DESIGN AND ANALYSIS OF DRUM AND MAIN FRAME OF TUMBLE DRYER

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Abstract : In recent decade every work has to be done as quickly as possible. Cloth washing and drying is also a work in day to today life. In this cloth drying process take a maximum time. It is possible to reduce the drying time with the help of tumble dryer. Tumble dryer is also called as cloth dryer. It is widely used now a day in order to dry the wet cloths. Tumble dryers are ending up increasingly more typical in common units as a supplement to the clothes washer. Tumble dryers offer a quick drying cycle free of climate conditions, and they just require a little space. The present cloth dryer is working with help of heat. The present dryers utilize a lot of power so as to create the warmth. Some of the proposed techniques to improve dryer efficiency are not cost effective and other techniques are environmentally hazardous. So the main objective of this project is to reduce the heat loss in the dryer and also to reduce the consumption of electric power. The major heat loses in the dryer is on the centrifugal drum and body of the dryer. These two parts contribute major role in the weight of the machine as well. So the aim of project is to design the new drum and the body of the dryer in such a way that it has a minimum heat loss and comparatively less weight than previously existing dryer. And also, analyze the heat distribution in drum and body of the dryer. By this, minimize the heat loss and utilize the maximum heat to dry the wet cloth in the drum. By this efficiency of the tumble dryer can be enhanced.

IndexTerms **- Tumble Dryer, Heat, Dryer Drum, Dryer Casing.**

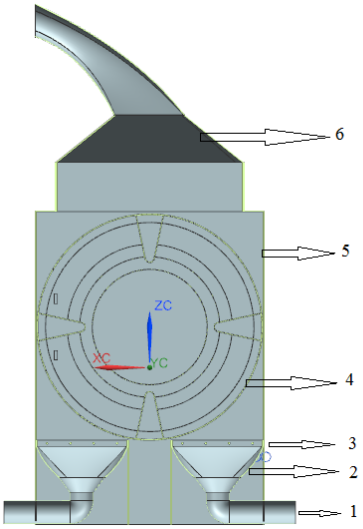
I. INTRODUCTION

Drying clothes normally by using the sun of light energy and the natural wind, but now a day the technology is generously developed upward and the clothes dryers that use the heat energy or electric energy and other energy come to use extensively. In the wet area, the air's relative humidity is high, drying of clothes takes a very long time, and clothes dryers especially get the favor of people. Especially in the urban area where limited sunlight due to high building and restricted air flow for house types such as high rise condominiums and apartments, natural drying is prohibited in some housing areas for aesthetic reasons. Dryers widely used, especially those who are busy working. The fast drying cycle that works independently of weather conditions, the fact that it requires only small space and the textiles not becoming contaminated by air pollution or insects, which may cause a problem when drying textiles on lines out of doors, represent the advantages of this appliance. By the electrical heating, environmental air is heated to a definite temperature through the fans driving action, hot air flows through clothes surface. After the heat and moisture transfer, the moisture is taken away by the hot air realizing the accelerating drying of clothes. If the large number of units then large amounts of electricity is consume. Besides that, most of laundries today have their own dryer cabinet. It is not just because to run their operation at all the time, but they also can prevent the risk to the cloths that might lose or dirty.

For drying process there are three methods, 1) Sun drying is conventional method for material drying, 2) Hot air drying where materials are exposed to flow of hot air 3) Freeze drying, in which solidified materials are put in a vacuum chamber to draw out the water. General drying is achieved by thermal techniques and thus includes the application of heat, most generally by convection from flow of air. In the convective drying of solid materials, two procedures happen at the same time namely, transfer of energy from the local environment in the dryer and transfer of moisture to within the solid. Therefore this operation is considered as simultaneous heat and mass transfer operation. This kind of dryer exist many deficiencies. First, a great deal of energy is wasted a lot of high quality energy directly convert to heat. Secondly, air with higher temperature and humidity was directly discharged into indoor, affecting the indoor air quality. If setting vent pipe to put the air out, the cost will be increased. In the heat exchanger, the high temperature and humidity air comes from the dryer is cooled by air or water, and the moisture condensates is eliminated. If using indoor air to cool, the humidity of room will be impenetrable. If using tap-water to cool, both the temperature and humidity in the room will be impenetrable. Drying processes and equipment for drying may be arranged according to several criteria, including the nature of material and the method of heat supply and the method of operation.

II. WORKING OF PROPOSED TUMBLE DRYER

The fundamental concept of the proposed tumble dryer same as existing tumble dryer. In this also blow the hot dry air in one side of the drum containing the wet cloths, it removes the wet content in cloth and get converted into steam and leaving into another side of the drum. But the procedure of the supply of hot air and steam exist is different than the existing tumble dryer.



Part number	Part name
1	Air pipe and Flange
2	Coil tray
3	Coils
4	Dyer Drum
5	Dryer Casing
6	Exhaust chamber

Fig Proposed Tumble Dryer

1. Initially air is blow into the pipe and flange is placed at bottom of the dryer as shown in fig … blowers is use to blow the air is 0.5HP blowers with 500CFM (cubic feet per minute). In this velocity of air is get decrease due to the flange conical shape. This decreased velocity is passed to the coil tray.
2. The two Coil trays are consisting of 8coils (4coils for each coil tray) as shown in figure. Each coil has 2KW capacity. The decreased velocity air is entered the coil tray and is disperses through the coil tray due to the geometry of the coil tray. Then air passed to the heated coil. Due to this movement air is get heated. By the natural phenomena it-self air move upwards. But here including this at the bottom continues supply of the air is given. So the hot air easily move upwards i.e it is ready to enter the dryer drum.
3. The blow hot air is enters the dryer drum through perforated wall
4. The dryer drum is made up of stainless steel material with large diameter. It heart of the tumble dryer. Dryer drum consist paddle around it inside edge of the rum rotates clockwise direction with help of electric motor by mean of belt dives
5. As drum is rotate paddle in the drum are get lift the wet cloth upwards. When wet cloth get fall down due to gravity it contact with the hot air blow from bottom of the drum. By this hot air coverts the wet content into steam. It means cloth get dry.
6. Exhaust steam is moving upwards trough the exhaust chamber. The exhaust chamber is design like chimney. By this geometry of the exhaust chamber it helps to exit the exhaust steam.

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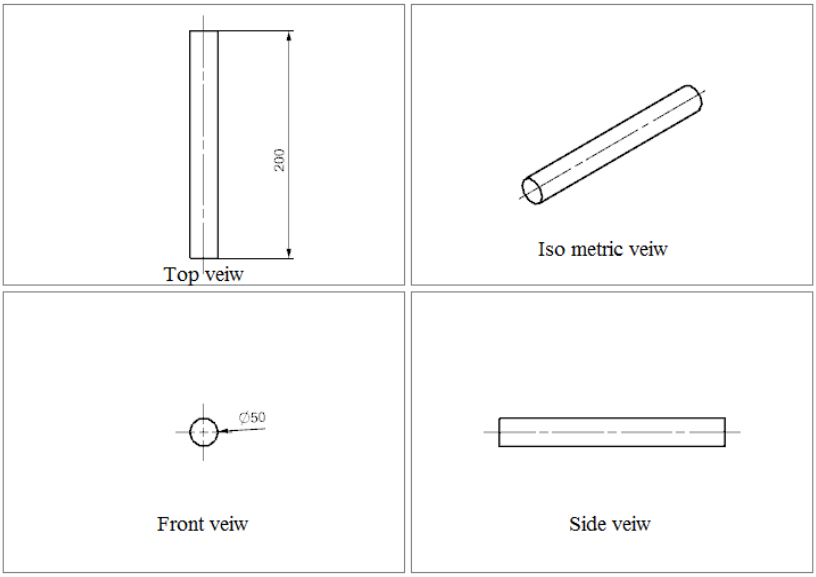
III. DRAWING AND MODELING OF THE DESIGNED PARTS

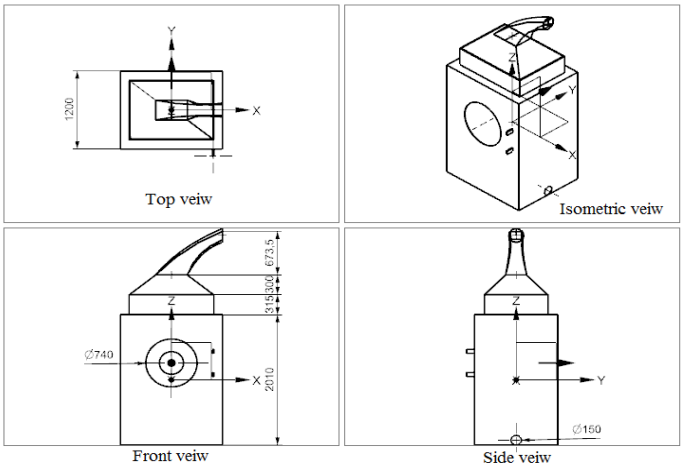
The detailed drawings of the parts were made according to the designed dimensions. The 3D modelling of the same is done using UG-NX software. The different views of the parts are as shown below. All dimensions are in mm.

3.1 DRYER DRUM SHAFT

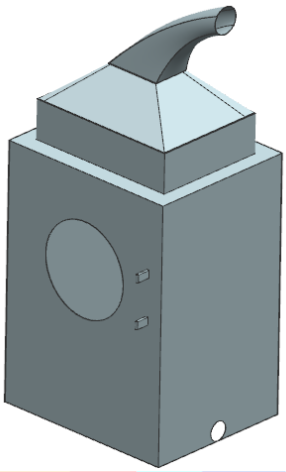


2-D drafting of dryer drum Shaft

3.2 DRYER CASING

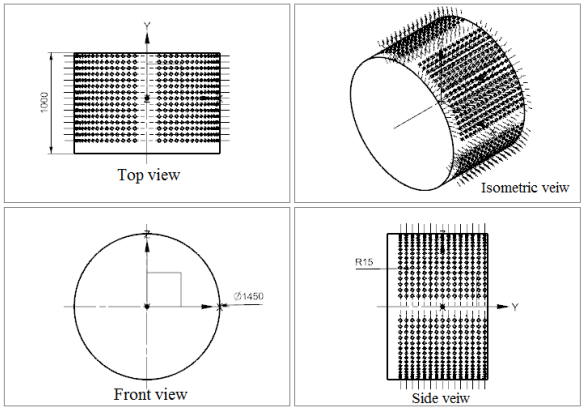


Drafting of Proposed Tumble Dryer Casing

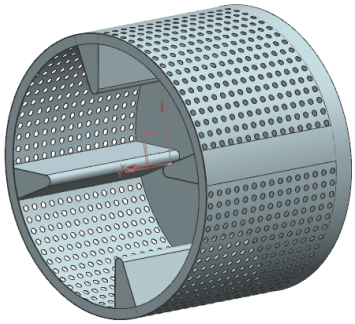


3-D Model of Proposed Tumble Dryer Casing

3.3 TUMBLE DRYER DRUM



2-D Drafting Of The Proposed Tumble Dryer Drum



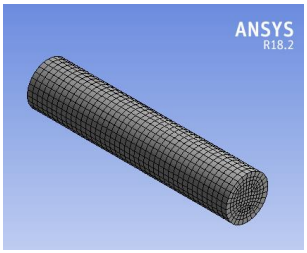
3-D Model of the proposed tumble dryer drum

IV. ANALYSIS

In order to know the detail element behavior due to thermal and static load analysis is important tool. For these project elements is analysis by ANSYSIS V-18 work bench software.

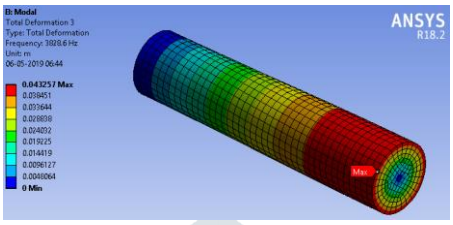
4.1. DRUM SHAFT

Drum Shaft



Meshed Drum shaft

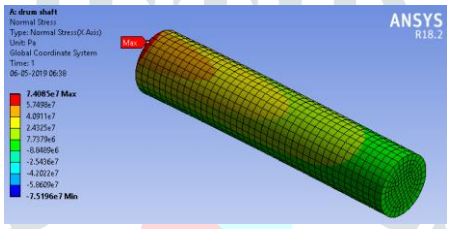
The modal analysis of the drum shaft is done to study the dynamic properties of the system. The first 6 mode shapes obtained from the results of the modal analysis are as shown below.



The maximum deflection of the shaft

The material of the shaft is carbon40. The load of 2060.1N is applied at the free end. Then the analysis done it gets the maximum deflection of 0.00019 m. This load is total load of the drum and the wet cloth.

The Normal Stress of the drum shaft



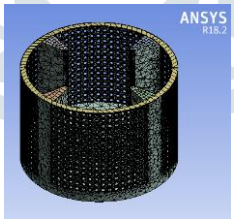
The stress distribution in the shaft is as shown in the figure. The maximum working stress obtain here is 74.085MPa. The ultimate stress of the Carbon-40 material is 380 MPa. So the component is within safe design.

4.2 Dryer Drum

Structural Analysis

The structural analysis was done using Ansys V-18 work bench to know the various deformations and the different types of stresses developed. First the frame was fixed at the shaft. Then the meshing is done. A pressure of 2.4094275e-5 MPa has been applied on the surface drum where wet cloth is placed and then analyzed for the results.

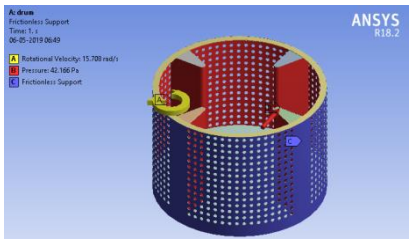
The results obtained from the structural analysis are as shown below. The maximum stress developed was found to be 1.2884 e2 MPa.



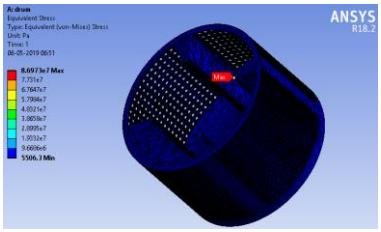
Meshed Dryer Drum

Boundary Condition (Load & Constraint)

Once the system is fully modelled, the last task is to burden the system with load and constraints, such as physical loadings or limit conditions. The examination is for the most part worried about a uniformly dispersed burden at a consistent precise speed. The load is applied with the help of lead plates instead of clothes. Pressure, Rotational Velocity 150 RPM, Frictionless Support of Drum are exposed.



Applied Boundary Condition



Equivalent Stress distribution

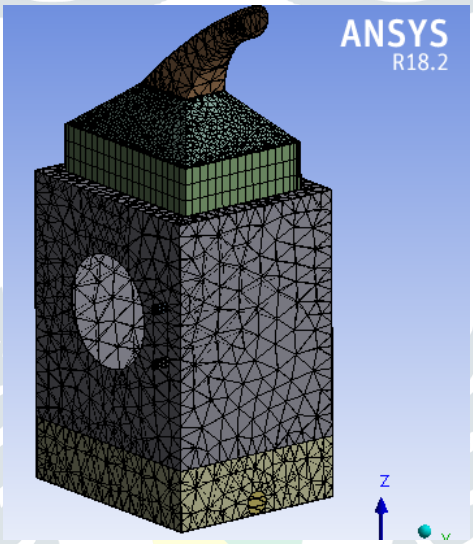
The dryer drum is made of SS316L material. Since this drum is rotating motion torsion is act on this. At the maximum condition means when the 70 kg of wet cloth is placed in the drum the small deletion is occur it is around 3mm. It is not exactly the deflection it is elongation of material in two opposite direction. The maximum stress obtain here is 86MPa. But the ultimate stress of the SS316L is 485 MPa. Since obtained stress below the ultimate it is in safe design

4.3 Main Frame (Casing)

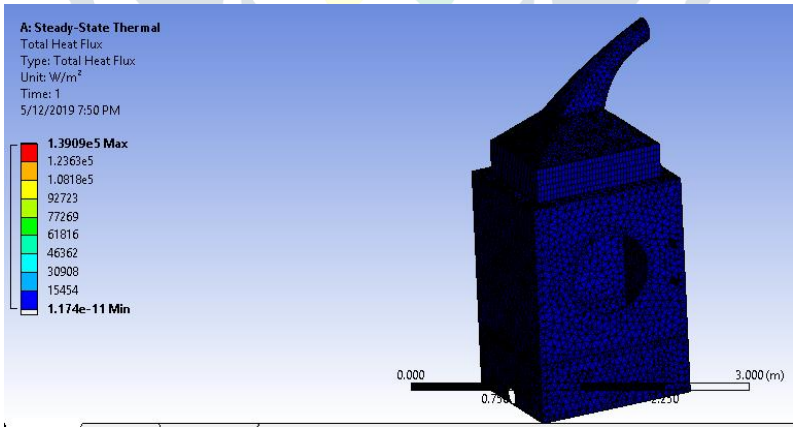
Thermal Analysis

The Thermal Analysis was done using Analysis V-18 to know the various temperature distributions and the amount of heat flow through the casing. It is analysis based on the Fourier law conduction. Then the meshing is done. Temperature of 75 degrees Celsius has been applied on the inner surface of the frame and then temperature 27 degree Celsius applied on outer surface of the main frame and analyzed for the results.

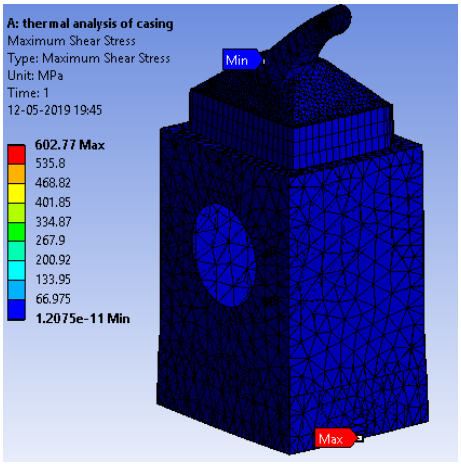
The results obtained from the Thermal analysis are as shown below. The maximum heat flow is 61316 W/ m^2.



Meshed Main Frame



Heat Flux



Maximum Shear Stress

The heat distribution of the main frame is shown in the analysis figure of deformation flow result. In this very small amount of heat is flow from inner to outside the dryer casing. This is due to the thermal conductivity property of the material. The material used is SS316L and its thermal conductivity is 17W/m K.

V. RESULT

After analysis the component of dryer with the help of ansys software the result is tabulated.

Sl no.	Component	Material	Allowable stress(MPa)	Ultimate stress(MPa)	Factor of Safety
1	Drum Shaft	Carbon40	74.08	380	5.12
2	Dryer Drum	SS316L	86.97	485	5.5
3	Main Frame	SS316L	116.6	485	4.15

VI. CONCLUSION

Tumble dryer is a essential machine to dry the wet cloth faster than the conventional method. But in the existing tumble dryer consume more power to dry the required amount of wet cloth. By adopting proposed tumble dryer power consumption is reduced compare to existing tumble dryer. In the present study the component of the tumble dryer are in detail designed and analysis in software. And the result is obtain from analysis is the maximum stress developed in the component is below the ultimate stress of the respective material. Hence it is prove it is safe design. By this achieving the overall weight of the machine is reduced. And also the total time consume for drying the wet cloths is reduced. This makes fasten the drying process. Since weight of the machine is decrease and also the power consumption decrease the overall cost of the machine is also decreases than the existing tumble dyer.

Existing tumble dryer	Proposed tumble dryer
24 air heater coil use	Only 8 coil
Total 53kw power use including motor	Only 20 kw power is use
Total weight of the dryer 2860kg	Approximately 1200kg only

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