A

PROJECT REPORT ON

MODELING AND FABRICATION OF DEHUMIDIFIER

Submitted in partial fulfilment

of the requirements for the award of the Degree of

BACHELOR OF TECHNOLOGY IN

MECHANICAL ENGINEERING

By

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CERTIFICATE

This is to certify that the project report titled **"MODELING AND FABRICATION OF DEHUMIDIFIER"** submitted by **S.V.S SUDARSHAN** bearing **16P61A0366, P.SAI KEERTHANA** bearing **16P61A0355, K.VINEETH KUMAR** bearing **17P65A0323** and **M.SANJAY KUMAR** bearing **16P61A0350** to the department of mechanical engineering, for partial fulfilment of the award of the degree of **Bachelor of Technology in Department of Mechanical Engineering,** Jawaharlal Nehru Technological University, Hyderabad is a record of conduct work carried out by him under guidance and supervision.

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ABSTRACT

As India is an agricultural country, most of the farmers follow primitive techniques for drying the harvested crops. But it requires constant supervision and maintenance in order to protect them from harsh and fluctuating whether conditions. Here, the dehumidifier works to protect and dry the grains simultaneously. The dehumidifier helps in completing the drying operation quickly i.e. within a day. In order to acquire the desired dryness of the grains, the temperature in the repository is maintained at around 50 degrees centigrade. And the temperature distribution is done by means of blowers and exhaust. The temperature of the repository can be varied between 120F to 150F. To obtain the optimum dryness of the grains, the continuous flow should be generated with the help of porous conveyer belt. Heater with diffuser is used to maintain the dew point temperature and relative humidity. This helps to obtain required dryness and humidity percentage of the grains. By using this dehumidifier, we can benefit the farmers to get the optimum price for the same yield, and it also greatly reduces the time taken compared to the conventional sun drying, simultaneously we can help the farmers to get more profit.

DECLARATION

We declare that this written submission represents our ideas in our own words and where other ideas have been included. We have adequately referenced the original sources and we also declare that we have followed all principles of academic honesty and integrity and have not miss-represented or falsified any idea/data/fact/source in our submission.

We hereby declare that the results occurred in this project report titled **"MODELING AND FABRICATION OF DEHUMIDIFIER"** requirements for the award of degree or obtained by us from our project. We have not submitted this project to any other university/institute for the award of degree/diploma.

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CONTENT

CHAPTER 1: INTRODUCTION TO GRAIN DRYING

1.1 INTRODUCTION:

In general, the drying methods are classified on the basis of either the mode of heat transfer to the wet solid or the handling characteristics and physical properties of the wet material. The first method of classification reveals difference in the design and operation, while the second method is most useful in the selection of a group of drying for preliminary consideration in a given drying problem.

According to the mode of heat transfer, drying methods ca be divided into: (a) conduction drying, (b) convection drying and (c) radiation drying. There are other methods of drying also, namely, dielectric drying, chemical or sorption drying vacuum drying, freeze drying, etc. Of them, convection drying is commonly used for drying of all types of grain and conduction drying can be employed for drying of parboiled grain.

Conduction drying

When the heat for drying is transferred to the wet solid mainly by conduction through a solid surface (usually metallic) the phenomenon is known as conduction or contact drying. In this method, conduction is the principal mode of heat transfer and the vaporized moisture is removed independently of the heating media. Conduction drying is characterized by:

(a) Heat transfer to the wet solid takes place by conduction through a solid surface, usually metallic. The source of heat may be hot water, steam, flue gases, hot oil, etc.
(b) Surface temperatures may vary widely.
(c) Contact dryers can be operated under low pressure and in inert atmosphere,
(d) Dust and dusty materials can be removed very and
(e) When agitation is done, more uniform dried product and increased drying rate are achieved by using conduction drying Conduction drying can carried out the continuous or batch wise. Cylinder dryers, drum dryers, steam table rotary dryer are some of the continuous conduction dryers Vacuum tray dryers, freeze dryers, agitated pan dryers are the examples of batch conduction dryers.

Convection drying

In convection drying, the drying agent (hot gases) in contact with the wet solid is used to supply heat and carry away the vaporized moisture and the heat is transferred to the wet solid mainly by convection. The characteristics of convection drying are

(a) Drying is dependent upon the heat transfer from the drying agent to the wet material, the former being the carrier of vaporized moisture.
(b) Steam heated air, direct flue gases of agricultural waste etc., can be used as drying agents.
(c) Drying temperature varies widely.
(d) At gas temperatures below the boiling point, the vapor content of the gas affects the drying rate and the final moisture content of the solid.
(e) If the atmospheric humidity is high, natural air-drying needs dehumidification.
(f) Fuel consumption per kg of moisture evaporated is always higher than that of conduction drying.

Convection drying is most popular in grain drying. It can be carried out either continuously or batch-wise. Continuous tray dryers, continuous sheeting dryers, pneumatic conveying dryers, rotary dryers, tunnel dryers come under the continuous system, whereas tray and compartment dryers, batch through circulation dryers are the batch dryers.

Convection drying can be further classified as follows:

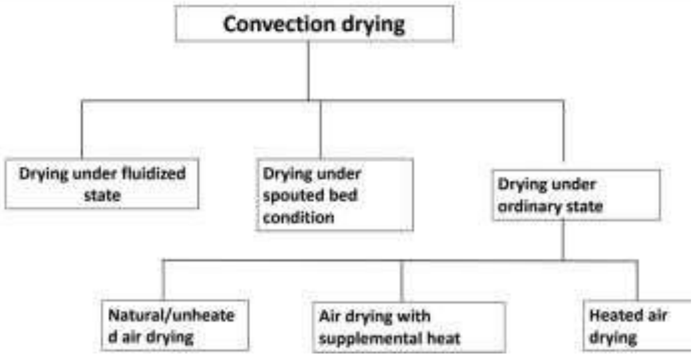


Fig. 1.1: type of convection grain dryers

Pneumatic or fluidized bed drying: When the hot gas (drying agent) is supplied at a velocity higher than the terminal velocity of the wet solid, the drying of the wet solid occurs in a suspended or fluidized state. This phenomenon is known as fluidized bed drying. Drying may be carried out in a semi-suspended state or spouted bed condition also. Generally, the convection drying is conducted under ordinary state, i.e., drying agent is supplied at a velocity much lower than the terminal velocity of the wet material. In natural air drying, the unheated air as supplied by the nature is utilized. In drying with supplemental heat just sufficient amount of heat (temperature rise within 5 to 10° C) only, is supplied to the drying air to reduce its relative humidity so that drying can take place. In heated air drying, the drying air is heated to a consider able extent. The natural air drying and drying with supplemental heat methods which may require one to four weeks or even more to reduce the grain moisture content to safe levels, are generally used to dry grain for short term storage in the farm. Heated air drying is most useful when large quantity of grain is to be dried within a short time and marketed at once.

It is used for both short- and long-term storage.

1.2 LITERATURE SURVEY:

Grain drying begins in the field after the grain is fully mature. The primary objective of grain drying and storage is to manage the temperature and moisture of the air around the grain to minimize grain quality and market value losses while holding the grain for better market opportunities. Maintaining grain quality requires drying the grain to safe moisture content levels after harvest followed by lowering and maintaining the grain temperature within a few degrees of ambient air temperatures. Natural drying exposes the wet grains to sun and wind. Artificial dryers employ high temperature directly or indirectly in both natural and forced convection systems. Mechanical dryers have been widely used in developed countries and new systems are being developed with the increased demand in their application in farming and grain handling systems. Grain drying Agri-Processing Engineering Jan 1920 QLiuC, WCaoF,W.Bakker-ArkemaLiu,C.W.,Bakker-Arkema, F.W.Grain drying. In CIGR Handbook of Agricultural Engineering Volume Agri- Processing Engineering, Bakker-Arkema, F.W., DeBaerde-maeker, Amirante, P Ruiz-Altisent, M., Studman, C.J., Eds.American Society of Agricultural Engineers: St. Joseph, Michigan, 1999.Drying and Storage of Grains and Oilseeds Jan 1992D B BrookerF W Bakker-ArkemaC W Hall rooker, D.B. ,Bakker-Arkema, F.W. Hall, C.W. Drying and Storage of Grains and Oilseeds; Van Nostrand Reinhold: New York, 1992. Grain Storage Techniques: Evolution and Trends in Developing Countries. Jan 1994 D L Proctor, D.L. Grain Storage Techniques: Evolution and Trends in Developing Countries, FAO Agricultural Services Bulletin No. 109, Rome, Italy, 1994. Jan 1985pp B BrenndorferL KennedyC D Oswin-BatemanD S TrimG C MremaWereko-Brobby. Brenndorfer, B., Kennedy, L., Oswin-Bateman, C.D., Trim, D.S., Mrema, G.C. Wereko-Brobby, C. Solar Dryers-Their Role on Post-Harvest Technology; Commonwealth Science Council: London, 1985.

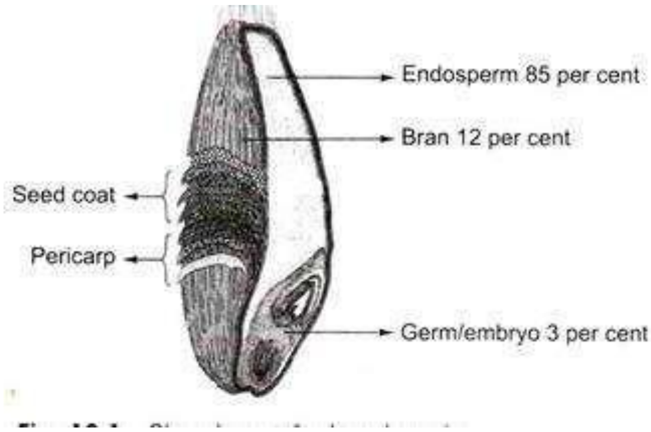


Fig. 1.2 structure of the grain

1.3 PROBLEM STATEMENT:

- Loss of harvested crop while drying grains.
- More time and more effort.
- In some case loss of crop due to undefined climatic changes.
- While drying the grains on road accidents may occur.

CHAPTER 2: DEHUMIDIFIER

2.1 INTRODUCTION:

A dehumidifier is an electrical appliance which reduces and maintains the level of humidity in the air, usually for health or comfort reasons, or to eliminate musty odder and to prevent the growth of mildew by extracting water from the air. It can be used for household, commercial, or industrial applications. Large dehumidifiers are used in commercial buildings such as indoor ice rinks and swimming pools, as well as manufacturing plants or storage warehouses.Dehumidifiers extract water from air that passes through the unit. There are two types of dehumidifiers - condensate dehumidifiers and desiccant dehumidifiers. Condensate dehumidifiers use a refrigerator to collect water known as condensate, which is normally greywater but may at times be reused for industrial purposes. Some manufacturers offer reverse osmosis filters to turn the condensate into potable water. Some designs, such as the ionic membrane dehumidifier, dispose off water as a vapor rather than liquid. Desiccant dehumidifiers (known also as absorption dehumidifiers) bond moisture with hydrophilic materials such as silica gel. Cheap domestic units contain single- use hydrophilic substance cartridges, gel, and powder. Larger commercial units contain hot air recovery systems in order to remove humid air from outside the room. The energy efficiency of dehumidifiers can vary widely.

2.2 COMPONENTS:

The main components of the dehumidifier are:

- Shafts
- Bearings
- Heater regulators
- Blowers
- Blowers regulators
- Exhaust fans
- 1/12 hp Motors
- Teeth gears
- Display
- Temperature sensor
- Bearings
- Chain
- S.S Mesh
- Mild steel sheet

2.2.1 Shaft:

Shaft is the most vital component which forms the key component of the machine. All of the key components of the dehumidifier including gears, chain and motor are attached to the shaft.

Fig. 2.1 design of the shaft attached to gears

It is made up of stainless steel whose dimensions are dia20mm and length400mm.The shafts perform the function of transmitting power from one rotating member to another supported by it or connected to it. Thus, they are subjected to torque due to power transmission and bending moment due to reactions on the members that are supported by them. Shafts are to be distinguished from axles which also support rotating members but do not transmit power. Shafts are always made to circular cross- section and could be either solid or hollow. The shafts are classified as straight, cranked, flexible or articulated. Straight shafts are commonest to be used for power transmission. Such shafts are commonly designed as stepped cylindrical bars, that is, they have various diameter along their length, although constant diameter shafts would be easy to produce. The stepped shafts correspond to magnitude of stress which varies along the length. Moreover, the uniform diameter shafts are not compatible with assembly, disassembly and maintenance such shafts would complicate the fastening of the parts fitted to them, particularly the bearings, which have restricted against sliding in axial direction. While determining the form of stepped shaft it is borne in mind that the diameter of each cross- section should be such that each part fitted on to the shaft has convenient access to its seat.

2.2.2 Bearings Flangd ball bearings

A ball bearing is a type of rolling-element bearing which uses balls to maintain the separation between the moving parts of the bearing. The purpose of a ball bearing is to reduce rotational friction and support radial and axial loads. It achieves this by using at least two races to contain the balls and transmit the loads through the balls. Usually one of the races is held fixed. As one of the bearing races rotates it causes the balls to rotate as well. Because the balls are rolling, they have a much lower coefficient of friction than if two flat surfaces were rotating on each other. Ball bearings tend to have lower load capacity for their size than other kinds of rolling-element bearings due to the smaller contact area between the balls and races. However, they can tolerate some misalignment of the inner and outer races. Compared to other rolling-element bearings, the ball bearing is the least expensive, primarily because of the low cost of producing the balls used in the bearing. There are several common designs of ball bearing, each offering various trade-offs. They can be made from many different materials, including: stainless steel, chrome steel

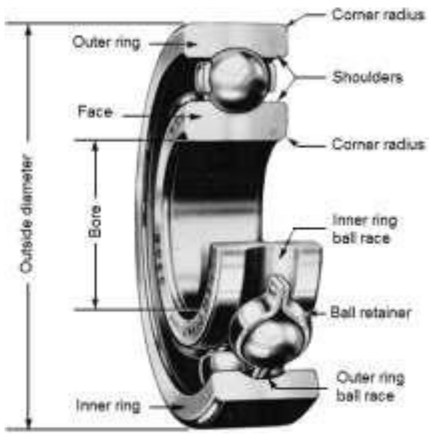


Fig. 2.2 Explanation of bearing

Bearing life

Fatigue is a type of failure of a material, occurring under alternating loads. Most of the failures of machine details are caused by fatigue. Fatigue life is the number of cycling stresses, causing failure of the material. Frequency of these stresses is not important. Fatigue limit is the maximum value of repeatedly applied stress that the material can withstand after an infinite number of cycles. Fatigue strength at N cycles is the load, producing the material fracture after N cycling applications of the load. Fatigue limit of a material is much lower, than its ultimate tensile strength. The rotating specimen in form of a cantilever is driven by an electric motor. The specimen is loaded by the force F, applied to the ball bearing, mounted on the end of the specimen. Since the force direction does not change, the direction of the stress applied to the specimen will be reversed each 180º of the shaft rotation. The tests results are presented in form of S-N curve (stress vs. number of cycles) Fatigue fracture is characterized by presence of two different types of the surface: One part is smooth and discolored with ripple-like marks, indicating slow crack growth from the centre of the crack formation. Another part of the surface has coarse crystalline appearance resulted from the final catastrophic crack propagation.

The following factors affect fatigue fracture:

Surface factor: Fatigue cracks form and initiate on the specimen surface therefore hardened and smooth surface (without stress concentrations, notch, flaw will increase the fatigue limit.

Compressive stress: Compressive stresses, produced in the specimen surface by shot peening, cold work or heat treatment result in considerable increase of fatigue limit

Micro-structure defects: Non-metallic inclusions and other micro-defects may initiate formation of fatigue cracks.

Environmental factor: Fatigue in the presence of corrosive environment (Corrosion fatigue) occurs at lower cycling stresses and after lower number of cycles.

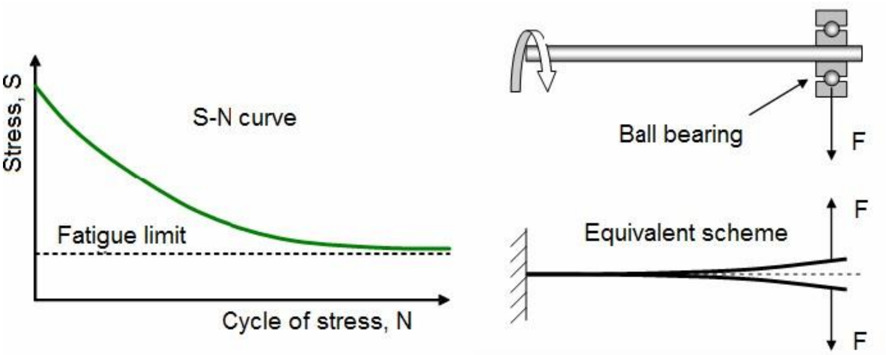


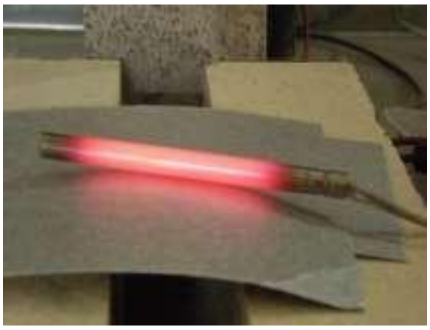
Fig. 2.3 (a)fatigue limit of ball bearing(b)vibration in roller bearing

2.2.3 Heaters:

The heating coil is the actual resistance which is where the electrical load occurs. The most common type of metal alloy used for this purpose is a nickel-chromium mixture, also known as nichrome. The nichrome wire is wound around a ceramic core, and the number of spirals per inch vary according to the requested watt density. Potential from an alternating current source, which can either be 2 phase or 3 phases, flows through the coiled nichrome wire, heating up the wire, which in turn, heats the cartridge heater sheath.

Cartridge heaters

A cartridge heater is a tube-shaped, heavy-duty, industrial Joule heating element used in the process heating industry, usually custom manufactured to a specific watt density, based on its intended application. Compact designs are capable of reaching a watt density of up to 50W/cm² while some specialty high temperature designs can reach 100w/cm².



(a) **(b)**

Fig. 2.4(a), (b)cartridge heaters

2.2.4 Blowers

An air blower is a machine used for generating flow of air at substantial pressure. The air flow generated is used for different purposes. Blowers increase the pressure of the absorbed gas by a series of vortex motions formed by the centrifugal movement of the impeller. When the impeller is rotating, the channels in the impeller push the air forward by the centrifugal movement and a helical movement occurs.

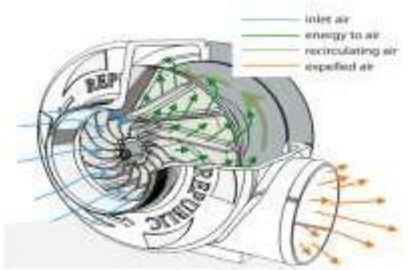


Fig. 2.5 blower working

2.2.5 Exhaust fans

Exhaust fans are used to pull excess moisture and unwanted odours out of a particular room or area. They are commonly found in bathrooms and kitchens, where moisture can build up due to activities such as heat rooms Exhaust Fans Suck Heat Right Out of Your cabin Exhaust fans are used to pull air particles from your rooms and out into the atmosphere and can help remove heat during the summer.

2.2.6 1/12 hp Motor

An electric motor is an electrical machine that converts electrical energy into mechanical energy. Most electric motors operate through the interaction between the motor's magnetic field and electric current in a wire winding to generate force in the form of torque applied on the motor's shaft. Electric motors can be powered by direct current (DC) sources, such as from batteries, motor vehicles or rectifiers, or by alternating current (AC) sources, such as a power grid, inverters or electrical generators. An electric generator is mechanically identical to an electric motor, but operates with a reversed flow of power, converting mechanical energy into electrical energy motor can produce 10 kW output or more.

2.2.7 Gears

A gear or cogwheel is a rotating machine part having cut teeth or, in the case of a cogwheel, inserted teeth (called cogs), which mesh with another toothed part to transmit torque. Geared devices can change the speed, torque, and direction of a power source. Gears almost always produce a change in torque, creating a mechanical advantage, through their gear ratio, and thus may be considered a simple machine. The teeth on the two meshing gears all have the same shape.[1] Two or more meshing gears, working in a sequence, are called a gear train or a *transmission*. A gear can mesh with a linear toothed part, called a rack, producing translation instead of rotation. The gears in a transmission are analogous to the wheels in a crossed, belt pulley system. An advantage of gears is that the teeth of a gear prevent slippage.

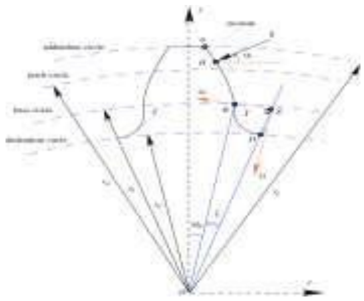


Fig. 2.6 gear explanation

2.2.8 Temperature sensors

A temperature sensor is an electronic device that measures the temperature of its environment and converts the input data into electronic data to record, monitor, or signal temperature changes These types of temperature sensor vary from simple ON/OFF thermostatic devices which control a domestic hot water heating system to highly sensitive semiconductor types that can control complex process control furnace plants.

- Contact Temperature Sensor Types – These types of temperature sensor are required to be in physical contact with the object being sensed and use conduction to monitor changes in temperature. They can be used to detect solids, liquids or gases over a wide range of temperatures.
- Non-contact Temperature Sensor Types – These types of temperature sensor use convection and radiation to monitor changes in temperature. They can be used to detect liquids and gases that emit radiant energy as heat rises and cold settles to the bottom in convection currents or detect the radiant energy being transmitted from an object in the form of infra-red radiation (the sun).

Fig. 2.7 DHT11 sensor

2.2.9 Mild steel sheets

Mild steel is a general-purpose steel, in industry it is commonly referred to as low carbon steel. I’m not sure on the origin of the name mild steel. It is the easiest type of steel to work with it is a very common type of steel used in most things from table frames to cargo ships some of its characteristics include:

- easy to weld, needing no special attention or equipment
- easily formed and bent, unlike other grades of carbon and alloyed steels such as: railway line and basally plates. These take a large amount of force to bend compared to mild steel due to the higher strengths
- magnetic
- can be cut with all common metal cutting tools.

You have specified plate in your question, plates are sheets of steel commonly thicker than 5 mm(3/16 inch) in thickness and comes in different lengths and widths Sheet metal is metal formed by an industrial process into thin, flat pieces. Sheet metal is one of the fundamental forms used in metalworking, and it can be cut and bent into a variety of shapes. Countless everyday objects are fabricated from sheet metal. Thicknesses can vary significantly; extremely thin sheets are considered foil or leaf, and pieces thicker than 6 mm (0.25 in) are considered plate steel or "structural steel".

Fig. 2.8 mild steel sheet

2.2.10 Chain

A chain is a serial assembly of connected pieces, called links, typically made of metal, with an overall character similar to that of a rope in that it is flexible and curved in compression but linear, rigid, and load-bearing in tension. A chain may consist of two or more links. Chains can be classified by their design, which can be dictated by their use.

- Those designed for lifting, such as when used with a hoist; for pulling; or for securing, such as with a bicycle lock, have links that are torus shaped, which make the chain flexible in two dimensions (the fixed third dimension being a chain's length). Small chains serving as jewellery are a mostly decorative analogue of such types.

- Those designed for transferring power in machines have links designed to mesh with the teeth of the sprockets of the machine, and are flexible in only one dimension. They are known as roller chains, though there are also non-roller chains such as block chain

Fig. 2.9 bicycle chain

2.2.11 Mesh

The welded wire mesh is a metal wire screen that is made up of low carbon steel wire or stainless-steel wire. It is available in various sizes and shapes. It is widely used in agricultural, industrial, transportation, horticultural and food procuring sectors. It is also used in mines, gardening, machine protection and other decorations. Weld mesh is the term given to the kind of barrier fencing that is manufactured in square, rectangular or rhombus mesh from steel wire, welded at each intersection.

Fig. 2.10 ss mesh

2.3 SUMMARY:

The dehumidifier can dry the grains within hours depending on the quantity and the main objective of this is to reduce the farmers work and also to automize the process. By regulating the temperature via blowers and all other components in the dehumidifier we can dry the seeds at the we are eased to. This gives us the freedom to dry the grains irrespective of the moisture content in it before. In this we are just building a prototype which gives us the exact ideas on how the actual dehumidifier work

CHAPTER 3: DEHUMIDIFIER MECHANISM

3.1 GRAIN DRYER

Grain drying is process of drying grain to prevent spoilage during storage. The grain drying described in this article is that which uses fuel- or electric-powered processes supplementary to natural ones, including swathing/windrowing for drying by ambient air and sunshine. Unheated or natural air drying is usually performed in the grain storage bin. That is why unheated air drying is also known as in-bin or in-storage drying. Natural air drying is commonly used for on-farm drying for a relatively small volume of grains. Either full bin or layer drying system is employed in natural air drying. The period of drying for either system may be as long as several weeks depending on the weather. In layer drying, the bin is filled with a layer of grain at a time and drying, is begun. After the layer is partially dried, other layers of grain are added periodically, perhaps daily with the continuation of drying until the bin is full and the whole grain mass is dried. In full-bin drying, a full bin of grain dried as a single batch. Then the drying bin is used for storage purposes. The air flow rate provided is relatively low. Though natural air is supposed to be used, an air heating system should be kept so that supplemental heat may be supplied to the natural air during rainy seasons and during periods of high humidity weather and for highly moist grains. Natural air drying cannot be used if the ambient relative humidity exceeds 70 per cent. So also grains containing moisture higher than 20 per cent should not be dried with natural air. Various types of heated air dryers with different constructor tins, shapes, grain feeding and discharging mechanisms and aeration systems are available. Some of the common types of dryers are described here. As in natural air drying the grain is aerated (for drying) and stored in the same unit, the complete installation simply consists of a storage unit equipped with ducts for air distribution and devices for air exhaustion and a blower. Storage unit Any shape of grain holding bin such as semi-circular, circular, square or rectangular and of any material like metal wood, concrete, asbestos or mineral agglomeration can be used provided the bin is made moisture proof.

3.2 MECHANISMS IN DEHUMIDIFIER:

The dehumidifier mechanism is the combination of the 3 separate mechanisms which work together to dry the grains equivalently with the time. These mechanisms take care of the grains in perfect drying without leaving any moisture content in them. The whole body is fixed and can be moved when not working. The body consists of all the components and the power supply is 220v power supply.in this dehumidifier all the parts move through linkages like chains and mesh through sprockets

3.2.1 Working of the dehumidifier

In the dehumidifier the temperature of the container is maintained at the 50 centigrade. Care will be taken so that the temperature is equally distributed throughout the container. After this step the exhausts are kept on so that any moisture content in the container is removed.

As the container gets heated the heat flow takes place in the container due to the small pressure difference and due to the conduction and convection. The heat is supplied via cartridge heaters, which have the capacity of 700W. (based on calculation).

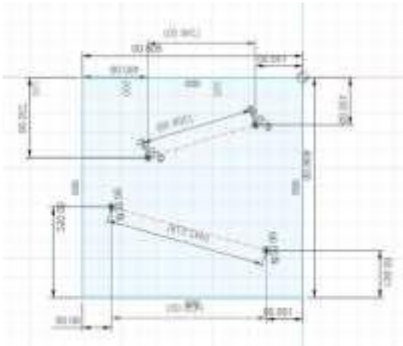


Fig. 3.1: dimensional over view of the container

The grains enter into the container at 5grms/sec, before entering into the container the grains are tested for the moisture content and the moisture of the dried grains needed is also noted. Depending on the relative decrease in the moisture content the other mechanisms are going to work.

In this case we are taking the grains that have entered are having 26% moisture in them and the output has to be 14% i.e., the net decrease in the moisture content is 12%. The grains will be falling on the top belt in the container at the rate of 5grms/sec. The SS mesh will be moving will the same speed depending upon the grains input speed.

Fig. 4.2: shaft with the mesh

The shafts are attached to the sprockets with 4 each and these sprockets are linked through the chain from the outside and with the ss mesh from the inside.

In the dehumidifier we are using 4 shafts in which 2 make a pair as shown in the fig. these 2 shafts are connected with the mesh where the grains move.

The mesh size is smaller than the grain size and the mesh are make in a v shape on both ends so that there will be no slipping of the grains. The shafts position is predefined based on the inclination of the belt. And the directed heated area.

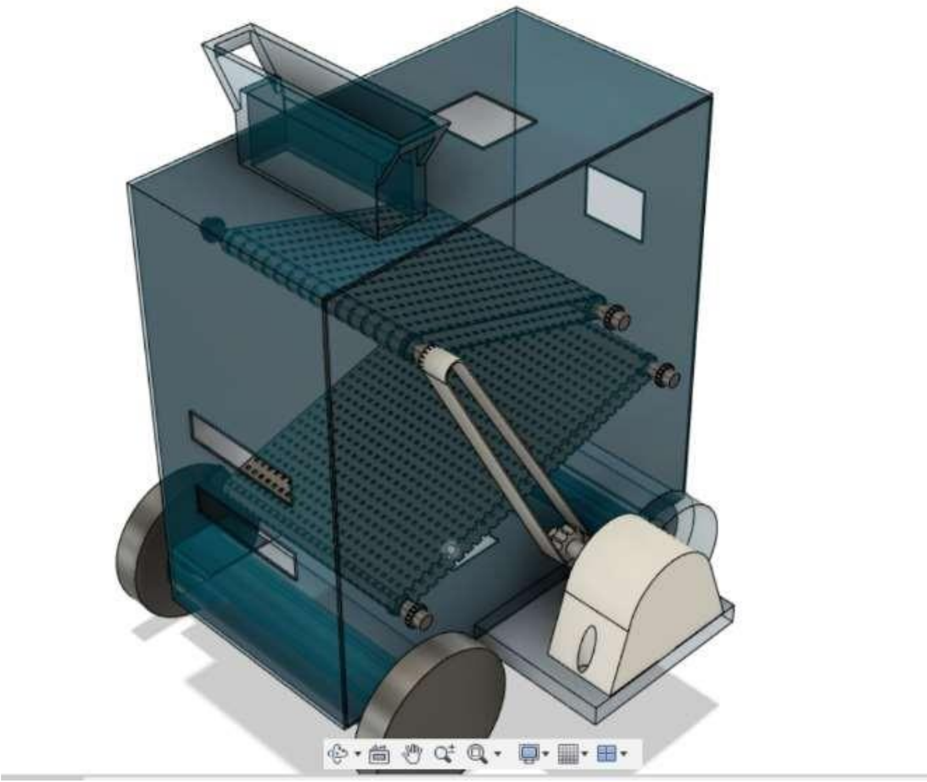


Fig. 3.3: over view of the dehumidifier

There are 2 meshes which are present inside the body which help to remove the moisture content in two different stages. mostly the unbounded and bonded moisture is removed on the top belt and the bounded is removed in the below belt.

As the grains passes through top mesh the heat waves from the below comes in the contact with the grains because as the exhaust is placed ono the top of the container due to the pressure difference the heat flow take place.

After passing through the top mesh the grains now travel through the below mesh which is longer than the top mesh and rotating at much lower velocities. The heat flow takes place because of the same reason as for the top mesh.

Care should be taken that there is no fire catching inside the container. In order to prevent this the cycle is repeated several times and there will be a storage provided at the bottom of the container.

3.3 METHODS OF CALCULATIONS:

The calculations can be done in the following ways

- By using analytical method
- By using software(testing)

3.3.1 Calculation for the shaft

a) Analytical method:

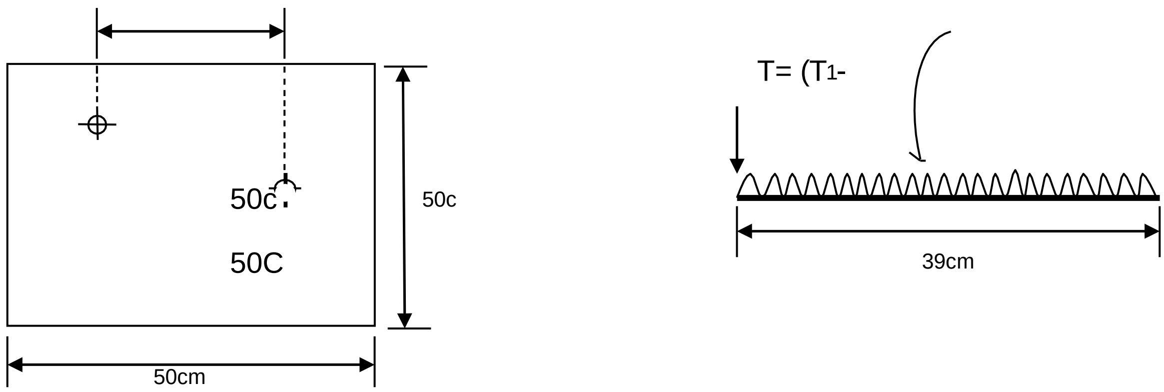


Fig. 3.4: shaft design side view of the dehumidifier

Calculation for T:

Motor type: AC

House motor: 1/12 HP

$1HP = \frac{Torque*speed}{9550}$

1/12*9550 = Torque * speed

$\frac{\frac{1}{12}*9550}{30\ RPM}$ = Torque

$T = \frac{9550}{12*30}$

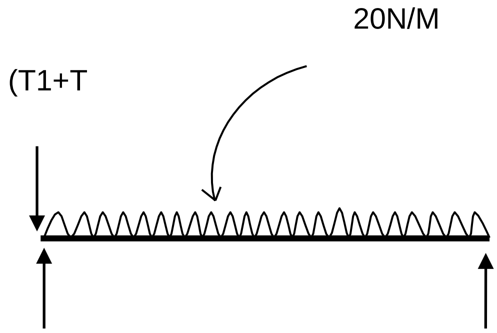
T = 26.52 ≈ 30 N-m

T=30 N-m $\Longrightarrow$ (T=F×r) $\Longrightarrow$

30=f×(0.03) f=30×(100/3)

f=1000N

Calculation for RA and RB: for 20N/M load



$R_A + R_B = 1000N + (200 * 0.34)$

Moment at A:

$RA \quad \times (0.39) = (20 \times (0.39)) \times (\frac{0.39}{2})$

$R_B = 3.9N$

$R_A = 1000N + (7.8) – 3.9$

$R_A = 1003.9N \cong 1010N$

Material: S.S

τ u= 74000 N/mm^2

σu = 48N/mm^2

Factor of safety = 6

$\sigma t = \frac{\sigma u}{F.S} = \frac{480}{6}$ = 80N/mm^2

σt = 80N/mm^2

CALCULATION OF MOMENT DUE TO BELT CONVENER &

THE SPEED :

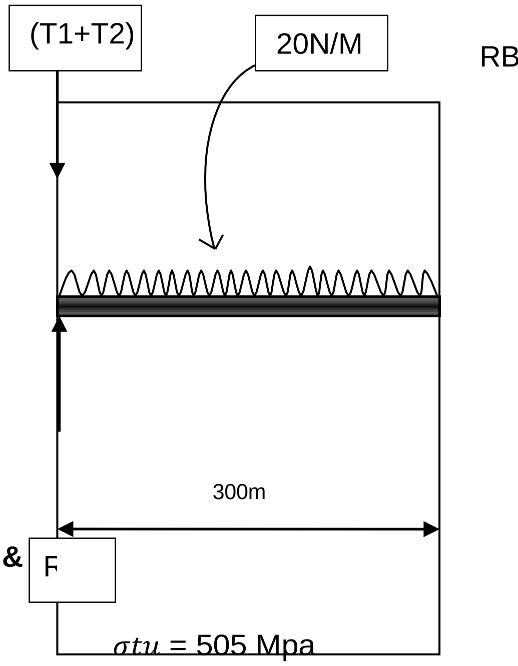


Fig. 3.5: UDL on shaft

Moment (m) = 3.9 *0.39

m = 1.525 N-m

DIA OF SHAFT BASED ON TORQUE :

$T_e = \sqrt{M^2 + T^2}$

(σb)steel =1000

T = $\frac{\pi}{32} \times \sigma b \times d^3$

30 × 10^3 (N/mm) = $\frac{\pi}{32} \times 1000 \times d^3$

d = 6.73 ≈10mm

ULTIMATE TENSILE STRESS OF S.S:

$\sigma t = \frac{\sigma tu}{f.s} = \frac{505}{6} = 84.16 \cong 85$

τu = 5792 Mpa
N/mm^2

σt = 84.16 ~ 85N/mm^2

$\tau = \frac{\tau u}{f.s}$ +965.33 ≈ 966

N/mm^2

$T_e = = \sqrt{M^2 + T^2}$

$=\sqrt{(1.52 \times 10^3)^2 + (30 * 10^3)^2}$

T_e = 30038.532 N-m

DIMENTION OF SHAFT BASED ON TORQUE:

$30038.532 = \frac{\pi}{16} \times \tau \times d^3$

d^3 =

1799.823 d

= 12.16mm

≈ 16mm

MAXIMUM NORMAL STRESS THEORY:

$M_e = \frac{1}{2}(M + \sqrt{M^2 + T^2})$

$= \frac{1}{2}(M+T_e$

$=\frac{1}{2}$ (1521+30038.53)
)

M_e = 15779.765N-mm

DIA OF SHAFT BASED ON MOMENT :

$$15779.765 = \frac{\pi}{32} \times Z_b \times d^3$$

$$= \frac{\pi}{32} \times 966 \times d^3$$

d^3=166038

d = 5.5mm ~ 6mm

b) By using software

Study Type	Static Stress
Last Modification Date	2020-04-20, 12:13:42

Settings

General

Contact Tolerance	0.1 mm
Remove Rigid Body Modes	No

Damping

Mesh

Average Element Size (% of model size)	
Solids	10
Scale Mesh Size Per Part	No
Average Element Size (absolute value)	-
Element Order	Parabolic
Create Curved Mesh Elements	Yes
Max. Turn Angle on Curves (Deg.)	60
Max. Adjacent Mesh Size Ratio	1.5
Max. Aspect Ratio	10
Minimum Element Size (% of average size)	20

Adaptive Mesh Refinement

Number of Refinement Steps	0
Results Convergence Tolerance (%)	20
Portion of Elements to Refine (%)	10
Results for Baseline Accuracy	Von Mises Stress

Materials

Component	Material	Safety Factor
Body1	Steel	Yield Strength

Steel

Density	7.85E-06 kg / mm^3
Young's Modulus	210000 MPa
Poisson's Ratio	0.3
Yield Strength	207 MPa
Ultimate Tensile Strength	345 MPa
Thermal Conductivity	0.056 W / (mm C)
Thermal Expansion Coefficient	1.2E-05 / C
Specific Heat	480 J / (kg C)

Contacts

Mesh

Type	Nodes	Elements
Solids	27094	14171

Load Case1

Constraints

Fixed3

Type	Fixed
Ux	Yes
Uy	Yes
Uz	Yes

Selected Entities

Loads

Force1

Type	Force
X Value	0 N
Y Value	1010 N
Z Value	0 N
Force Per Entity	No

Loads

Force1

Type	Force
X Value	0 N
Y Value	1010 N
Z Value	0 N
Force Per Entity	No

Selected Entities

Force2

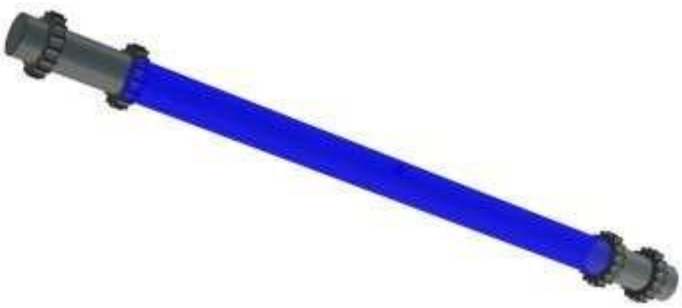
Type	Force
X Value	0 N
Y Value	3.9 N
Z Value	0 N
Force Per Entity	No

Selected Entities

Moment1

Type	Moment
Magnitude	1.525 N mm
X Value	-1.525 N mm
Y Value	0 N mm
Z Value	0 N mm

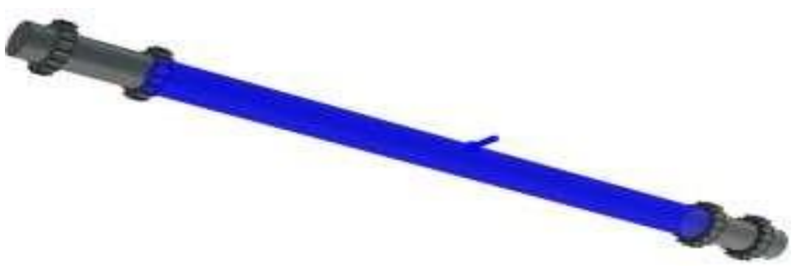
Selected Entities



Force3

Type	Force
Magnitude	25 N
X Value	0 N
Y Value	-25 N
Z Value	0 N

Selected Entities



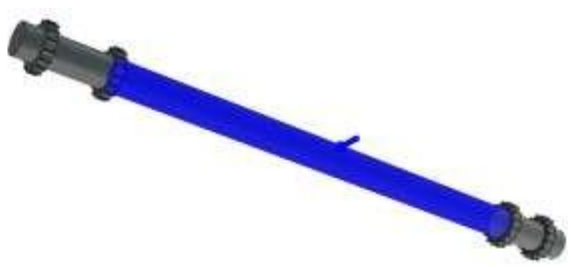
Force4

Type	Force
X Value	0 N
Y Value	-30 N
Z Value	0 N
Force Per Entity	No

Selected Entities

X Angle	0 deg
Y Angle	0 deg
Z Angle	0 deg
Force Per Entity	No

Selected Entities



Force4

Type	Force
X Value	0 N
Y Value	-30 N
Z Value	0 N
Force Per Entity	No

Results

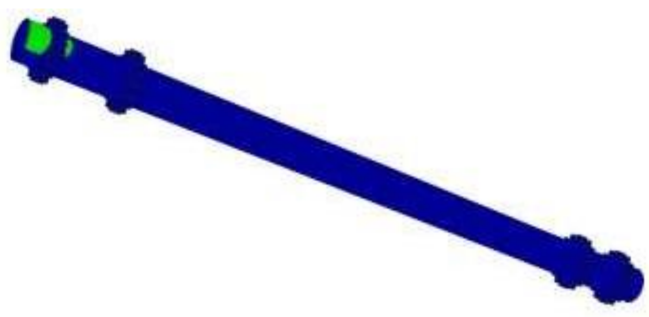
Result Summary

Name	Minimum	Maximum
Safety Factor		
Safety Factor (Per Body)	3.87	15
Stress		
Von Mises	2.656E-07 MPa	53.49 MPa
1st Principal	-24.03 MPa	70.68 MPa
3rd Principal	-70.08 MPa	23.96 MPa
Normal XX	-67.44 MPa	68.22 MPa
Normal YY	-28.36 MPa	28.32 MPa
Normal ZZ	-28.15 MPa	28.11 MPa
Shear XY	-10.05 MPa	11.98 MPa
Shear YZ	-4.95 MPa	5.618 MPa
Shear ZX	-7.579 MPa	7.587 MPa
Displacement		
Total	0 mm	0.225 mm

X	-0.009999 mm	0.01 mm
Y	0 mm	0.225 mm
Z	-3.079E-04 mm	3.064E-04 mm
Reaction Force		
Total	0 N	637.1 N
X	-636.9 N	635.2 N
Y	-158.3 N	22.04 N
Z	-81.05 N	81.26 N
Strain		
Equivalent	2.73E-12	2.716E-04
1st Principal	-3.636E-12	3.189E-04
3rd Principal	-3.188E-04	1.425E-12
Normal XX	-2.626E-04	2.645E-04
Normal YY	-8.964E-05	8.739E-05
Normal ZZ	-6.696E-05	6.712E-05
Shear XY	-1.245E-04	1.484E-04
Shear YZ	-6.128E-05	6.956E-05
Shear ZX	-9.383E-05	9.393E-05

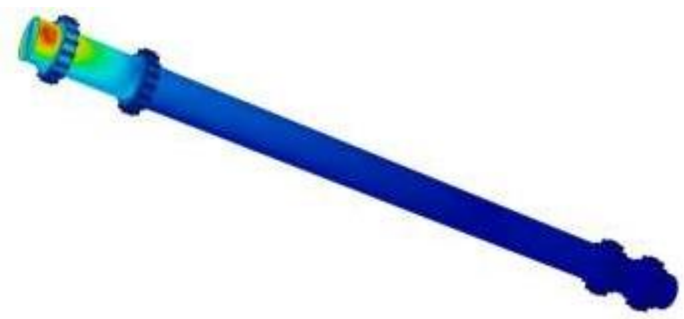
Safety Factor

Safety Factor (Per Body) 0 8



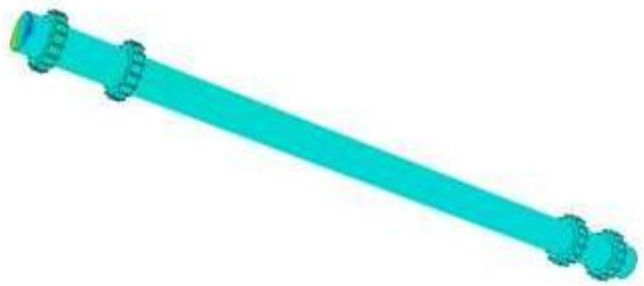
Stress

Von Mises [MPa] 0 53.49



1st Principal

[MPa] -24.03 70.68

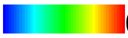


3rd Principal

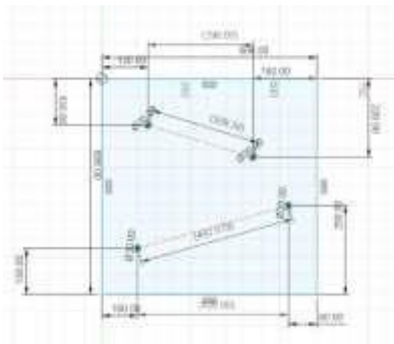
[MPa] -70.08 23.96

Displacement

Total

[mm] 0  0.225

3.3.3 CALCULATION FOR SPROCKET AND CASSETTE



Power supply(P)=1/2HP=746/12=63W

Actual RPM of motor N1=1500rpm

Reduced RPM of motor N2 = 300 rpm

x = Distance between 2 points A and B =510m

Time of run(T) = full day

Velocity ratio=1500/300=5

Roller=21(from the table)

T2=T1×N1/N2=25×1500/300

Load factor(k)=2.25

Power=0.063x2.25

= 0141kw

=141.75w

Table 21.4. Power rating (in kW) of simple roller chain.

Speed of smaller sprocket or pinion (r.p.m.)	Power (kW)				
	06 B	08 B	10 B	12 B	16 B
100	0.25	0.64	1.18	2.01	4.83
200	0.47	1.18	2.19	3.75	8.94
300	0.61	1.70	3.15	5.43	13.06
500	1.09	2.72	5.01	8.53	20.57
700	1.48	3.66	6.71	11.63	27.73
1000	2.03	5.09	8.97	15.65	34.89
1400	2.73	6.81	11.67	18.15	36.47
1800	3.44	8.10	13.03	19.85	
2000	3.80	8.67	13.49	20.57	-

The service factor (K_s) is the product of various factors, such as load factor (K_1), lubrication factor (K_2) and rating factor (K_3). The values of these factors are taken as follows:

1. Load factor (K_1) = 1, for constant load
   = 1.25, for variable load with mild shock
   = 1.5, for heavy shock loads
2. Lubrication factor (K_2) = 0.8, for continuous lubrication
   = 1, for drop lubrication
   = 1.5, for periodic lubrication
3. Rating factor (K_3) = 1, for 8 hours per day
   = 1.25, for 16 hours per day
   = 1.5, for continuous service

Fig. 3.6: table power rating

For 1400RPM of pinion and based on the power in kw

From table no. 21.4 we choose 06B series which is 2.73

From table no.21.1

Table 21.1. Characteristics of roller chains according to IS: 2403 — 1991

ISO Chain number	Pitch (p) mm	Roller diameter (d_1) mm Maximum	Width between inner plates (b_1) mm Maximum	Transverse pitch (p_1) mm	Breaking load (kN) Minimum		
					Simple	Duplex	Triplex
05 B	8.00	5.00	3.00	5.64	4.4	7.8	11.1
06 B	9.525	6.35	5.72	10.24	8.9	16.9	24.9
08 B	12.70	8.51	7.75	13.92	17.8	31.1	44.5
10 B	15.875	10.16	9.65	16.59	22.2	44.5	66.7
12 B	19.05	12.07	11.68	19.46	28.9	57.8	86.7
16 B	25.4	15.88	17.02	31.88	42.3	84.5	126.8
20 B	31.75	19.05	19.56	36.45	64.5	129	193.5
24 B	38.10	25.40	25.40	48.36	97.9	195.7	293.6
28 B	44.45	27.94	30.99	59.56	129	258	387
32 B	50.80	29.21	30.99	68.55	169	338	507.10
40 B	63.50	39.37	38.10	72.29	262.4	524.9	787.3
48 B	76.20	48.26	45.72	91.21	400.3	800.7	1201

Fig. 3.7: roller chain dimensions

P = 9.525mm

P1=10.25mm

d=6.35mm

Wb=17KN

=17×10^3N

b1=5.72 mm

Roller diameter of pinion (d1)

=P Cosec(180/T1)

=9.6×Cosec (180/21)

=64.41mm

Pitch circle diameter(d2)

=P cosec (180/T2)

=320mm

Pitch line velocity (PLV)=πd1N1/60

=π×0.064×1500/60

=5.02m/s

Load on chain:

W=rated power/PLV

=0.063/5.02

=0.0125KN

Factor of safety (FOS) =W_b/W

=17×10^3/12.5

=1366

Which is acceptable based on all the complications

Distance between the center of motor shaft to the roller shaft (X)

X=510mm

X=510-4=506mm

K=126/2+20506/9.6(105-21/2π) ^2×9.6/506

=171.80

Apprx=172

Length of chain

L=Kp=172×9.6=1651.2mm. =1.65m

Roller section radius(r1)

R1=0.0505 d1+0.069(d1) ^ (1/3)

R1=0.503×6.3+0.69(6.3) ^1/3=3.1815mm

Roller shaft angle(α)

=140°-90°/T

=140°-90°/21

=135°

Tooth Hight above the pitch polygon

$ha=0.5(P-d1)$

$=0.625P-0.5d1+(0.8p/T)$

$=9.39mm$

Top diameter (Da)

$Da =D+1.25P-d1$

$Da=65+1.25\times9.6-655$

$=70.65mm$

Root diameter (Df)

$Df=D-2r1$

$=65-2\times3.308$

$=5.384mm$

Tooth width(df1)

$bf1=0.946b1$

$bf1=0.93\times5.72$

$=5.31mm$

3.3.4 THERMAL ANALYSIS ON THE SHAFT AND SPROCKET

⊟ Results

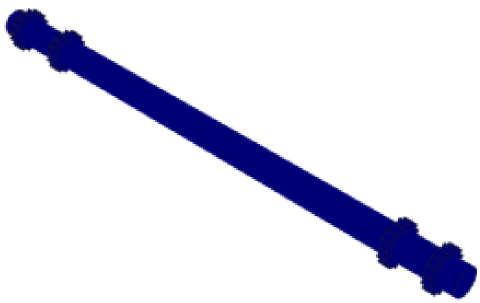
⊟ Result Summary

Name	Minimum	Maximum
Temperature		
Temperature	50 C	50 C
Heat Flux		
Total	4.416E-10 W / mm^2	4.155E-06 W / mm^2
X	-3.426E-06 W / mm^2	4.129E-06 W / mm^2
Y	-1.453E-06 W / mm^2	1.255E-06 W / mm^2
Z	-1.407E-06 W / mm^2	1.102E-06 W / mm^2
Thermal Gradient		
Total	7.885E-09 C / mm	7.419E-05 C / mm
X	-7.373E-05 C / mm	6.117E-05 C / mm
Y	-2.24E-05 C / mm	2.595E-05 C / mm
Z	-1.968E-05 C / mm	2.512E-05 C / mm
Applied Heat Flow		
Applied Heat Flow	0 W / mm^2	0 W / mm^2

⊟ Temperature

⊟ Temperature

[C] 50 50



3.3.5 THERMAL ANALYSIS ON THE CONTAINER

Study Type	Thermal
Last Modification Date	2020-05-04, 15:49:50

Settings

General

Contact Tolerance	0.1 mm
Global Initial Temperature	20 C

Damping

Mesh

Average Element Size (% of model size)	
Solids	10
Scale Mesh Size Per Part	No
Average Element Size (absolute value)	-
Element Order	Parabolic
Create Curved Mesh Elements	Yes
Max. Turn Angle on Curves (Deg.)	60
Max. Adjacent Mesh Size Ratio	1.5
Max. Aspect Ratio	10
Minimum Element Size (% of average size)	20

Adaptive Mesh Refinement

Number of Refinement Steps	0
Results Convergence Tolerance (%)	20
Portion of Elements to Refine (%)	10
Results for Baseline Accuracy	Heat Flux

Materials

Component	Material	Safety Factor
Body1	Steel, Mild	Yield Strength

Steel, Mild

Density	7.85E-06 kg / mm^3
Young's Modulus	220000 MPa
Poisson's Ratio	0.275
Yield Strength	207 MPa
Ultimate Tensile Strength	345 MPa
Thermal Conductivity	0.045 W / (mm C)
Thermal Expansion Coefficient	1.2E-05 / C
Specific Heat	480 J / (kg C)

Contacts

Mesh

Type	Nodes	Elements
Solids	56594	28137

Load Case1

Loads

Applied Temperature1

Type	Applied Temperature
Value	40 C

Selected Entities

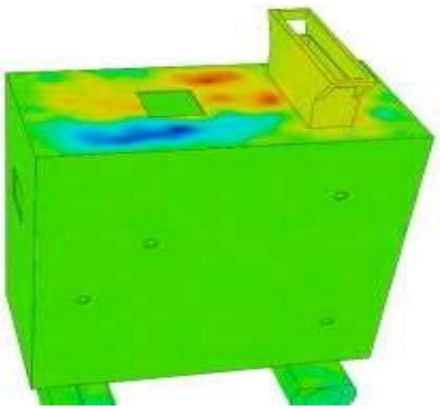
Results

Result Summary

Name	Minimum	Maximum
Temperature		
Temperature	39.87 C	40.12 C
Heat Flux		
Total	6.3E-09 W / mm^2	3.455E-04 W / mm^2
X	-2E-04 W / mm^2	3.387E-04 W / mm^2
Y	-1.232E-04 W / mm^2	9.701E-05 W / mm^2
Z	-2.125E-04 W / mm^2	2.093E-04 W / mm^2
Thermal Gradient		
Total	1.4E-07 C / mm	0.007677 C / mm
X	-0.007527 C / mm	0.004445 C / mm
Y	-0.002156 C / mm	0.002738 C / mm
Z	-0.004651 C / mm	0.004722 C / mm
Applied Heat Flow		
Applied Heat Flow	0 W / mm^2	0 W / mm^2

Temperature

[C] 39.87 40.12



3.3.6 STATIC STRESS ANALYSIS ON THE CONTAINER

Study Properties

Study Type	Static Stress
Last Modification Date	2020-05-04, 15:41:04

Settings

General

Contact Tolerance	0.1 mm
Remove Rigid Body Modes	No

Damping

Mesh

Average Element Size (% of model size)	
Solids	10
Scale Mesh Size Per Part	No
Average Element Size (absolute value)	-

Element Order	Parabolic
Create Curved Mesh Elements	Yes
Max. Turn Angle on Curves (Deg.)	60
Max. Adjacent Mesh Size Ratio	1.5
Max. Aspect Ratio	10
Minimum Element Size (% of average size)	20

Adaptive Mesh Refinement

Number of Refinement Steps	0
Results Convergence Tolerance (%)	20
Portion of Elements to Refine (%)	10
Results for Baseline Accuracy	Von Mises Stress

Materials

Component	Material	Safety Factor
Body1	Steel, Mild	Yield Strength

Steel, Mild

Density	7.85E-06 kg / mm^3
Young's Modulus	220000 MPa
Poisson's Ratio	0.275
Yield Strength	207 MPa
Ultimate Tensile Strength	345 MPa
Thermal Conductivity	0.045 W / (mm C)
Thermal Expansion Coefficient	1.2E-05 / C
Specific Heat	480 J / (kg C)

Contacts

Mesh

Type	Nodes	Elements
Solids	56594	28137

Load Case1

Constraints

Fixed1

Type	Fixed
Ux	Yes
Uy	Yes
Uz	Yes

Selected Entities

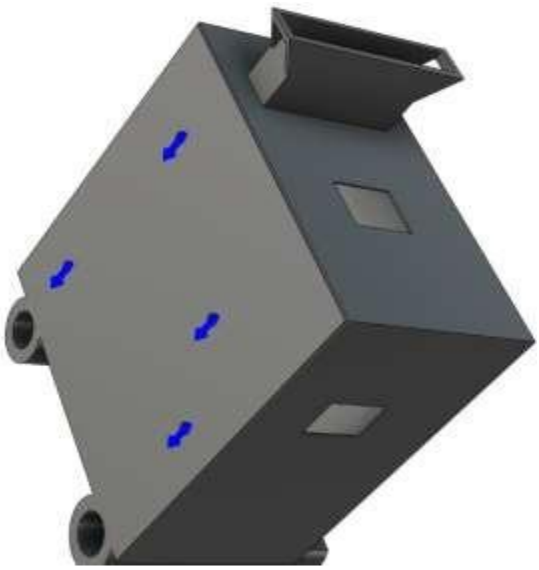
Loads

Force1

Type	Force
Magnitude	-1010 N
X Value	0 N
Y Value	-1010 N

Z Value	0 N
X Angle	0 deg
Y Angle	0 deg
Z Angle	0 deg
Force Per Entity	No

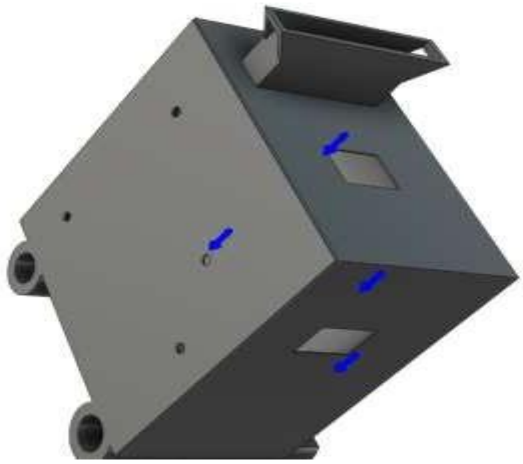
Selected Entities



Force2

Type	Force
Magnitude	-3.9 N
X Value	0 N
Y Value	-3.9 N
Z Value	0 N
X Angle	0 deg
Y Angle	0 deg
Z Angle	0 deg
Force Per Entity	No

Selected Entities



Results

Result Summary

Name	Minimum	Maximum
Safety Factor		
Safety Factor (Per Body)	15	15
Stress		
Von Mises	4.373E-17 MPa	2.562 MPa
1st Principal	-0.6019 MPa	1.674 MPa
3rd Principal	-3.042 MPa	0.3474 MPa
Normal XX	-0.6784 MPa	0.5265 MPa
Normal YY	-3.026 MPa	1.663 MPa
Normal ZZ	-1.069 MPa	0.7921 MPa
Shear XY	-0.7233 MPa	0.3418 MPa
Shear YZ	-1.028 MPa	1.069 MPa
Shear ZX	-0.3824 MPa	0.3518 MPa
Displacement		

Total	0 mm	0.002276 mm
X	-1.461E-05 mm	0.001973 mm
Y	-0.001364 mm	1.063E-04 mm
Z	-9.427E-04 mm	6.079E-04 mm
Reaction Force		
Total	0 N	37.3 N
X	-10.11 N	15.79 N
Y	-10.36 N	33.17 N
Z	-12.46 N	12.04 N
Strain		
Equivalent	0	1.489E-05
1st Principal	-3.503E-08	1.248E-05
3rd Principal	-1.476E-05	1.127E-08
Normal XX	-2.86E-06	3.65E-06
Normal YY	-1.249E-05	7.198E-06
Normal ZZ	-3.007E-06	4.245E-06
Shear XY	-8.384E-06	3.962E-06
Shear YZ	-1.192E-05	1.239E-05
Shear ZX	-4.432E-06	4.078E-06

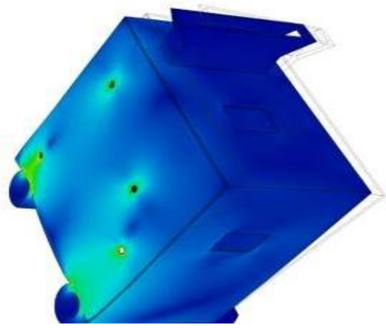
Safety Factor (Per Body)

0 8

Stress

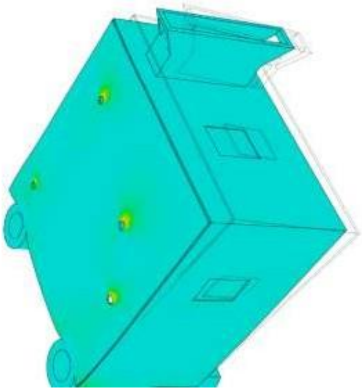
Von Mises

[MPa] 0 2.562



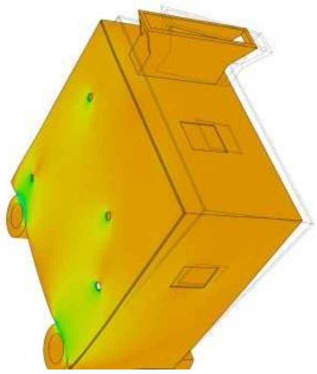
1st Principal

[MPa] -0.602 1.674



3rd Principal

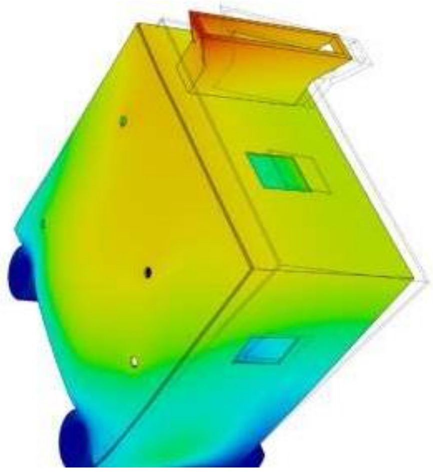
[MPa] -3.042 0.347



Displacement

Total

[mm] 0 0.002276



3.4 SUMMARY:

By the analytical and system analysis methods, we can conclude that:

- The shaft is designed as per the requirement and the analysis results are also quite good with about 4 factors of safety.
- The sprockets and pinions are also been calculated based on the availability of them in the market and cost factor.
- The chain we are using for the motion transmission is just a normal cycle chain. The analysis of this have also gave us a good scope.
- The body material can withstand temperatures up to 70, which doesn’t have scope for further analysis.
- Depending on the controlled motion of the motor and the constant flow of the seeds into the container, we can get up 1000kgs a day of dried grains.
- The above point is purely theoretical which can be changes to 5% upon calculating the experimental results.

CHAPTER 4: SOFTWARES

FUSION 360

Fusion 360 is a CAD program that is free for students, makers and small companies. It comes with a very powerful CAM suite.

Fusion 360 supports editing inside the browser. This version of Fusion 360 does not yet have the full set of features, but might still be useful in case you cannot install the desktop version.

- Log in with your Autodesk account and select "Edit in browser" on any design or create a new project and select "New -> Fusion design".

Fig. 4.1: Fusion 360 software

Why Use Fusion 360?

- World's first cloud-based 3D CAD/CAM/CAE software.
- Helps students and educators prepare for the future of design.
- Connects entire product development process into one platform.
- Enables real-time collaboration for engineers, designers, manufacturers, and product managers.
- Powerful software with advanced features for professional use.

REFERENCES

[1] Author: CIMBRIA

- ECO-LOGIC CONTINUOUS FLOW COLUMN DRYER INTELLIGENT DRYING FOR HIGH PERFORMANCE AND OPTIMUM VALUE
- State-of-the-art technology: Cimbria to supply new ECO-Logic dryer ECO- Logic dryer is manufactured in standard capacities covering drying requirements from 20 to 250 t/h wheat based on a moisture reduction of 19- 15% and is capable of drying all major cereals. Larger capacities are available upon request.

[2] Author: AUSH ENGINEERING WORKS

- Published on Sep 7, 2017, continues dryer machine for removing moisture from maize.

[3] Author: ALVAN BLANCH GRAIN DRYER

- Published on Mar 14, 2014.New Working Animation of Alvan Blanch Continuous Double Flow Grain Drier. Showing extra footage nor seen before.

[4] Author:MECMAR

- Published on Mar 9, 2017.Short animation showing the grain drying process of MECMAR mobile grain dryers. Such dryers are a flexible, reliable and easy to use machines suitable for drying grain, corn, wheat, rice, sorghum, oilseed rape.
- PHTC Recirculating batch dryer.
- Mixing type baffle dryer.
- LSU type dryer.
- Continuous flow type non mixing double column dryer.
- Continuous flow type non mixing double screen columnar dryer with grain cooling chamber.
- Columnar dryer with overhead tempering bin.
- Text book by Chakravarty on post-harvest technology of cereals, pulses and oilseeds.