analysis is the ability to perform any of these types of studies accurately without building a single thing. All that is needed is a CAD model

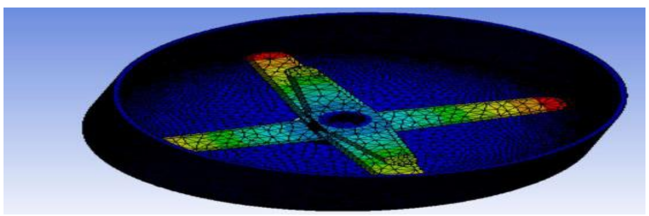


**Figure 5 FEA Simulation of a PVC MIXER**

**4.4 STRESS AN ALYSIS:**

The most common design analysis application in the field of mechanical engineering is stress analysis. Engineers study the stresses (both structural and thermal) on a part to determine whether it will fail or not and whether design modifications are necessary to overcome potential problems. Design analysis can be used in a wide variety of fields;

Here are just a few examples:

Determine the potential for deformation of parts

Measure resonant frequencies and modes of vibration of parts and assemblies Calculate dynamic and seismic responses Determine Contact stresses

Provide temperature distribution. Analyze fluid flow, whether it be a gas or liquid in a pipeline, the mixture of air and fuel in an engine intake manifold, or molten plastic filling up a mould

**4.5 MOTION ANALYSIS:**

Besides working very closely with CAD packages, commercial design analysis application s also interface with increasingly popular programs for motion analysis to create complete virtual analysis an d test systems. In other engineering disciplines, design analysis is used to study electromagnetic fields, soil mechanics, groundwater flow, bone growth, etc

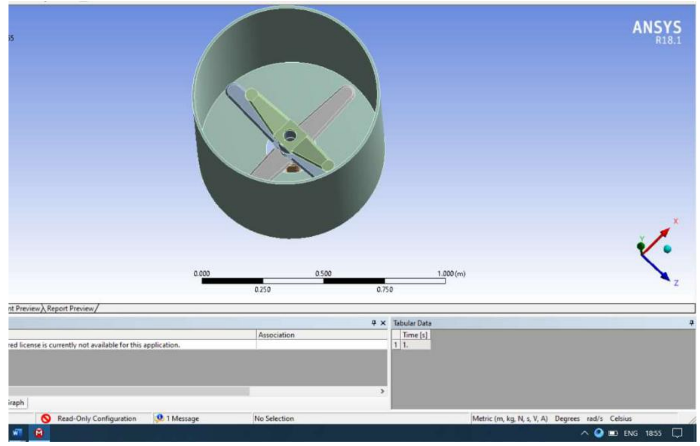



**Figure 6: Motion analysis**

**4.6 THERMAL A NALYSIS:**

is a branch of materials science where the properties of materials are studied as they change with temperature. Several methods are commonly used – these are distinguished from one another by the property Simultaneous thermal analysis generally refers to the simultaneous application of thermo gravimetric and differential scanning calorimetric to one and the same sample in a single instrument. The test conditions are perfectly identical for the thermo gravimetric analysis and differential scanning calorimet ric signals (same atmosphere, ga s flow rate, vapour pressure of the sample, heating rate, thermal contact to the sample crucible and sensor, radiat ion effect, etc.). The information gathered can even be enhanced by coupling the simultaneous thermal analysis instrument to an Evolved Gas Analyzer like Fourier transform infrared spectroscopy or mass spectrometry.

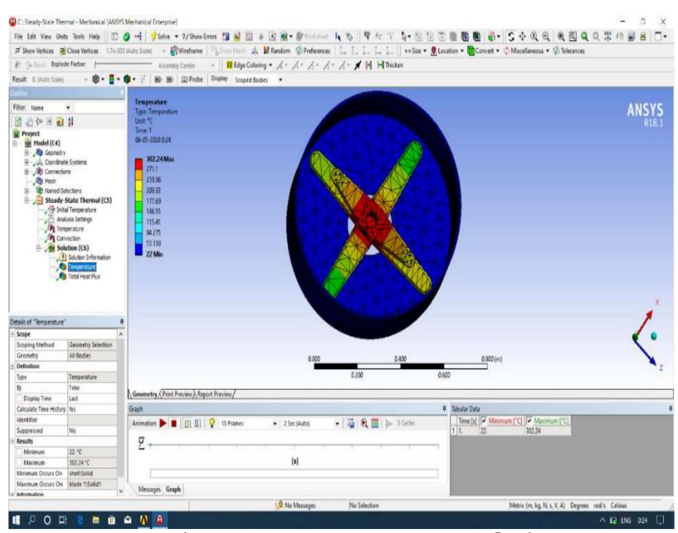



**Figure 7A: Temperature analysis**

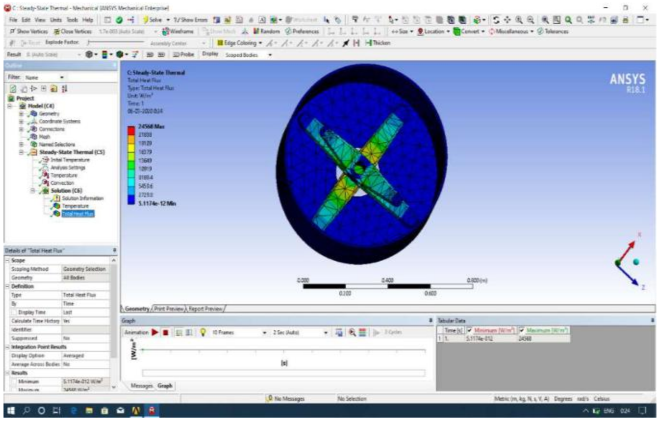


**Figure 7B: Temperature Total heat flux**

## V PROCEDURES FOR ANALYSIS OF PVC MIXER BLADE

### 5.1 MODELLING:

The 2-Dimensional modeling of the nozzle was done u sing ansys 18.1 and file was saved in .step format. The dimensions of the PVC mixer blades are presented in the tab le given below.

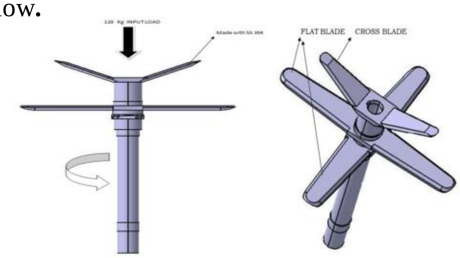



**Figure 5.1: Blades views in isometric**

### 5.1.1 Structure:

The blades is precisely cast of stainless steel and tre ated by dynamic and static balancing , the blades of cooling machine adopt the advanced spiral stirring structure , which avoid dead angle, and with the feature of quick cooling, thorough ly discharging, high efficient of mixing.

### 5.1.2 PVC MIXTURE BLADE DIMENSIONS:

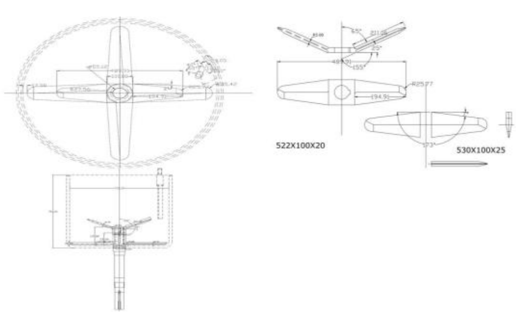
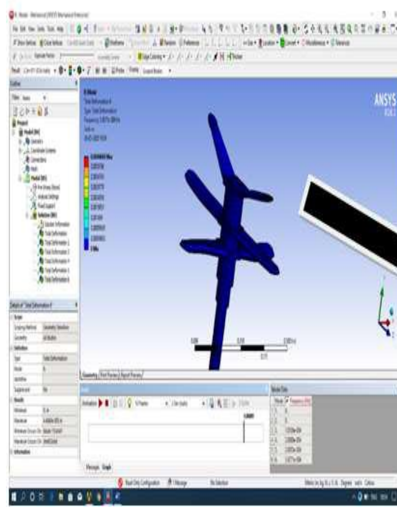



**Figure 5.2: orthographic projection**

### 5.2 MESHING:



| Entity | Size |
|---|---|
| Nodes | 1520 |
| Elements | 5209 |

**Figure 5.3: Meshing**

After modeling of the PVC mixture, its meshing was don e using ANSYS 18.0 software. Pre-proce ssing of the PVC mixture was done in ANSYS FLUENT. 2-D and double preci sion settings were used while reading the mesh. The mesh was scaled si nce all dimensions were initially specified in mm. The mesh was checked in fluent and no critical errors were reported.

### 5.2.1 ANALYSIS OF PVC MIXER BLADE MATE RIAL (SS304):

### 5.2.2 MATERIA L (SS404):

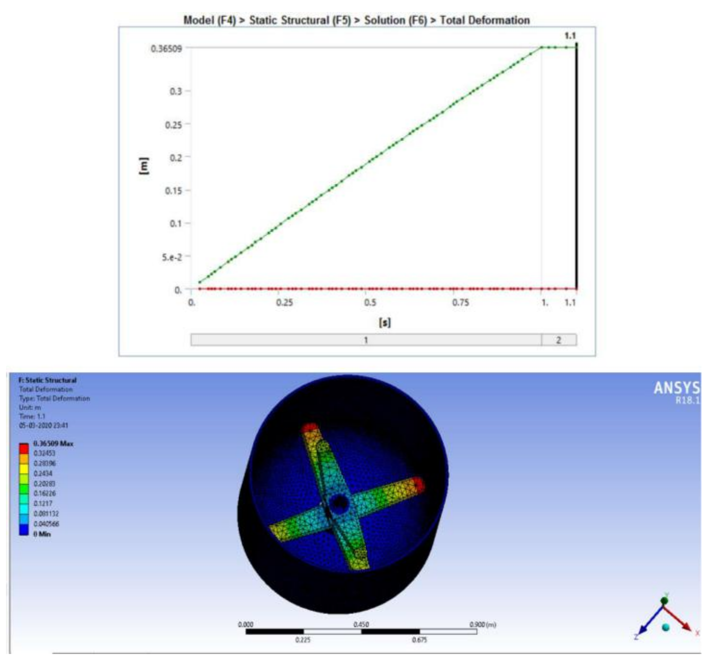



**Figure 5.4: SS 404 material analysis**

## VI RESULT AND CONCLUSION

The above table has the clear parameters at different materials and justifications of the obtained theoretical solution have shown that the theoretical obtained solutions with considerations of all necessary boundary conditions

By the end of modeling and analysis In project work is to increase blade efficiency by designing a mixture blade with new profile and material. In this work, the modeling of the blade will done using CATIA software package and analysis viz., static, dynamic and model analysis will be carried out using ANSYS software package. The proposed new design ensures longer life and uniform mixing of PVC elements in lesser time**.**

The aim of this project work is to increase blade efficiency by designing a mixture blade with new profile and material. The efficiency of blade is increases by changing the different engineering material such as SS404, Titanium and high speed tool steel.

By the analysis can obtained different results of different properties of materials. By the results high speed tool steel material is good efficiency and uniform mixing of PVC elements and durability is more compare to existing material that is SS304. Titanium material is excellent material and also durability it is very expensive material.

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