



18th International Conference - Science, Technology and Innovation

Booklets



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Title: Design of a lettuce dryer machine for the company JASL TETLA

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Editorial label ECORFAN: 607-8695
BECORFAN Control Number: 2021-01
BECORFAN Classification (2021): 131221-0001

Pages: 17
RNA: 03-2010-032610115700-14

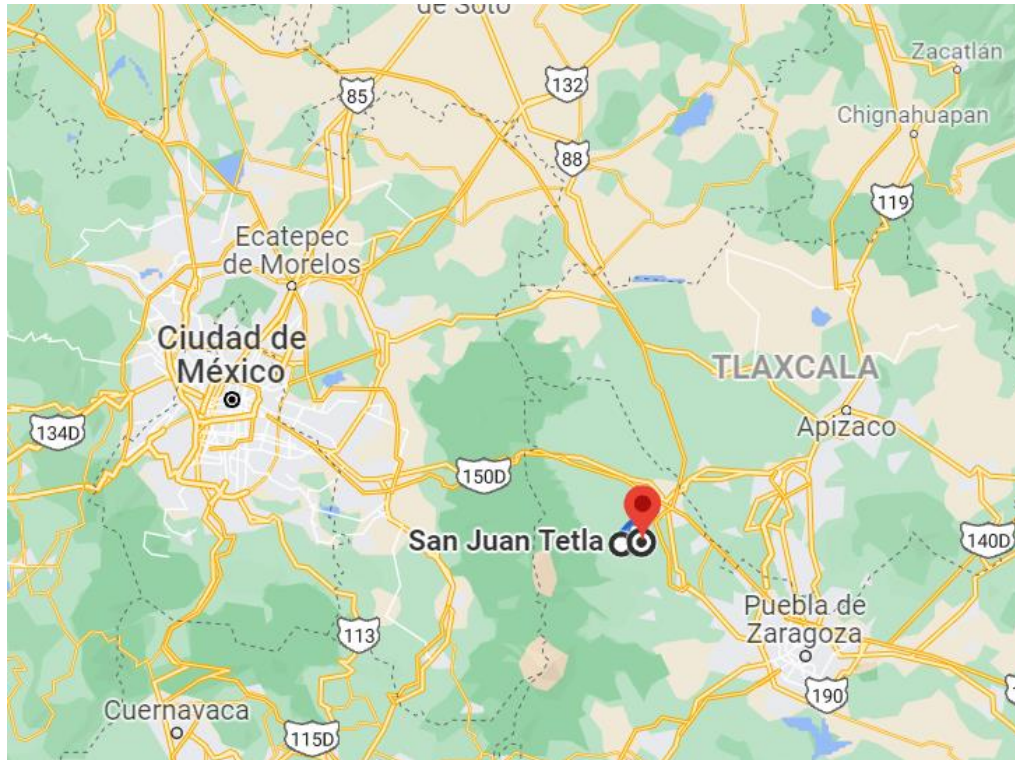
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INTRODUCTION

The agricultural company JASL TETLA, located in the community of San Juan Tetla, in the Municipality of San Lorenzo Chiautzingo, in the State of Puebla is dedicated to the planting of different types of lettuce, as well as the distribution of them, being a company that is expanding and in one of the different stages of its process require a machine, that allows the lettuce to dry before being packaged, the lettuce is sold washed and disinfected, ready to be consumed.



Of the different types of vegetables consumed in Mexico and in the world, lettuce is the one that has registered a better acceptance in consumption (Rios, 2012), these regulate bodily functions, are a source of nutritious subsistence, produce energy, which is why they are of vital importance for man (Alcazar O, 2010)



Considerations for the design process

In order to carry out the design of the vegetable centrifuge machine, we start from the existing problem in the company JASL TETLA that consists of reducing the drying time of the lettuce, currently the time is 5 boxes of the product in 30 minutes.

Tipo de lechuga	Peso por ciclo
Lechuga romana	20 a 25 kg por 30 minutos
Lechuga lollo rosso	15 kg por 30 minutos

To deposit the lettuces already leafless, the company uses mesh containers of polyethylene material that facilitate the flow of air and drainage as shown in figure 1, are resistant to shocks, cracks and chipping with molded handles on the 4 sides to lift easily, the measures are: 0.60 m long by 0.40 m wide by 0.28 m high with eyelet (handle) of 0.11 m by 0.035 m.



Figure 1. Container with leafed lettuce.

METHODOLOGY



First an investigation was carried out on the characteristics of lettuce where it was necessary to know the weight, height and volume that a lettuce can occupy.

It was determined that the most convenient thing is to avoid sudden contact and not manipulate the product so much.

The revolutions of the structure were set at 1200 rpm and the rest of the elements were determined for the correct operation of the centrifuge.

For the design of the machine it was considered to use the containers inside the structure to avoid manipulating or mistreating the lettuces, so a rectangular and not circular design was chosen.

RESULTS



Calculation of the strap.

The service factor k , selected is 1 which is recommended to work in a shift, according to the request of the company.

For the calculation of the gear ratio R

$$R = \frac{N}{n} = \frac{1800rpm}{1200rpm} = 1.5 \quad (1)$$

N the revolutions of the driver engine

n the revolutions of the driven machine

Larger pulley diameter

$$D = dR = 4.72 \text{ in} = 120\text{mm} \quad (2)$$

4.75 is selected for being a commercial value

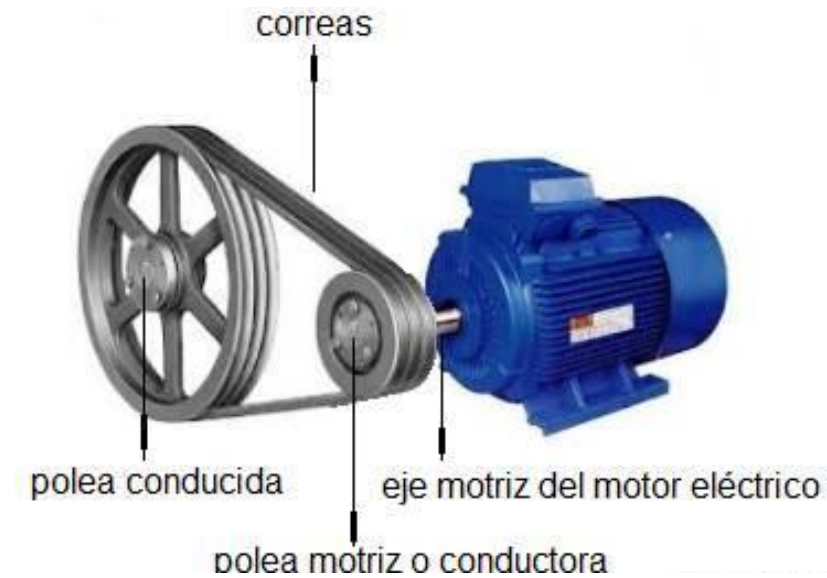
Wheelbase of pulleys

$$E > \left(\frac{(R + 1)d}{2} \right) + d \quad (3)$$

To calculate the length of the strap

$$Lp = 2E + \frac{\pi}{2}(D + d) + \frac{(D-d)^2}{4E} \quad (4)$$

$$Lp = 1116.38\text{mm}$$



Calculation of contact angle A

$$A = 180 - 57 \frac{(D-d)}{E} = 174.3^\circ \quad (5)$$

Belt speed

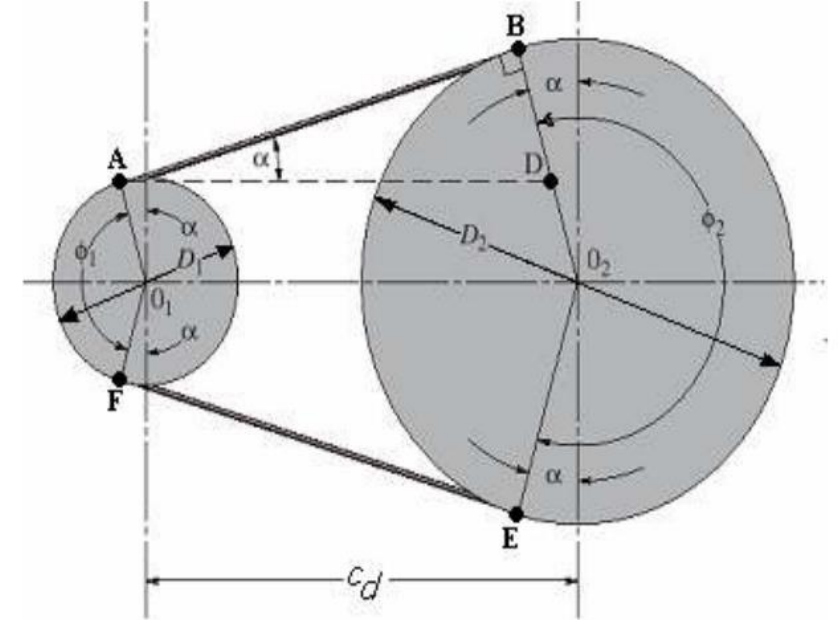
$$V_t = \frac{\pi d N}{60(100)} = \frac{7.54 \text{ m}}{\text{s}} \quad (6)$$

Effective belt power

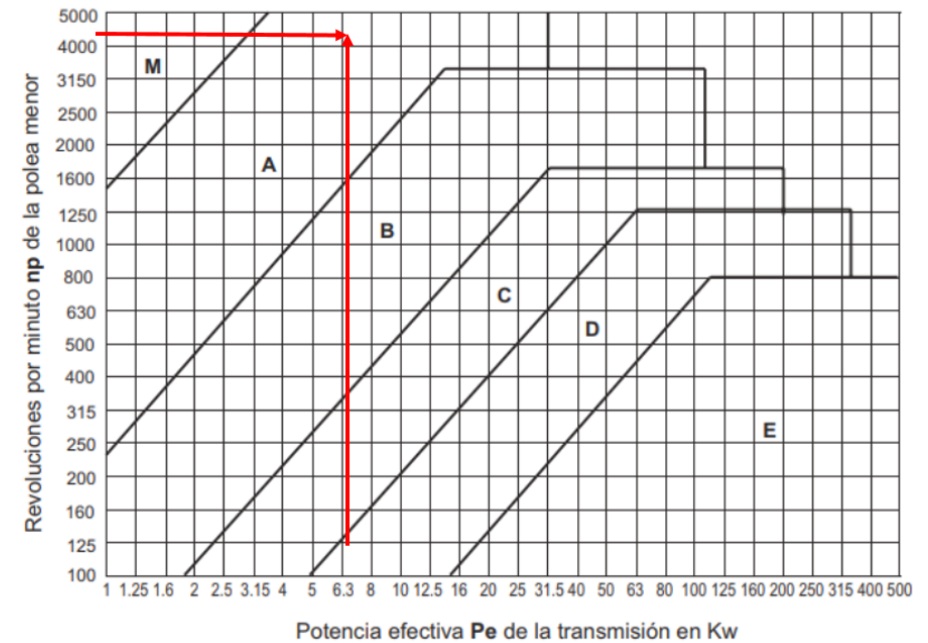
$$Pe = Pb * Fcl * FcA = 1.39 \text{ Hp} \quad (7)$$

Calculation of the number of straps

$$N_{correas} = \frac{Pc}{Pe} = 2.1 = 2 \text{ correas} \quad (8)$$



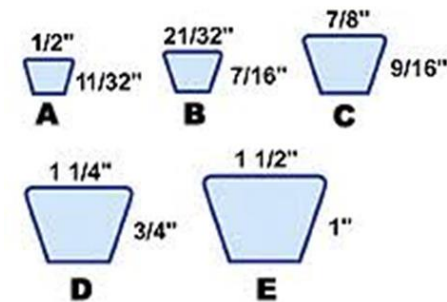
Gráfica 1: Elección de la Sección de las Correas Clásicas



Calculation of the number of straps

$$N_{\text{straps}} = \frac{P_c}{P_e} = 2.1$$

V-belts are used that do not require lubrication or maintenance, also solve problems of slip and alignment, they are capable of covering a load range from less than 1 HP to 500 horsepower. Basically they serve to reduce the input speed and increase the torque values.



Centrifuge machine design

The design of the base that will support the structure and the weight of the lettuces was made, for the construction the structural tubular profile of stainless steel was used that is recommended for structures, as well as cuts of stainless steel plates of 8" x 8 " of 1/4" thick and with wall chumaceras that work to support a rotation axis and have high load capacities as shown in Figure 2, the base has dimensions of 0.25 m high by 0.80 m wide

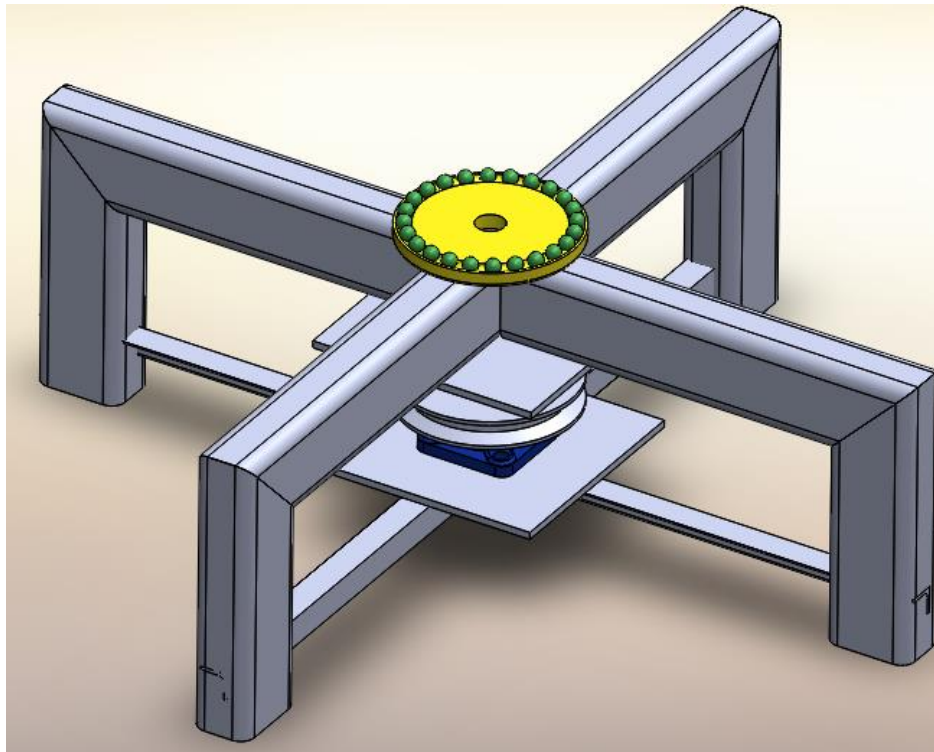


Figure 2. Machine base

Source: own

Figure 3 shows the yellow structure that was built with two plates, one fixed at the base below and the other part is movable in the upper structure and must rest on the bearings of diameter of $\frac{3}{8}$ ", which will be lubricated with grease registered as category H1 with suffix VP311 and NBR rubbing seal, on both sides.

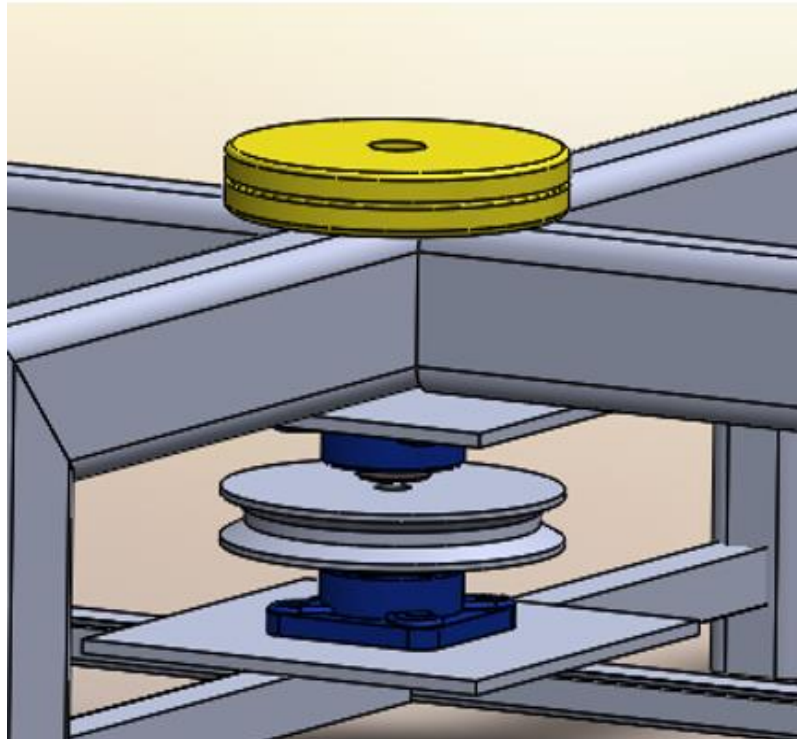


Figure 3. Bearing plate

Source: own

Source: own

Figure 5. It shows the assembly of the base and the mobile structure coupled with the design of the bearing plate, the gray structure is a door to give access to place the boxes and at the same time prevents movement between them and prevents them from leaving.

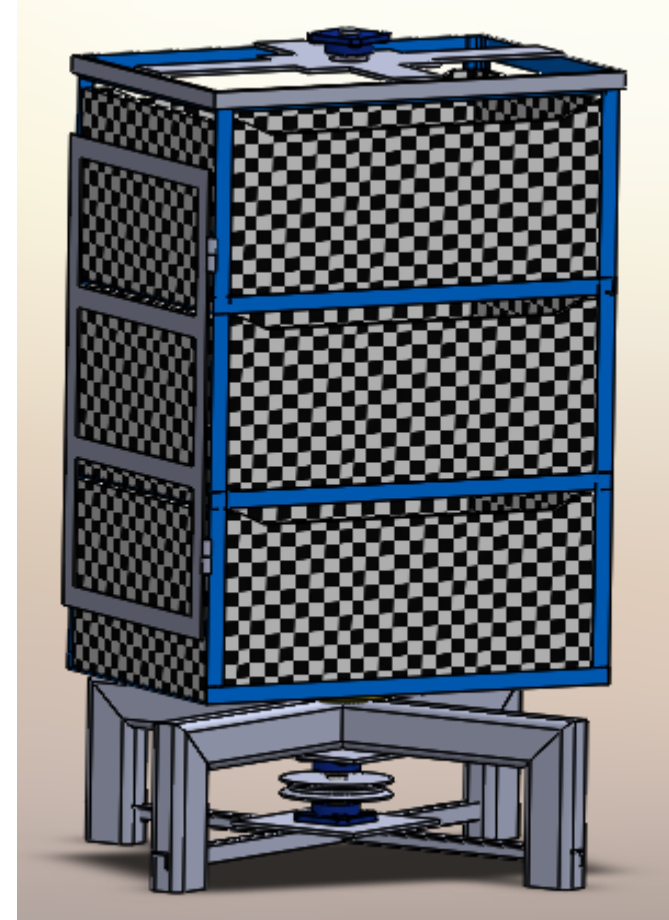


Figure 5. Machine Assembly

Source: own

ANNEXES

Stainless steel data sheet

Fuente: Carbone Stainless Steel

TABLA DE CARACTERÍSTICAS TÉCNICAS DEL ACERO INOXIDABLE			SERIE 300	
			Acero al Cromo - Níquel	Acero al Cromo - Níquel - Molibdeno
DESIGNACIÓN	TIPO AISI		304	316
	COMPOSICIÓN QUÍMICA		C ≤ 0.08%* Si ≤ 1.00% Mn ≤ 2.00% Cr 18% - 20%* Ni 8% - 10,5%*	C ≤ 0.08%* Si ≤ 1.00% Mn ≤ 2.00% Cr 16% - 18%* Ni 10% - 14%* Mo 2% - 2.5%*
PROPIEDADES FÍSICAS	PESO ESPECÍFICO A 20C (DENSIDAD)	(g/cm³)	7.9	7.95 - 7.98
	MÓDULO DE ELASTICIDAD	(N/mm²)	193,000	193,000
	ESTRUCTURA		AUSTENÍTICO	AUSTENÍTICO
	CALOR ESPECÍFICO A 20C	(J/Kg K)	500	500
	CONDUCTIVIDAD TÉRMICA A 20C/100C	(W/m K)	15 / 16	15 / 16
	COEFICIENTE DE DILATACIÓN A 100C	(x 10⁶ C⁻¹)	16.0 - 17.30	16.02 - 16.5
	INTERVALO DE FUSIÓN	(C)	13981454	13711398
PROPIEDADES ELÉCTRICAS	PERMEABILIDAD ELÉCTRICA EN ESTADO SOLUBLE RECOCIDO		AMAGNÉTICO 1.008	AMAGNÉTICO 1.008
	CAPACIDAD DE RESISTENCIA ELÉCTRICA A 20C	(μΩm)	0.72 - 0.73	0.73 - 0.74
	DUREZA BRINELL RECOCIDO HRB/CON DEFORMACIÓN EN FRÍO		130150 / 180330	130185 / -
PROPIEDADES MECÁNICAS A 20C	DUREZA ROCKWELL RECOCIDO HRB/CON DEFORMACIÓN EN FRÍO		7088 / 1035	7085 / -
	RESISTENCIA A LA TRACCIÓN RECOCIDO / DEFORMACIÓN EN FRÍO	Rm (N/mm²)	520 - 720 / 540 - 750	540690 / -
	ELASTICIDAD RECOCIDO / CON DEFORMACIÓN EN FRÍO	Rp (N/mm²)	210 / 230	205410 / -
	ELONGACIÓN (A₅) MIN	(%)	≥ 45	
	RESILIENCIA KCUL / KVL	(J/cm²)	160 / 180	160 / 180
	ELASTICIDAD	RP(0.2) A 300C/400C/500C (N/mm²)	125 / 97 / 93	140 / 125 / 105
		RP(1) A 300C/400C/500C (N/mm²)	147 / 127 / 107	166 / 147 / 127
PROPIEDADES MECÁNICAS EN CALIENTE	LÍMITE DE FLUENCIA A 500C/600C/700C/800C	σ1/10⁵/t (N/mm²)	68 / 42 / 14.5 / 4.9	82 / 62 / 20 / 6.5
TRATAMIENT. TÉRMICOS	RECOCIDO COMPLETO		ENFR. RÁPIDO	ENFR. RÁPIDO
	RECOCIDO INDUSTRIAL	(OC)	10081120	10081120
	TEMPLADO		NO ES POSIBLE	NO ES POSIBLE
	INTERVALO DE FORJA INCIAL / FINAL	(C)	1200 / 925	1200 / 925
OTRAS PROPIEDADES	FORMACIÓN DE CASCARILLA, SERVICIO CONTINUO / SERVICIO INTERMITENTE		925 / 840	925 / 840
	SOLDABILIDAD		MUY BUENA	MUY BUENA
	MAQUINABILIDAD COMPARADO CON UN ACERO BESSEMER PARA a. B1112		45%	45%
	EMBUTICIÓN		MUY BUENA	BUENA

* Son aceptables tolerancias de un 1%

CONCLUSIONS

For the design of the lettuce centrifuge machine, special characteristics of size, shape and position were chosen. Considering that lettuces are leafless and placed in a mesh container for transport and washing, the machine was designed to maintain that principle.

The design of the machine is to place inside 3 of the boxes filled with lettuce that can be easily placed within the spaces of the structure.

Different calculations were made to determine a good transmission system that can favor the correct drying in the shortest possible time of 5 minutes per cycle.

The materials for the construction of the lettuce centrifuge are AISI 304 steel (see annex A) which have excellent corrosion resistance, ductility and shock resistance and are easily found on the market, allowing viability and is approved for the food industry.

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