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# Development and Manufacture of a Hand Ironer

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**Abstract:** The Calenders are made to be used as a sheet forming equipment and have the purpose and needs to supply some activities of industrial projects, as well as the manufacture of various equipments and products in which they need Curved or calendered plates.
With Intuit demonstrates a way to obtain a deformation in the material and accomplish the desired goals. For this to give an emphasis on this process of mechanical conformation and show how easy it is to get a simple plate calendering simply, only with a mechanical machine that assists in the calendering of them.

## I. INTRODUCTION

The Calenders are made to be used as a sheet forming equipment and have the purpose and needs to supply some activities of industrial projects, as well as the manufacture of various equipments and products in which they need Curved or calendered plates.

It is understood about folding as a plastic deformation of a material in the expansion of its flat area, characterized as a system in which there are some components: product, material (part), equipment used, environment of use, matrix used, Interference and deformation interface of the material. With this it obtains one of the most used types to obtain a curvature, both cylindrical and conical, using rolls called Calenders.

This project aims to improve the learning of students from the Faculty of Mechanical Engineering (FER). Given that colleges possess a large part of their subjects with more theories than practices. Having thus a greater use of matter and a broader understanding of the content learned. Because the members have an experience in the construction area, a technical course of mechanics, and with this it is easier to carry out the Calandra project. The project does not aim to solve scarcity in the combination of teachings, but to approach and be able to learn in the practical part what was learned in the classroom. Moreover, companies nowadays do not want an employee who only performs the basics. Thus being an employee but empowered to perform functions in various problems and if you need to even put into action by itself the action to execute what was requested.

## II. PROJECT DESCRIPTION

The project consists of a 3-roller calender, shown according to the drawing of the following figure (Figure 1), with the table (table1), in which this same design has components of various types, sizes, with various forms of fabrication composing thus, the project by in the end to enjoy all its characteristics determined by the project. In table (table 2) we have the prices and the quantity of materials in which we will use for the manufacture of the project.

**Figure 1 :Calenderdesign**

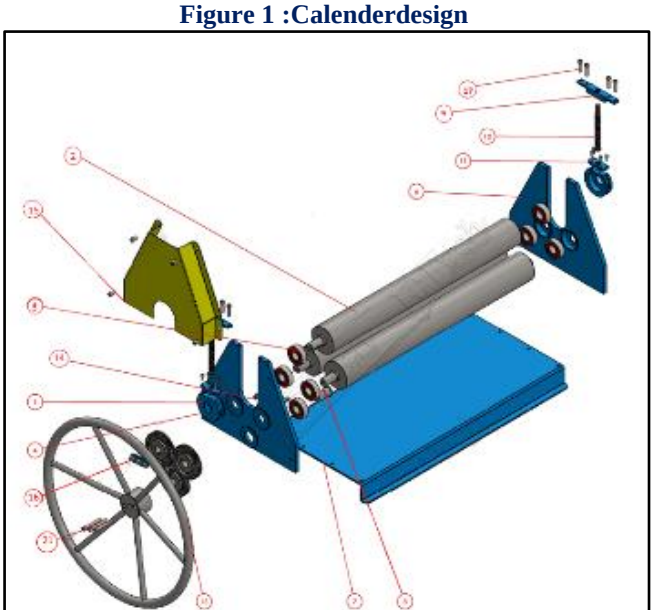


**Table 1 :Components of the calender**

| Nº DO ÍTEM | Nº DA PEÇA | QTD. |
|---|---|---|
| 1 | CCC-01 | 1 |
| 2 | CCC-02 | 3 |
| 3 | ROLAMENTO SKF 6204 20 47 14 | 7 |
| 4 | CCC-03 | 2 |
| 5 | Engrenagem 52D | 3 |
| 6 | CCC-04 | 1 |
| 7 | CCC-05 | 1 |
| 8 | CCC-06 | 1 |
| 9 | CCC-07 | 2 |
| 10 | CCC-08 | 2 |
| 11 | CCC-09 | 2 |
| 12 | Circlip DIN 471 - 17 x1.5 | 1 |
| 13 | CCC-10 | 1 |
| 14 | CCC-11 | 2 |
| 15 | CCC-12 | 1 |
| 16 | CCC-13 | 2 |
| 17 | 17 B18.3.1M - 6 x 1.0 x 25 Hex SHCS -- 25NHX | 8 |
| 18 | B18.3.1M - 6 x 1.0 x 12 Hex SHCS -- 12NHX | 6 |
| 19 | B18.3.1M - 4 x 0.7 x 10Hex SHCS -- 10NHX | 8 |
| 20 | B18.3.1M - 6 x 1.0 x 10Hex SHCS -- 10NHX | 4 |
| 21 | B18.3.1M - 6 x 1.0 x 50Hex SHCS -- 24NHX | 3 |

**Table2 :Values of the Calender fairings**

| Material | Unit price | Units | Total |
|---|---|---|---|
| 1045 of 75mm Round bar | $ 50,00 | 3 | $ 150,00 |
| 1/2 Flat Plate | $ 100,00 | 1000 x 1000 mm | $ 100,00 |
| 1/4 Flat Plate | $ 100,00 | 1000 x 1000 mm | $ 100,00 |
| 6004 Bearing | $ 10,00 | 7 | $ 70,00 |
| Gear | $ 50,00 | 3 | $ 150,00 |
| | | | $ 570,00 |

## III. METHODOLOGY

The best materials were chosen in which they have a better performance of the project, obtaining a result similar to that obtained in the design studies of the project, Ansys, where were used the standards of calendering and tools that could help in their Calculations in order to ensure perfect accuracy in the design.

For the construction of the project in 2D and 3D, we used CAD drawing software, such as Solidwork and CatiaV5, these softwares have several applications in which it has capabilities to design all parts of the structure of the project, allowing to replicate the same Dimensions of the drawing for the physical parts in its assembly.

It will also be used a structural analysis software by the finite element method, ANSYS, which has for its ability to analyze the most diverse cases of structures and engineering problems.

Chosen materials by type and price, initiate the physical construction of the project, in which enters the machining processes (turning and milling), welding (coated electrode), finishing (sander) and painting

## IV. METHODOLOGY OF THE PROCEDURE

For the construction of the calender, it became necessary to understand the whole functional part of the mechanical conformation, because it uses this principle, which is when changes in the structure of the material to another, pre-defined, guaranteeing its Very well controlled geometry and dimensions, using a mechanical stress application.

Knowing this, its processes can be seen between two groups such as:

**Metallurgical processes** – where their shape and modified through the temperature variation applied.

**Mechanical processes** – where its shape has a modification caused by the application of external forces.

Metallurgical processes have their characteristics divided into: solidification forming where its temperature and superior to the melting temperature of the material and the other in the final form by the liquid transformation – Solid.

The mechanical processes are constituted by the plastic conformation in which the stresses are generally applied inferior to the tensile strength and machining process. The final form and generated by the removal of the material, as the figure presents us below on mechanical conformation:

In practice the calenderoccurs some mechanical phenomena that must be learned beforehand so that at the time of its construction can recognize them being:

**Folding**

We understand about folding as a plastic deformation of a material in the expansion of its flat area. The folding is characterized as a system in which they have some components: product, material (part), equipment used, environment of use, matrix used, interface of interference and deformation of the material. With this we have one of the most used types to obtain a cylindrical bend as conical using rolls called Calendrers.

This process can be performed manually or with machines. When using the manual process, you use tools, jigs or very basic (simple) machines for the operation. The use of the machines in this process and very common in materials of large thicknesses. These machines are called benders, their choice depends on the type of operation and the need for production.

This process can be accomplished in two main ways:

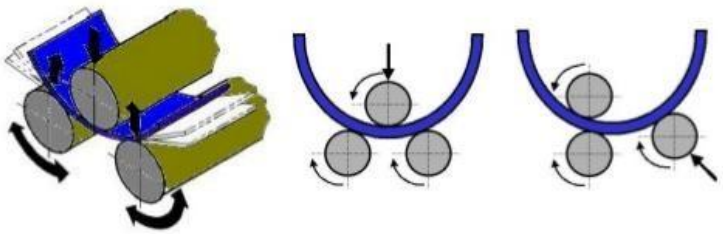
• Hot – A temperature above the temperature of the material is used. Its advantage is that it can be used in materials with larger thicknesses and with larger rays. But at a higher cost and a slower process.

• Cold – A temperature below the temperature of the material is used. The advantage of using this type of process and for providing a better finish, higher productivity of parts, with a variation of the most controlled material. But it requires a greater effort of the equipment used.

**Bending**
The bending of metals (plates and profiles) and a forming process in which its cylindrical or oval shape, total or partial, of a material (plate or bar). This process and performed by bending forces using manual machines or tools, can be performed either hot or cold.

**Calenders**
The calenders in usually are built with 3 or 4 rolls. In the industries and more common the use of the 3-roller calender, shown in figure (Figure 3). Those of 4 rolls, have a pre-bending work facility, this pre-bending is done manually when using 3-roller calenders.

**Figure2 :**Schematic layout of a 3-roller calender



**Calendering process**

$$\left[(R_i + h) + \frac{d_i}{2}\right] \sin\frac{\alpha}{2} = \frac{\mathrm{a}}{2}(R_i + h)\sin\frac{\alpha}{2} = \frac{\mathrm{v}}{2}$$

$$\mathrm{v} = \frac{R_e}{R_e + {}^{d_i}/_2}\mathrm{a}$$

$$\mathrm{p}_c = -\left(\mathrm{A} - \frac{d_i}{2} - R_e\right) = R_e + \frac{d_i}{2} - \left(\frac{\mathrm{a}}{2}\frac{1}{\tan({}^{\alpha}/_2)}\right)$$

$$\mathrm{p}_c = \left(R_e + \frac{d_i}{2}\right)\left(1 - \cos\frac{\alpha}{2}\right)$$

**Maximum deformation of a calendering.**

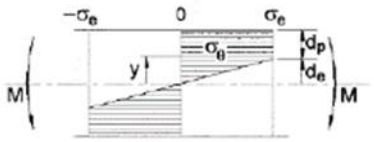
$$(\mathrm{e}_\theta)_{\max} = \frac{\mathrm{h}}{2\mathrm{R_e}}\left(1 - \frac{\mathrm{R_e}}{\mathrm{R_o}}\right)$$

(Ro) Initial radius of curvature,
(Re) Radius of final curvature.

**Calendering**

$$F = \frac{\sigma_e b h^2}{\mathrm{v}} - \frac{4}{3\mathrm{v}}\frac{R_e^2}{E^2}\, b\sigma_e^3$$

**Figure3 :**Maximum deformation of a calendering




$$F = \frac{\sigma_e b h^2}{\mathrm{v}}$$

Compensating for approximations,

$$F = \frac{0.7\sigma_R b h^2}{\mathrm{v}}$$

**Figure4 :**Compensating for approximations

Tangential load voltages in a calendering where Re < 100h

**Calendering Power:**

$$F = \frac{0.7\sigma_R b h^2}{\mathrm{v}}$$

**Figure5 :** Tangential load voltages

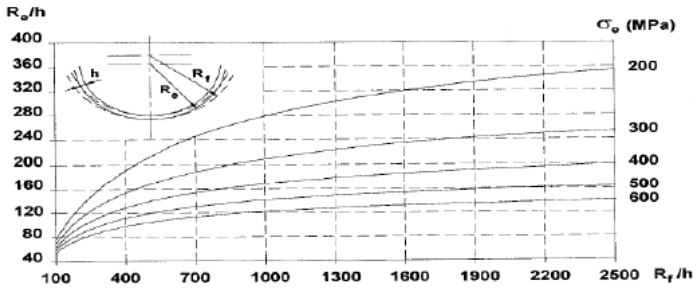
VR is the peripheral velocity of the motor rollers (3 to 7 m/min in Coldcalendering) and (a) is the coefficient of friction (plate/roll).

$$P = F\mathrm{v}_R = \frac{R_e - \frac{1}{2}\sqrt{4R_e^2 - \mathrm{v}^2}}{\mathrm{v}}$$

**Plastic recovery**

And shown in the table (Table 3) is a curve of the plastic recovery in which material can behave, within its elastic boundary.

**Table3 :** Behavior Chart of a material




**Calendering reaction**

Relationship between the calendering radius (Re) and the end of the plate, (RF), for various values of tensile strength limit of the material, considering the module of Young, E = 210.0 Mpa.

$$R_e = \frac{R_f}{1 + 3\frac{R_f}{h}\frac{\sigma_e}{E}} R_e < 100\ h$$

**Calendering steps:**
Conditions under which (RF0) is the initial radius of the calendering plate for a passage.

$$\frac{4\square}{\mathrm{v}} = \left(\frac{1}{R_e} - \frac{1}{R_{t_0}}\right)$$

The most common types are the step calender and the pyramidal calender.
• Step Calender – Aligns the gap between the rollers adjusting for certain thicknesses in which to use for the different diameter. This type of calender is used for a large production of parts and of different diameters same figure (Figure 6).

**Figure6:**Schematic layout of a 3-roller calender

Pyramidal Calender – Adjusts the upper roller to achieve higher or lower pressure, producing parts of larger or smaller diameters, according to the producer's need. It has its maximum diameter limited by the stability of the workpiece being folded

## V. CONCLUSION

With the elaboration of this project, we can conclude that there are many ways to obtain a deformation in the material and accomplish the desired objectives. That is why we decided to emphasize this process of mechanical conformation and show how and easy to obtain a simple plate calendering, only with a mechanical machine that assists in their calendering.

So with the formularies already standardized for this process, it is easier to calculate the effort that the material and the machine need to perform a job in a correct way, obtaining a perfect calendering, as calculated.

This project has several construction projects where we learned several processes that have led us to successful completion and in which we can demonstrate in the practical (physical) how this process works. Calenders are one of the best ways to achieve the calendering of plates of certain thicknesses.

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