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Presentation of content

In the first article we present, *Design of a chamber for the characterization of gas sensors in dynamic flow*, by CASTAÑEDA-LARA, Omar, ROJAS-GARNICA, Juan Carlos, MUÑOZ-MATA, José Lorenzo and ESPINOSA-MARTÍNEZ, Marcos, with adscription in the Universidad Tecnológica de Puebla, Puebla; in the next article we present, *Design and construction of a knife sharpening machine*, by PÉREZ-VILLEGAS, Manuel, TENORIO-CRUZ, Fermín, TÉLLEZ-HERNÁNDEZ, Rubén and RODRÍGUEZ-ZEPEDA, José Donato, with adscription in the Universidad Tecnológica de Tecamachalco; in the next article we present, *Elaboration of germinable bioplastic based on corn olot*, by MORENO-RODRIGUEZ, Bertha María, RODRIGUEZ-DE LA CRUZ, Sofia Alejandra, LOYA-, ESCALANTE, María Teresa and DARÍO-RAMOS, Jazmín Elizabeth, with adscription in the Tecnológico Nacional de México / ITS de Poza Rica; in the final article we present, *Feasibility and viability analysis in railway system projects*, by GARCIA-CASTILLO, Rodrigo, CRUZ-GÓMEZ, Marco Antonio, LARA-ANDRADE, María Verónica Altagracia and MEJÍA-PÉREZ, José Alfredo, with adscription in the Benemérita Universidad Autónoma de Puebla.

Content

Article **Journal of Technology and Innovation**

June 2023, Vol.10 No.26 1-6

Design of a chamber for the characterization of gas sensors in dynamic flow

Diseño de una cámara para la caracterización de sensores de gas en flujo dinámico

CASTAÑEDA-LARA, Omar, ROJAS-GARNICA, Juan Carlos, MUÑOZ-MATA, José Lorenzo and ESPINOSA-MARTÍNEZ, Marcos

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Abstract

In the present work, the description of a design is presented, as a proposal, for the evaluation or characterization of gas sensors. The proposed design allows the introduction of gas into a chamber at one end and its exhaust at the other, so that a flow of this is generated during the evaluation of the sensors. The gas to be evaluated in the first instance is ethanol. On the other hand, the use of peltiers was contemplated to heat the chamber at different temperatures, with a series of heatsinks and fans for its regulation, for which the use of a temperature sensor and a humidity sensor were incorporated. In total, eight gas sensors manufactured specifically with QCM crystals and an ethyl-cellulose film are contemplated. So, also, the corresponding electronic circuit is shown. Finally, the results of the simulation, in Abaqus, of the temperature distribution inside the chamber for a certain value in the peltiers and the variation of the gas flow along the duct inside the chamber are shown.

Gas, Dynamic flow, Sensors, Design, Peltiers

Resumen

En el presente trabajo se presenta la descripción de un diseño, como propuesta, para la evaluación o caracterización de sensores de gas. El diseño propuesto permite la introducción del gas a una cámara por un extremo y su escape por el otro, por lo que se genera un flujo de este durante la evaluación de los sensores. El gas a evaluar en primera instancia es el etanol. Por otro lado, se contempló el uso de peltiers para el calentamiento de la cámara a diferentes temperaturas, con una serie de disipadores y ventiladores para su regulación, por lo cual se incorporó el uso de un sensor de temperatura y otro de humedad. En total se tienen contemplados ocho sensores de gas fabricados exprofeso con cristales QCM y una película de etil-celulosa. Por lo que, también, se muestra el circuito electrónico correspondiente. Finalmente, se muestran los resultados de la simulación, en Abaqus, de la distribución de temperatura dentro de la cámara para un determinado valor en los peltiers y la variación del flujo del gas a lo largo del conducto dentro de la cámara.

Gas, Flujo dinámico, Sensores, Diseño, Peltiers

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Introduction

During the history of humanity, we have faced great changes and within those changes is the use of several gases, which are very useful in different industrial sectors. However, their management must be adequate, since many are toxic and flammable, so there is interest in having detection mechanisms for the different types of gases to react on time in case of leaks or gas excess in a closed space, due to this necessity arise the term of Electronic Nose.

Electronic noses can be defined (Busto O., 2002) as an instrument equipped with chemical sensors and a chemometric pattern recognition program that is capable to recognize and compare individual or complex odors of substances.

In this work, the information that is intended to obtain with this instrument is both quantitative and qualitative, or, in other words, its objective is to analyze and recognize the olfactory traces of ethanol gas, assessing the volatile compounds of the sample as a whole to analyze or classify, thus imitating the human olfactory system.

The quantitative composition of the aroma can be performed using instrumental analysis techniques such as gas chromatography (GC), particularly the one in which the instrumental detection is performed in parallel with an olfactometer that allows determining the odor of each compound. Another investigation (Biedman et al., 2004) consisted of taking a sample of 32 cheeses, where two variables are presented, the state of maturation and the maturation temperature, with Tin Oxide sensors and Figaro Sensors, these have great amplitude. of designs and compounds that are used for different applications. On the other hand, in a study (Osorio-Arrieta et al., 2018) the use of QCM sensors coated with an ethyl cellulose sensor film was introduced to detect ethanol, a volatile organic compound that is frequently found in beverages or flavors and that is suitable for conducting this type of study due to its low toxicity. The operating principle of the QCM gas sensor is based on the interaction of gas molecules with the detection film deposited on the electrodes of the gas sensor. When the mass attached on the sensing film increases, the resonance frequency decreases due to the mass charge effect.

There are several techniques used to make these sensors, however, something important to analyze the response of these sensors are the different devices using measurement chamber, which are responsible for housing the gas that will be introduced into it, the sensors that will generate the detection of the sampling inside it and in strategic places.

It is similar for the case of the research performed in the sampling of cheeses (Biedman et al., 2004) in which a measurement chamber with semiconductor chemical sensors is also used, for the analysis of the Tin Oxide sensors, with controlled temperatures.

Currently there are chambers that have the capacity sense gases in a static system, as is the case of (Arenas L. N., 2015), who made a closed static chamber design, in order to evaluate the emissions of greenhouse gas flows. greenhouse in soils from the International Center for Tropical Agriculture (CIAT), obtained from different closed static chamber designs, using two sampling methodologies (Conventional and Gas Pooling). Another chamber, with a Dynamic design, was developed in studies by (Cueva-Rodríguez et al., 2004) for a soil respiration measurement system with closed dynamic chambers. Another chamber, with a Dynamic design, was developed in studies by (Cueva-Rodríguez et al., 2004) for a soil respiration measurement system with closed dynamic chambers. This leads us to understand that the generation of sensors for the detection of gases in the industry, establishments or houses is of the utmost importance, and the test methods that are performed on the elaborated sensors are by the use of measurement chambers in a static system or chambers using a dynamic flow, for this reason the Design of a Chamber for the Characterization of Gas Sensors in Dynamic Flow, with controlled temperature, is proposed.

Basic design conditions

The development and use of gas detector sensor arrays (commonly called "Electronic Noses" EN), has gained great importance in the field of scientific research due to the need to detect, recognize and discriminate gases or complex mixtures in the environment. This particular area is of great interest due to the enormous variety of gas sensors and the great diversity of materials that can be used as sensitive film.

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Likewise, there is a wide range of applications for detection, recognition and discrimination systems, such as air quality monitoring, quality control in the food and beverage industry, cosmetology, biotechnology, etc.

QCM sensors, which will be exposed to ethanol samples, have a radius of 4.3 mm as we can see in figure number 1, will be covered with a sensing film on their surface that will react at different frequencies depending on the thickness of the film and/or the concentrated quantity of the gas within the controlled environment since these crystals are considered as piezoelectric sensors giving different response frequencies. The sensor dimension was taken as the basis for the creation of the conduit through which the ethanol will be applied, that is, the conductive channel must guarantee not only the gas flow, but also contain 8 QCM sensors with total hermeticity between the gas inlet and their respective output.

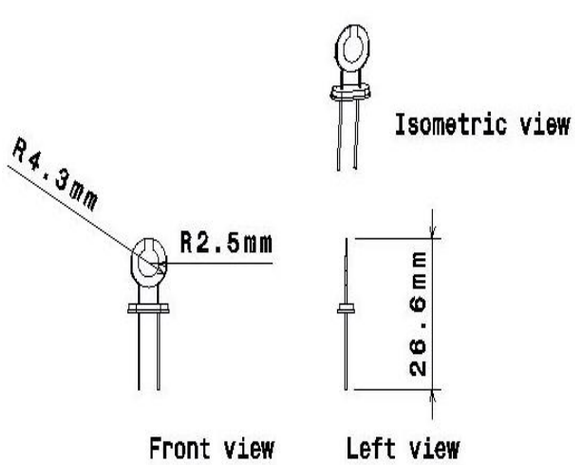

Figure 1 QCM gas sensor dimensions
Source: Own elaboration

The response frequencies are sent from the crystal thanks to the administered sample, since the principle of adsorption of the molecules of the sensing film.

Ethanol is a simple hydrocarbon, with a colorless and odorless gas nature that has a highly valuable and diversified use in the synthesis of ethylene. It occurs in nature as an odorless and colorless gas at standard pressures and temperatures (1 atm and 25°C).

Furthermore, is not affected by the exposure to acids or strong bases, ethanol's solubility is considerably low, increasing slightly when system pressure is raised. With a decrement in temperature beyond -183.2° C, its structure becomes monoclinic, increasing the stability of its molecule. The density of Ethanol is 0.789 g/cm^3, its melting point is -114°C, its boiling point is 78.4 °C.

To evaluate the presence of ethanol at different temperatures, the generation of heat in the chamber through electrical components called Peltier Cells, with a size of 5 by 5 cm, will be considered.

The innocuousness of the system must be guaranteed, therefore, materials that do not contaminate the samples must be chosen.

In this work, the challenge for the optimization of a system based on electronic nose is assumed, through a Dynamic Flow chamber that will contain the sensors and an ethanol flow will be injected.

In addition, with the developing of this design, it will be possible to have a piece of equipment that could be helpful in the performance tests of new sensors that can detect different types of gases and thus be able to distinguish the odors that have been registered in a series of samples.

This system and its components will perform the analysis of the gas sample that will be injected to generate a dynamic flow, this sample will flood through the entire volume of the chamber designed to contain the gas sensors hermetically at a constant temperature, the sensors will be placed at equal distances and, thus, the sample will be taken in the system.

Once the chamber was designed, a series of computations with finite elements is carried out to verify the temperature distribution of the chamber and the gas flow in it.

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Operative description of the design proposal

In order to perform the chamber design (Figure 2), there is in the first instance the sealing plate, which will help to maintain hermeticity, it is manufactured using Teflon, which helps to prevent contamination of the samples, and by At the same time, it contains eight QCM sensors placed linearly and at equal distances between them.

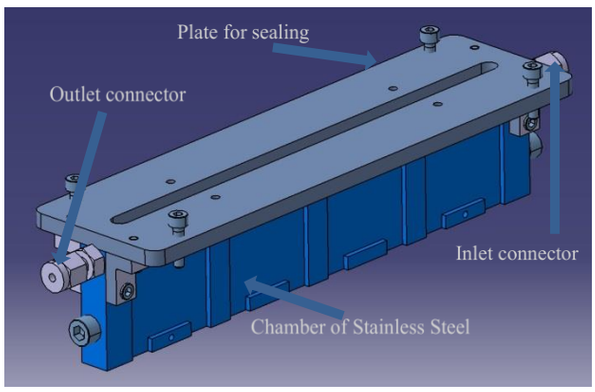

Figure 2 Stainless Steel Chamber, Seal Plate and Connectors
Source: Own

Below the Chamber cap, where the gas flow occurs inside. The Peltier cells (Figure 3) will be placed between this Chamber made of stainless steel, next to these, some aluminum heatsinks, four on one side and four on the other, in order to help regulate the temperature. Moreover, eight fans are added, one for each Peltier, which will serve as extractors on the heatsinks.

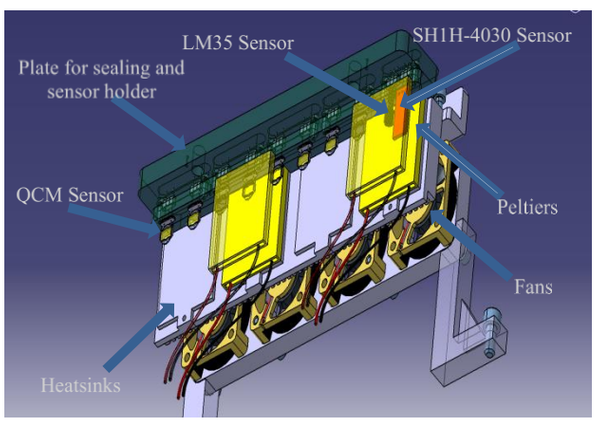

Figure 3 Components inside and out of the measurement chambe
Source: Own elaboration

The conical connectors for the gas inlet and outlet are screwed to both ends of the chamber. Specifically, the LM35 temperature sensor and the SH1H-4030 humidity sensor (Figures 3 and 4) are placed at the gas inlet. These sensors are fundamental devices for the correct operation of the equipment, with the aim of monitoring and thus regulate the temperature, and monitoring the internal humidity inside the chamber.

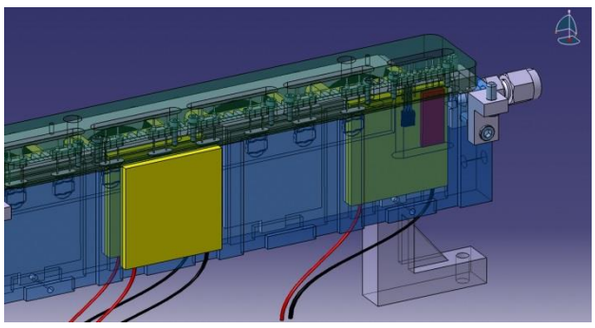

Figure 4 End with the inlet connector, followed by the temperature and humidity sensors
Source: Own elaboration

As previously mentioned, part of being able to estimate of the behavior of the measurement chamber, two simulations are performed, one of the temperature and another of the velocity of the gas, both inside the chamber, thus, the characteristics of the gas are set in the Simulia (Abaqus) CFD simulator, selecting only the basic elements of the chamber, the gas inlet and outlet, the hermeticity of the chamber and the heat sources of each of the Peltier cells.

In the first instance, the temperature distribution of the Stainless-Steel chamber is shown as shown in (Figure 5).

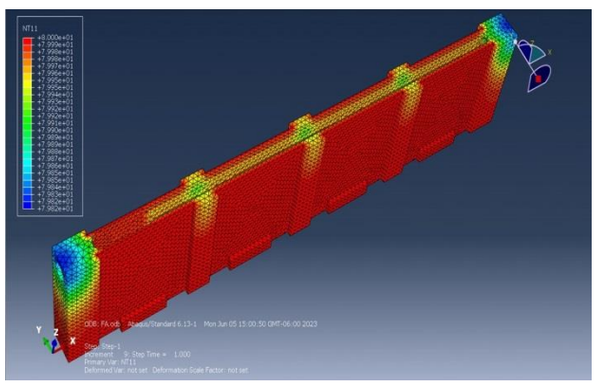

Figure 5 Temperature distribution of the measurement chamber
Source: Own elaboration

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Subsequently, the simulation of the velocity of the gas inside the measurement chamber performed as shown in Figure 6, setting the characteristics of the gas (Ethanol).

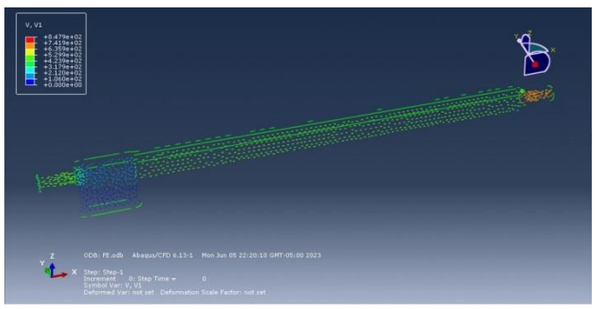

Figure 6 Abaqus simulation of the velocity of the gas inside the measurement chamber
Source: Own elaboration

With the development of these simulations, we realize that the design of the chamber is feasible since the temperature in the center of the measurement chamber remains uniform at an approximately constant temperature, the velocity of the gas stops once the injection begins due to the greater volume in the cavity for the sensors of temperature and humidity. However, it tends to stabilize such velocity maintaining a similar speed in each of the points where the QCM sensors are located until finding the exit of the chamber.

For the electronic configuration of the chamber, the power and control of the 8 QCM sensors, a LM35 temperature sensor, a SH1H-4030 humidity sensor and the TEC112710 cv-005 Peltier Cells are required, nominal voltage 12VDC, Qmáx 89W.

The functional operation of the circuit with a single Peltier Cell is described as follows (Figure 7): first the microcontroller sends a PWM signal (to control the power if Peltier Cells that will be paced on the sides of the stainless-steel chamber) the PWM signal travels through a transistor (VF547) to amplify the current, this signal passes to the Optocoupler (4N26) in order to isolate the power electronics from the microcontroller, Moreover, the microcontroller sends the polarity signals to the drivers (H bridge) to energize the Peltier plates. It is very important to recognize the polarity, because it determines if the measurement chamber is cooling or heating.

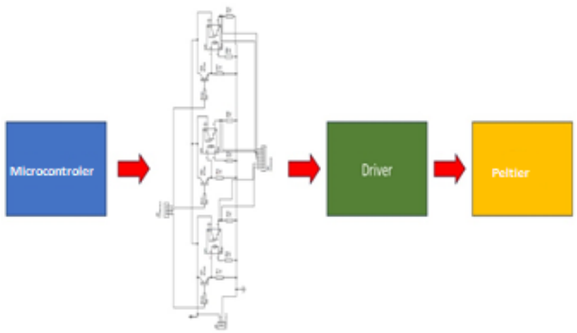

Figure 7 Block Diagram of the circuit connections
Source: Own elaboratrion

The development of this design will be a tool to contribute to the continuous development of chambers for gas detection of QCM sensors for different volatile organic compounds. This system is a prototype that allows the creation of necessary procedures that maximize the time necessary for leak detection. in closed room or continuous ventilation systems.

Conclusions

There is a complete design with a well-defined set of elements for its manufacture. Based on the aforementioned results obtained, future work will be the manufacture of the described proposal and the establishment of physical tests to perform the required adjustments and calibrations, in order to obtain the correct readings from the QCM sensors in the monitoring. of ethanol gas and other gases.

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References

Arenas L. N. (2015). *Diseño de cámara estática cerrada y medición de flujos de gases de efecto invernadero (GEI) en suelos*. Tesis. Universidad Nacional de Colombia. https://repositorio.unal.edu.co/handle/unal/56229

Biedman Perellón Óscar. (2004). *Diseño y Realización de una Nariz Electrónica para la Maduración de Quesos*. Tesis. Departamento de Enginyeria Electronic, Electrica i Automatica, Universitat Rovira i Virgili. http://deeea.urv.cat/public/PROPOSTES/pub/pdf/620pub.pdf

Busto Olga. (2002). *La nariz electrónica: una nueva herramienta para analizar el aroma*. Revista de enología científica y profesional. Dossier Enología Sensorial II. https://www.acenologia.com/ciencia60_2/

Correa Hernando E. C., Ortiz C., Ruiz-Altisent M., Robla Villalba J. I., Rodríguez, J. (2005). Establecimiento de las curvas de respuesta de una nariz electrónica QCM a distintas concentraciones de compuestos químicos conocidos. "AgroIngeniería 2005", 21 a 24 septiembre de 2005, León. ISBN 84-9773-208-1. https://oa.upm.es/9953/

Cueva-Rodríguez A., Yépez Enrico A., Garatuza-Payán J., Watts Christopher J., Rodríguez Julio C. (2012). *Diseño y uso de un Sistema Portátil para Medir la Respiración de Suelo en Ecosistemas*. Tierra Latinoamericana No. 30, Vol. 4. Pp. 327-336. <http://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S0187-57792012000400327&lng=es&nrm=iso>. ISSN 2395-8030.

Muñoz-Aguirre S., Yoshino A., Nakamoto T., Moriizumi T. (2003). *Odor approximation of fruit flavors using a QCM odor sensing system*. Sensors and Actuators B: Chemical, Volume 123, Issue 2. Pp. 1101-1106. https://doi.org/10.1109/SENSOR.2003.1217028

Muñoz-Mata J. L., Muñoz-Aguirre S., González-Santos H., Beltrán-Pérez G., Castillo-Mixcóatl J. (2012). *Development and implementation of a system to measure the response of quartz crystal resonator based gas sensors using a field-programmable gate array*. Measurement Science and Technology, Volume 23, Number 5. DOI 10.1088/0957-0233/23/5/055104.

Nagle H.T., Gutiérrez-Osuna R., Schiffman S. S. (1998). *The how and why of electronic noses*. IEEE Spectrum (Volume: 35, Issue: 9). Pp. 22-31. https://doi.org/10.1109/6.715180

Osorio-Arrieta D. L., Muñoz-Mata J. L., Beltrán-Pérez G., Castillo-Mixcóat J., Mendoza-Barrera C. O., Altuzar-Aguilar V., Muñoz-Aguirre S. (2018). *Reduction of the Measurement Time by the Prediction of the Steady-State Response for Quartz Crystal Microbalance Gas Sensors*. Sensors, 18(8), 2475; https://doi.org/10.3390/s18082475.

Rayment M. B. (2000). *Closed chamber systems underestimate soil CO_2 efflux*. Eur. J. Soil Sci. 51: 107-110. https://doi.org/10.1046/j.1365-2389.2000.00283.x

Rayment M. B., P. G. Jarvis. (1997). *An improved open chamber system for measuring CO_2 effluxes in the field*. J. Geophys. Res. 102: 28779-28784. https://doi.org/10.1029/97JD01103

Rosales Hernández, Cruz Teresa y Reyes Galaviz, Orión Fausto. (2016). *Clasificación de Datos de Olor de Café provenientes de una Nariz Electrónica Utilizando Redes Neuronales*. Researchgate.net. Pp. 2-7. https://www.researchgate.net/publication/228513703_Clasificacion_de_Datos_de_Olor_de_Cafe_provenientes_de_una_Nariz_Electronica_Utilizando_Redes_Neuronales

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Design and construction of a knife sharpening machine

Diseño y construcción de máquina afiladora de cuchillas

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Abstract

The objective of this project was to design and build a blade sharpening machine for bagging and sleeve machines from the Excel Nobleza company, with a capacity of up to 66 cm, to reduce the costs of the blade sharpening service and also eliminate shipping costs. First, an investigation on sharpeners and sharpening methods was carried out, then mechanical, structural and electrical calculations were carried out. The design of the machine depended absolutely on the materials obtained during the process of searching for materials within the company, adjusting them to the proposed calculation and design. Subsequently, the assembly of the machine, the assembly and programming of the electrical and electronic components, as well as the functional tests, were carried out. The design and manufacture of the sharpening machine was successfully completed, optimizing the sharpening process and saving monetary resources. The machine was manufactured with parts that the company already had in stock or were machined with existing resources, consequently, the investment was zero or minimal.

Capacity, Functional, Optimizing

Resumen

El objetivo del presente proyecto fue diseñar y construir una máquina afiladora de cuchillas para máquinas de bolseo y mangas de la empresa Excel Nobleza, con capacidad de hasta 66 cm, para reducir los costos del servicio de afilado de cuchillas y además eliminar los costos por envío. Primero se realizó una investigación sobre afiladores y métodos de afilado, después se realizaron los cálculos mecánicos, estructurales y eléctricos. El diseño de la máquina dependió absolutamente de los materiales obtenidos durante el proceso de la búsqueda de materiales dentro de la empresa, ajustándolos al cálculo y diseño propuestos. Posteriormente se realizó el ensamble de la máquina, el montaje y programación de los componentes eléctricos y electrónicos, así como las pruebas de funcionamiento. Se culminó con éxito el diseño y fabricación de la máquina afiladora, optimizando el proceso de afilado y ahorrando recursos monetarios. La máquina se fabricó con partes que ya tenía la empresa en existencia o se maquinaron con recursos existentes, en consecuencia, la inversión fue nula o mínima.

Capacidad, Funcional, Optimizando

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Introduction

This project was developed at the company Excel Nobleza, dedicated to the co-extrusion of plastic films and their conversion into labels, bags and printed and laminated wrappers of the highest quality. It has various machines such as flexographic presses, laminators, coaters, sealers, formers and cutters, among others, to provide comprehensive solutions in printing and flexible packaging.

Figure 1 Example of Excel Nobleza machines
Source: EXCEL NOBLEZA. (s. f.). media.cylex.mx. https://media.cylex.mx/companies/1123/7678/uploadedfiles/11237678_635101146670756514_EXCEL_NOBLEZA.pdf

Inside the Bolseo y Mangas line there was a problem regarding the blades that the machines need to carry out their daily activities. The problem mainly consisted in the fact that it was necessary to acquire the specialized services of an external company to sharpen the blades, also said company is located in the State of Mexico. Consequently, in addition to acquiring an expense for the service of sharpening the blades, it was necessary to pay an extra cost for the services of sending said material. The monthly cost for sharpening was 10,000 pesos and for transportation 1,500 pesos, giving a total of 11,500 each month, which gave an annual cost of 138,000 pesos.

That is why the workers of the maintenance department, in collaboration with the machine and tool shop of the plant, as well as the intern Efrén Hernández Rosas, who developed this project together with his adviser from the Technological University of Tecamachalco, M.C. Manuel Pérez Villegas, the decision was made to work on the project for the design and manufacture of a blade sharpening machine, a machine that will be delivered to the maintenance department, with the aim that they themselves would be able to carry out this blade maintenance process. and later, avoid unnecessary expenses for the acquisition of an external service and transport.

The main challenge of this project was to manufacture a functional machine from existing material in the machine and tool workshop, in addition to the company's warehouse. With this project, the company Excel Nobleza SAPI de C.V. will be able to implement the knife sharpening process. This project will equip the company with a machine with a minimum monetary cost, and most importantly, it will completely or largely eliminate the costs for the acquisition of the sharpening service and the transport of blades, thus contributing to growth and company success.

General objective

Design and manufacture a blade sharpening machine for bagging and sleeve machines from the company Excel Nobleza, with a capacity of up to 66 cm.

Specific objectives

- Reduce knife sharpening service costs, plus eliminate shipping costs.
- Enable the maintenance department of a specialized machine to carry out corrective maintenance tasks on the blades.
- Reuse existing equipment in the warehouse and optimize it to carry out the construction of the machine.

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Theoretical framework

According to Shigley, J. E., et al (2019), designing is formulating a plan to satisfy a specific need or solve a problem. If the plan results in the creation of something physically real, then the product must be functional, safe, reliable, competitive, useful, manufacturable, and marketable. Design is also a decision-making process, which must be made with very little information, or with just the right amount and sometimes with an excess of partially contradictory information. Sometimes decisions are made on a tentative basis, so reserve the right to make adjustments as more data becomes available. What is important is that the designer must be personally comfortable in exercising the decision-making and problem-solving function in order to achieve the goal of designing and subsequently building the required equipment.

Within an industrial plant there are a number of different needs to cover, many of these needs can be covered through the services of the different departments that the company has, for example, maintenance services for machinery and facilities, others without However, they require the hiring of an external provider, (electricity, gas and drinking water services, for example), but there are certain activities that only companies specialized in the subject can grant, (automation of certain lines, transport of dangerous substances, etc.) one of these services is the sharpening of knives.

General information on cutting blades

Blades are single-edged cutting tools. The typical shape of a cutting blade comprises three main faces (see Figure 2); the front face of the blade is called a mirror; the opposite side is called the spine; the skewed face of the blade is called the bevel. The edge or edge that forms the bevel and the mirror is the edge (Hernández Hernández, et al, 2017).

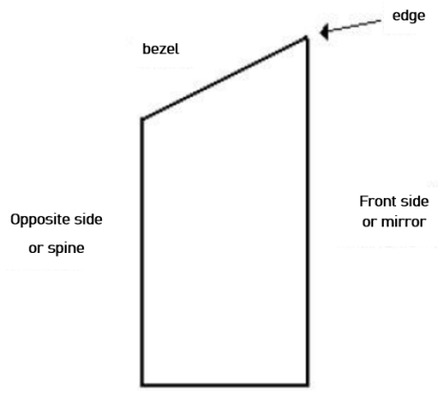

Figure 2 Typical profile of a cutting blade
Source: Hernández Hernández, et al (2017), pp. 6.

The characteristics that a cutting blade must have to achieve the longest useful edge life are a combination of wear resistance and toughness, characteristics that the material from which they are made must have.

Sharpener definition

The main function of sharpening machines, also called grinding machines, is to create or rectify the cutting surface of instruments or elements used in the cutting operation (Claudio Guerrero, 2013). It is a machine tool, used to carry out abrasion machining, with high dimensional precision and a high surface finish, that is, with lower roughness than in chip removal machining. Commonly one of these artifacts is made up of one or several emery stones (also called emery wheels) mounted on a rotating shaft or shaft that rotates at considerable speed, commonly supported on a table that allows the user to comfortably maneuver the shape. of the sharp

The parts that are ground are mainly steel hardened by heat treatment. For this reason it is very important to control the speed of rotation of the grinding wheel and the feed, to avoid damaging the blade. Manufacturers' tables or specialized machine tool manuals indicate the proper turning speed and feed.

Blade sharpening

The mission of sharpening machines is to create for the first time, or to regenerate the cutting edges of a tool. The tool used in sharpening is called a grinding wheel and the operation that is carried out with the sharpener is called sharpening (Claudio Guerrero, 2013).

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Sharpening is always done on the bevel side, with a fine-grained grinding wheel, with the three main movements shown in figure 2.

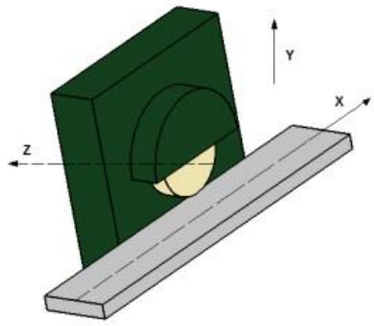

Figure 3 Main movements of the sharpening machine
Source: Claudio Guerrero, 2013, pp.7

- **Z axis of cutting movement:** This axis has the cutting power and the abrasive wheel is mounted on it.
- **X axis of feed movement**: This axis is horizontal and parallel to the clamping surface of the part. It is perpendicular to the Z axis.
- **Y axis of penetration movement**: This axis is vertical, perpendicular to the X axis and provides the movement of approach or penetration of the grinding wheel in the piece, until reaching the required dimension or until obtaining the necessary edge.

Tangential speed of the grinding wheel

It is the speed of the points of the piece that are in contact with the tool, it is measured in m/s, and it is represented by the following formula:

$$Vc = \frac{\pi * d * n}{1000} \quad (1)$$

Where:

Vc = Cutting speed (m/s).

d = Diameter of the tool (mm).

n = Rotational speed (rpm).

Type of grinding wheel	Vitrified and silicate binder Hardness			Synthetic resin and rubber binder Hardness		
	Soft	Half	Hard	Soft	Half	Hard
Disc	25	30	33	33	40	60
Annular, cup, conical	23	25	28	25	30	40
Disc for cutting					50	60
Special disc for cutting						60-80

Table 1 Tangential speed of the grinding wheels in m/seg
Source: ROSSI, MARIO; Máquinas-Herramientas Modernas, editorial Hopeli, Barcelona, 1971; pág. 1004

Longitudinal feed rate

In the sharpening of flat knives, the term longitudinal feed refers to the path in millimeters, according to which the tool or the piece moves relative to each other, this feed rate is indicated in millimeters per minute.

According to Bohórquez Suárez, G. R. (2011), the speed of the grinding wheel, the longitudinal and transversal feed speed, are values that depend on the following factors: quality of the material to be sharpened, surface condition, dimensions, degree of finish required, quality of the abrasive and its grain, quality of the binder and lubrication.

Material	Type of work	Type of grinding wheel		
		Of cup	Of segments	Tangential
Mild steel	Roughing	8--10	10--12	10 a 15
	Finishing	1--8	6--10	6 a 10
Tool steel	roughing	8--12	10--14	10 a 15
	Finishing	1--8	6--10	6 a 10
Foundry	roughing	8--0	10--12	10 a 15
	Finishing	1--8	6--10	6 a 10
light metals	roughing	…	….	20 a 30
	Finishing	….	….	10 a 20
Copper and alloys	roughing	…	….	15 a 20
	Finishing	….	…….	10 a 15

Table 2 Feed rate in m/min in flat grinding
Source: http://www.produccion.cps.unizar.es/info/tec_fab/.../mec%20abrasivos.pps

Methodology for the design of the machine

The design of the machine (the sharpener) absolutely depended on the materials obtained during the process of searching for materials within the company, with the aim of not acquiring external elements. In other words, this machine will not have an extra cost for the company, only labor in the design, research, machining, adaptation, optimization and assembly of the sharpener components.

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The methodology followed for the development of the project was the following:

- Research on sharpeners and sharpening methods.
- Manual sharpener design and approval.
- Software design of the sharpener.
- Mechanical, structural, and electrical calculations.
- Search for the mechanical and structural components of the sharpener.
- Table assembly by welding with 6013 coated electrode.
- Assembly and programming of electrical and electronic components, as well as functional tests.
- Final delivery of the project in the company.

Manual and computerized design

Once the project was approved in the company, the activities were planned and different designs were made, thinking about the possibilities of obtaining the materials. Initially, a fully automated machine model was proposed, which would include stepper motors, CNC machine spindles and guide axes, similar to the Metal Blade Sharpening Machine, developed by Sierra Garriga, C. (2022). However, the design had to be changed considering that only parts existing in the company would be used and those that would be manufactured would be made with the machine tools available in the plant and the experience of the workers.

According to the bibliographical research carried out, a great variety of sharpening machines were found on the market, among which there were some differences, from the position of the motor or sharpening head to the way of advancement, both of the head and of the blade (moving only the sharpening head in some cases while in other cases what moved was the blade) and the advance being both manual and automatic, using in some cases only guides and in others, a combination of spindle, guide axes and endless screw.

Finally, based on all the information collected, an own design was developed and presented to the project coordinator, the head of the maintenance area and the master turners, who after analyzing the initial proposal (figure 4) suggested changes in the design. , according to the materials that were available in the warehouse, the necessary machining operations and the sharpening needs.

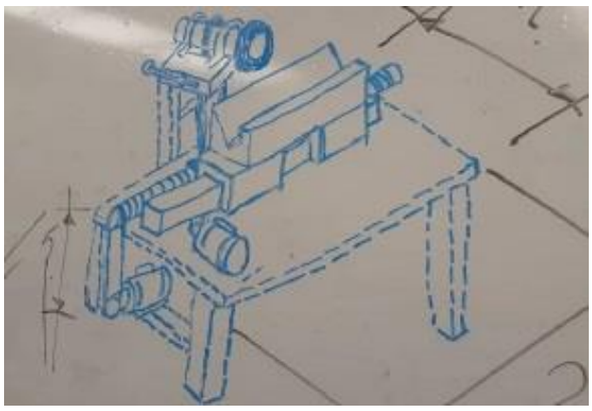

Figure 4 Sharpening machine design proposal
Source: Own elaboration

The final design was carried out with the help of specialized software, both for the mechanical and structural design. AutoCAD and SolidWorks were used (figure 5). Various calculations were also made to determine where it would be optimal to place the mechanical and electrical elements.

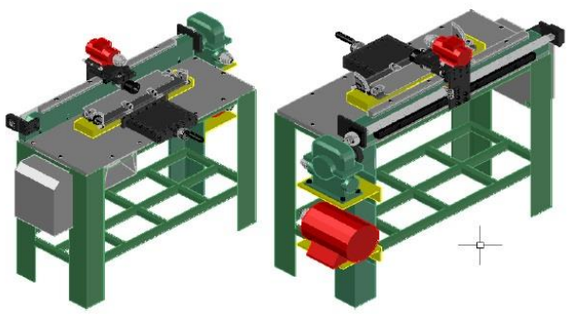

Figure 5 Final design of sharpening machine
Source: Own elaboration

Mechanical calculations

The mechanical calculations made for the design of the machine are mentioned: It is necessary to clarify that it refers to the transmission of force and speed between the motors and the mechanical components that will carry out the work of movement and load, with the following results:

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1. Calculation of the dimensions of the worm and spindle. ACME triple entry thread, 24mm pitch, 3/4" internal diameter, 1" external diameter, 1/8" thread height.

2. Advance calculations. Since the sharpening process is necessarily fast, it was established that the sharpening head should travel a distance of 1100 mm in 10 seconds or 110 mm/s, with a rotation speed of 275 RPM.

3. Calculation of pulleys. In this case, this transmission system is only to transmit the movement, with a 1:1 ratio.

Electrical calculations

1. Electric motors. An ASEA 220 volt AC three-phase motor was selected, with a speed of 3410 RPM, 0.5 HP, AMP. 0.85/1.7, for continuous operation, this in order to ensure good machining (sharpening) and avoid burning the blade or reducing its resistance or the effectiveness of its mechanical properties. A SIEMENS brand three-phase motor of 230/460 volts AC, type GP100, 2 HP, 1740 RPM, AMP 5.6/2.8 was also selected.

2. Motor wiring. TW 4x12 AWG wire (4 wires, 12 gauge) was used.

3. Control devices. To control the movement of the sharpener, the intervention of a MOELLER® brand PLC, model EASY 412-DC-TC, was necessary, which had the advantage of its compact size, its inputs and outputs more than enough to be able to operate the machine and Above all, the fact that it does not need software and a computer to be able to be programmed, this being its greatest advantage. A start button (NA), a stop button (NC), a button for turning the lead screw motor in the normal direction (NA) and a button for the reverse direction of the lead screw motor (NA) were programmed.

Machine manufacturing

Ten detailed plans were made for the manufacture of the machine in AutoCAD, in figure 6 and figure 7 two examples of plans are shown.

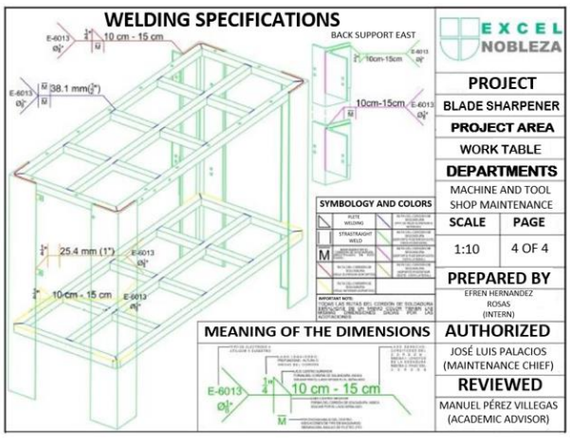

Figure 6 Work table design for the sharpening machine
Source: Own design

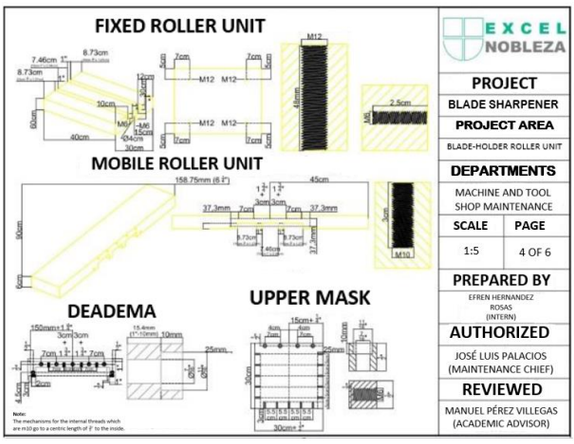

Figure 7 Design of fixed advance carriage, mobile advance carriage, deadema and upper mask for the grinder
Source: Own design

The materials used to make the machine were the following:

- SIEMENS GPS100 engine.
- ASEA MBT 48(71B)-2 motor with base for mounting on horizontal and transversal guides.
- MOELLER® EASY 412-DC-TC PLC.
- 1½ *11/2 PTR Tubular Profile, 4mm thick.
- Angular profile 6´´x 6´´, 1/8´´ thick.
- 2kg. 6013 stick electrode welder.
- Worm and spindle (manufactured in the company's machine tool shop).
- 2 CNC linear guides 120 cm long.
- Steel plate (front part of a sharpener).

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- 6 ¼ ´´ x 6 cm x 1.5 m steel plate.
- 2 skids for CNC linear guide.
- 1 m screed of 6´´x ½´´.
- ½" round Cold-Rolled.
- 1" square Cold-Rolled

Once the necessary materials for the manufacture of the equipment were obtained, the material cutting processes began. The first of the steps was to adjust the angle and the cutting line both in the PTR material and in the angular profile in the cutting machine, counting at all times with the support of the company's specialized machine tool personnel. After proceeded to weld the table, as shown in figure 8.

Once the table was made, the components that would make up the mechanical part of the sharpener were assembled, starting with the design of the head, for which a steel plate (front part of a sharpener) and a 6-inch steel plate were needed. ¼ ´´ x 6 cm x 1.5 m.

Figure 8. Table welded process
Source: Own design.

However, since they had been stored for a long time, the paint and the surface of these pieces were filling with rust, it was necessary to clean the pieces with the help of sandpaper and a manual polisher or grinder, to which a brush was adapted (emery brush) 5" diameter cup.

Figure 9. Plate drilling
Source: Own design

At the end of the cleaning process, we proceeded to verify if the surface was completely straight, and to the surprise of the workers in the machine and tool shop, the surface had a 1/8-inch buckling, so it was necessary to a rectification to this piece. For the process, the services of a milling machine were required, the same one found in the machine and tool shop. In the workshop bench drill, the plate that would be used to support the rest of the components was drilled.

Once the drilling process was finished, we proceeded to place the plate on the table, align and finally make the same perforations in the corresponding place, this time on the table, a couple of type c presses were used to fix our plate to the table and a drill to make these holes.

On the other hand, grooves were machined (figure 9) to function as guides in some metal pieces, pieces that would serve to make an advance carriage. Once the grooving process was finished, drilling was carried out and later another internal threading or tapping process was carried out, with 4 millimeter threads made with M10 taps, in order to fix this "feed carriage" to the table plate.

Figure 10 Moving part grooving process
Source: Own design.

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It is important to mention that, at the suggestion of the head of the machine and tool shop, the machine was assembled and disassembled each time a new element was added or a process or procedure was completed, that is, the progress of the project was "presented" in question. Apart from being the basis for verifying progress, this was used to better visualize both mechanical and structural elements that could be added to or removed from the project.

In order to solve the problem of the advance of the sharpening head and the advance carriage, the option of manufacturing an endless screw with its respective spindle was chosen, an element that would hold the mobile part (head or advance carriage) and slide or would advance along the screw and would help move these elements. For this, the same workers from the machine and tool workshop fully supported us in the manufacture of these elements, essential for the operation of the machine. It should be noted that these elements were made based on the calculations made and the plans that were made at the beginning of the project.

After the mechanical assembly, the electrical and electronic systems for the operation and control of the knife sharpener were installed and connected.

Figure 11 Machine assembly
Source: Own design.

As an initial step, an empty control cabinet that had not been used for a long time was chosen. Said cabinet belonged to a bagging machine and already had DIN rails installed inside it.

Once the cabinet was found, we proceeded to look for the contactors and the PLC that would be used to control the motors, however, it was found that both the available contactors and the PLC worked with 24V DC, therefore that a power source had to be found, which was not a problem, since there was also a power source available in stock. After this, it was necessary to look for THW-12X4 cable and 12 AWG cable to connect the control and power system of the machine, also available in the company's warehouse, and finally, it was necessary to look for 40mm x 40mm slotted conduit, which is would be used to protect the cable, in addition to the NO and NC pushbuttons to control the machine.

Results

Finally, and as part of the final quality control, the knife sharpening machine was subjected to functional tests, it was possible to verify the correct operation of the electrical components, making different measurements. Tests were carried out on the advance carriages, to verify that they could advance without any difficulty along their trajectory, likewise, by means of the buttons, the correct functioning of the program installed in the PLC was verified.

To test the machine, blades of different sizes were taken and fitted into the blade holder system, one at a time, the angle of inclination was adjusted and the sharpening process proceeded. With satisfaction, both the maintenance department staff, as well as the machine tool workshop and the trainees, observed the optimal result of the sharpening process with the new machine. Finally, the machine was transferred with the help of a forklift to the Maintenance Department Workshop and put into operation, thus achieving the main objective of this project, which was to provide the maintenance department and the company with a blade sharpening machine.

Financing

This work has been financed by the company Excel Nobleza SAPI de C.V.

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Conclusions

The design and manufacture of a knife sharpening machine for the company Excel Nobleza was successfully completed, optimizing the sharpening process and saving monetary resources. The machine was manufactured with parts that the company already had in stock or were machined with existing resources, for this reason, the investment was zero or minimal. In summary, the project was completed successfully.

References

I. EXCEL NOBLEZA. (s. f.). media.cylex.mx. Recuperado 4 de mayo de 2023, de https://media.cylex.mx/companies/1123/7678/uploadedfiles/11237678_635101146670756514_EXCEL_NOBLEZA.pdf

II. Shigley, J. E., Nisbett, J. K., & Budynas, R. G. (2019). Diseño en ingeniería mecánica de Shigley. McGraw-Hill Interamericana. Recuperado 8 de mayo de 2023, de https://termoaplicadaunefm.files.wordpress.com/2015/03/disec3b1o-en-ingenierc3ada-mecc3a1nica-de-shigley-8-edicic3b3n-budynas.pdf

III. Claudio Guerrero, L. D., & Segarra Muzo, D. J. (2013). Diseño y construcción de una rectificadora de cuchillas de 800 mm de longitud para la empresa CONFITECA CA (Bachelor's thesis, QUITO/EPN/2013). Recuperado 16 de mayo de 2023, de http://bibdigital.epn.edu.ec/handle/15000/6468

IV. Bohórquez Suárez, G. R. (2011). Diseño y construcción de una máquina afiladora de cuchillas planas de hasta 1m de longitud para la empresa MCS y PLASTIMAG (Bachelor's thesis, Quito, 2011.). Recuperado 19 de mayo de 2023, de http://bibdigital.epn.edu.ec/handle/15000/4398

V. Sierra Garriga, C. (2022). Diseño de una máquina de afilado de cuchillas metálicas. Recuperado 4 de mayo de 2023, de http://dspace.aeipro.com/xmlui/handle/123456789/3177

VI. Hernández Hernández, A. E., & Hernández Olvera, N. (2017). Diseño y manufactura de un prototipo para afilado de cuchillas de cizalla manual. Recuperado 16 de mayo de 2023, de http://132.248.52.100:8080/xmlui/handle/132.248.52.100/12112

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Elaboration of germinable bioplastic based on corn olot

Elaboración de bioplástico germinable a base de olote de maíz

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Abstract

The present work was developed within the facilities of the Instituto Tecnológico Superior de Poza Rica, said research work aims to develop a germinable bioplastic based on corn cob, which will reduce environmental contamination, generating a biodegradable and germinable product at the same time. time. The elaboration of the bioplastic was carried out taking into account the methodology described by Guzmán (2013) using cob powder instead of corn starch and with an additional input, gelatin. In this way, 10 tests were carried out, starting from procedure 1 in which 5 tests were carried out, from which it is concluded that the prototypes presented curves and breaks in their structure, and have even reduced their dimensions. Likewise, for procedure 2, 3 tests are carried out where it is obtained that if there has been a resistance to perforation (there is no fracture) and there has been a decrease in its size.

Bioplastic, Corn Cob, Biodegradable

Resumen

El presente trabajo se desarrolló dentro de las instalaciones del Instituto Tecnológico Superior de Poza Rica, dicho trabajo de investigación tiene como objetivo desarrollar bioplástico germinable a base de olote de maíz, mismo que permitirá reducir la contaminación ambiental, generando un producto biodegradable y germinable al mismo tiempo. La elaboración del bioplástico se llevó a cabo teniendo en cuenta la metodología que describe Guzmán (2013) utilizando el polvo de olote en lugar de almidón de maíz y con un insumo adicional, la grenetina. De este modo se llevaron a cabo 10 pruebas, partiendo del procedimiento 1 en el que se realizaron 5 pruebas, de las cuales se concluye que los prototipos presentaron curvas y rompimiento en su estructura, incluso se han reducido en sus dimensiones. Así mismo para el procedimiento 2 se realiza 3 pruebas en donde se obtiene que si se ha presentado una resistencia a la perforación (no hay fractura) y se ha presentado una disminución en su tamaño.

Bioplástico, Olote de maíz, Biodegradable

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Introduction

Plastic is a material that has multiple applications and is an important part of different industries, for example, in the food industry where plastics are used for food packaging or for the creation of plastic utensils better known as disposable plastics. These, as the name suggests, are disposable and therein lies the problem that most of these disposables are only used for 20 minutes or less and are quickly discarded and have a long decomposition time. Plastic disposables represent a big environmental problem that we should be concerned about, if a change is not made now there will be very serious problems such as the contamination of aquifers and soil contamination, to mention a few. These problems are due to the fact that past generations have not been more careful with this type of plastic, and this is where our work arises, we seek to reduce this environmental impact and our product is germinable, this means that we can plant the product and later a plant will come out which will be in accordance with the environment that surrounds it. With this we will be able to reduce the use of disposable plastics.
With the above mentioned, the research and development work was carried out to obtain a biopolymer that is made from corn stover and which has other elements that make up it and that make it possible to be planted and not generate damage to the land.

Increasing the consumption of bio-based type A plastics can help to reduce the dependence on oil for the manufacture of plastic products, since oil is a limited resource that will tend to increase in price. On the other hand, disposal by incineration (waste to energy) results in green energy, since the CO2 expelled into the atmosphere was previously consumed by plants, so we could talk about an almost neutral carbon footprint. On the other hand, biodegradable plastics (type B) have advantages only in certain fields of application. For example, in agricultural mulch films, waste bags and packaging. Other applications where biodegradability makes sense are agricultural aids, such as clips used in tomato harvesting. Such parts can be disposed of together with waste and green waste more easily than clips made of non-degradable plastics.

According to the United Nations Environment Programme (UNEP), the global production of plastics has increased 20 times over the last 50 years. In that period, around 320 million tonnes were produced, dumping 13 million tonnes into the seas and oceans, of which a large number sank, or were left floating on beaches, causing environmental and economic damage that transcends borders and affects more than 700 marine species [4]. In the national context, Mexico produces more than seven million tonnes of plastic per year; of which 48% is single-use plastic, and only 6.07% is recycled. [4]. Meanwhile, disposable cutlery takes 400 years to degrade, the straw 100, the cup 65-75, and the bag 55 [] The pollution generated by disposable plastics affects more than 100,000 marine animals and causes the death of one million birds a year, as well as damaging human health Gareli (2020). It is worth noting that Greenpeace conducted a study showing the impact of microplastics on commercially popular fish in the Gulf of California, the Gulf of Mexico and the Mexican Caribbean. It is worth mentioning that 20% of the 755 fish had plastic in their stomachs. A total of 2,718 microplastics were found, the region with the greatest impact was Veracruz with 96% of contaminated fish and 1,865 pieces found; on the other hand, La Paz represents 21% of affected species and 110 pieces were found. These figures are alarming for the health of aquatic organisms and therefore also for fishing activity, which could be affected [4].

Due to the global environmental problem, it is important to consider a sustainable alternative to replace the use of petroleum-based plastics, which have a great environmental impact. Biopolymers fulfil the purpose of reducing this problem, as they are characterised by their ability to degrade quickly, as well as having properties similar to those of traditional plastics, and can be applied in a wide range of industries such as food packaging, surgery, pharmaceuticals, etc. [1].

Thus, we asked ourselves whether it is possible to produce a germinable bioplastic based on corn stover, which contributes to reducing environmental pollution, generating a biodegradable and germinable product at the same time.

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Thus, one of the objectives is the production of biopolymers for the manufacture of disposable products.

Development

Bioplastics

Biopolymers are defined as a variety of macromolecules, produced by biological systems, such as animals, plants or microorganisms. They can be chemically synthesised, but their polymeric units must be derived from biological systems such as amino acids, sugars, lipids, etc. (Tharanathan, 2003).

In general, natural biopolymers come from four main sources:

- Animal origin (collagen/gelatin).
- Marine origin (chitin/chitosan).
- Agricultural origin (lipids, fats, hydrocolloids, proteins and polysaccharides).
- Microbial origin (polylactic acid (PLA) and Polyhydroxyalkanoates (PHAs).

The development of biodegradable plastics from organic sources such as starch derivatives, polylactic acid and cellulosic polymers, represent a more environmentally friendly option than those obtained from petroleum, resulting in increased social awareness of the environmental problems generated by plastics (Demirbaş, 2007; Nath, Dixit, Bandiya, Chavda, & Desai, 2008).

Characteristics of bioplastics

Bioplastics are biodegradable and/or bio-based materials. Bio-based polymers are produced using renewable resources. It simply refers to plastic made from plant or other biological material instead of petroleum. It is also often called bio-based plastic.

It can be made from polylactic acids (PLA) found in plants such as corn and sugar cane, or it can be made from polyhydroxyalkanoates (PHA) made from microorganisms [7].

Bioplastic materials have similar properties to conventional plastics, and can be stored in a similar way and processed in conventional machines, but the big difference is that they are biodegradable and environmentally friendly.

Industrial applications and properties

Bioplastics are divided into:

A) Plastics from renewable sources such as corn, sugar cane or even agricultural waste.

B) Biodegradable plastics. Some bioplastics are both renewable and biodegradable, but not all bioplastics are biodegradable. [8]

Advantages and disadvantages of using biodegradable plastics

The benefits of bioplastics include:

- Most of them are biodegradable, so they contribute to the care of the planet by producing less waste.
- They come from 100 percent renewable raw materials and less energy is needed for their production.

Disadvantages:

- With the large-scale production of bioplastics, other problems could arise, such as the availability and rising prices of food derived from maize and wheat, as most of them are currently made from these elements.
- However, bioplastics are an ideal option for reducing the use of plastics and for the care of our planet.

Methodology of the experiment

The methodology to be followed is the scientific method, where experimentation is the basis with which to find the correct formula to obtain the desired results, it is worth mentioning that experimentation is a quantitative method, therefore we involve quantities to carry out the project.

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Inputs and equipment to be used

The inputs used for the creation of the prototype are:

- 5g dried Olote (powdered)
- 1/2 ear of corn
- 1/4 litre of water
- 17ml distilled water
- 1.7ml glycerine
- 3ml vinegar
- 7g of grenetin
- 3ml additional 3ml distilled water
- 1 seed

The equipment required is:

- Knife
- Blender
- Sieve
- Tray
- Scales
- Syringe
- Measuring cup
- Containers
- Metal spoons
- Saucepan

Flowchart of bioplastic processing

Flow diagram for the production of pulverised corncob

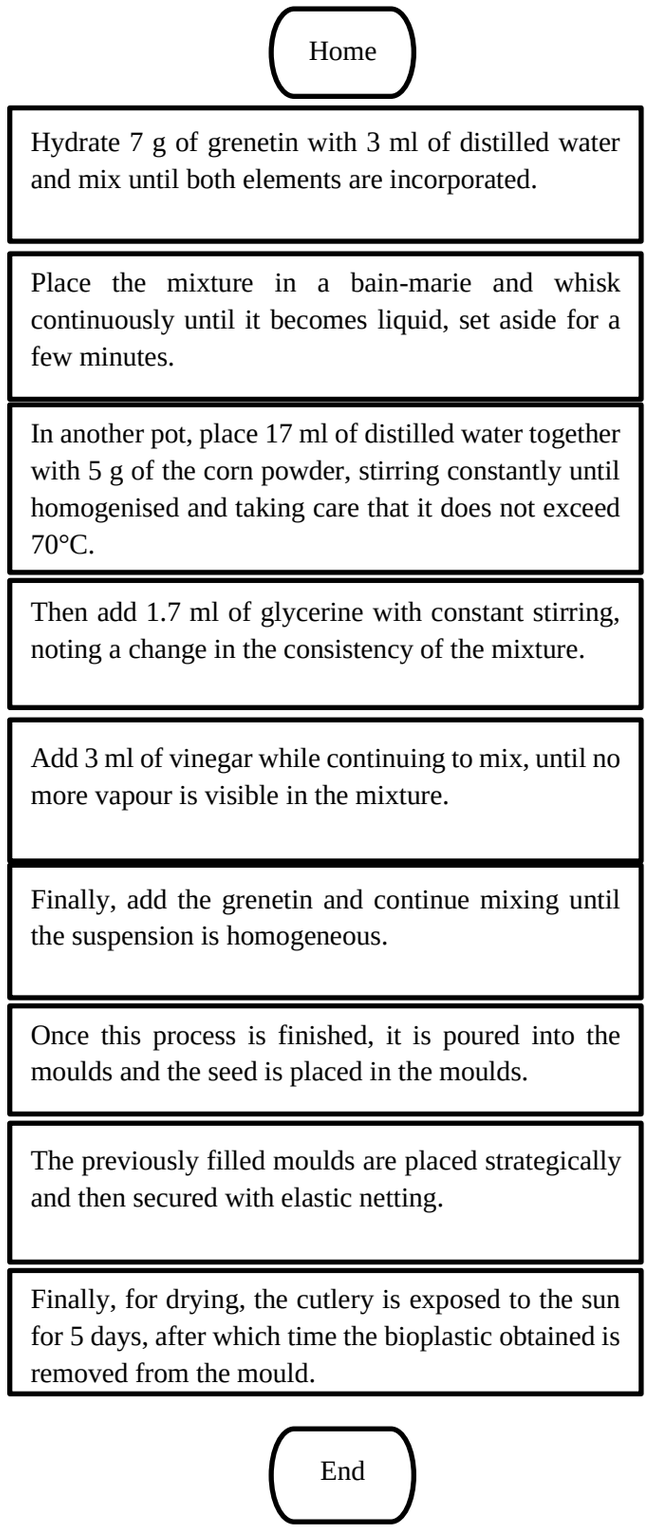

Figure 1 Obtaining pulverised corncob

Flow diagram for the production of the biopolymer.

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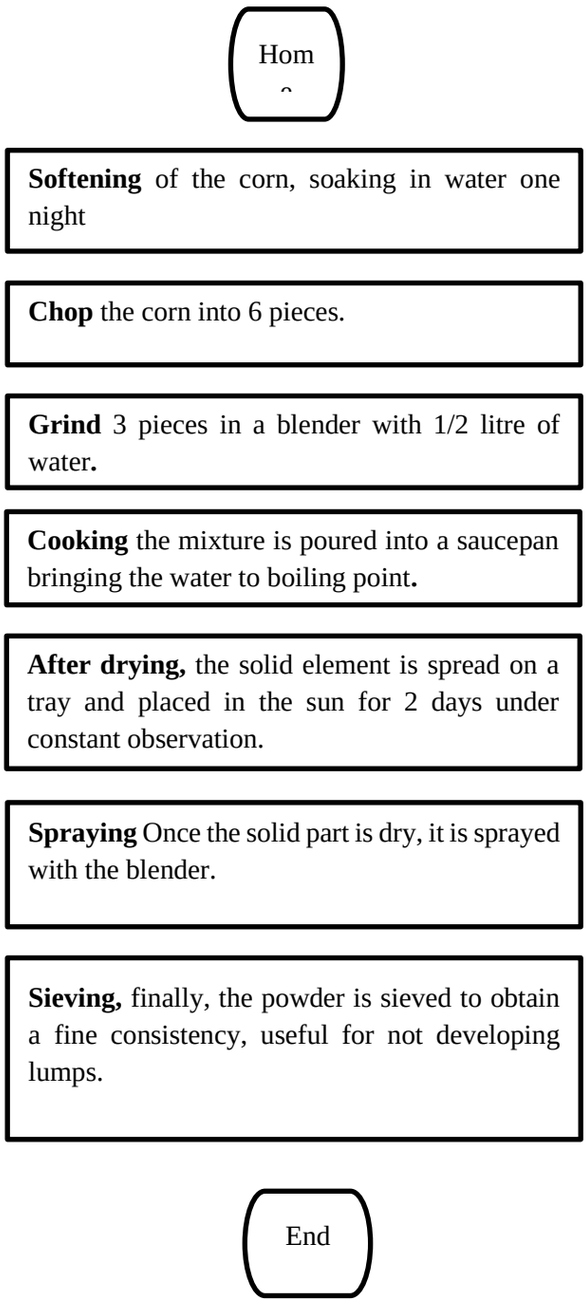

Figure 2 Obtaining the polymer

Obtaining pulverised corncob

The production of the dried and pulverised corncob was carried out in nine stages: softening, chopping, wet milling, cooking, suspension filtration, drying, pulverising and sieving.

- Softening: In order to facilitate chopping, the three olotes are soaked in water overnight.
- Chopping: The olote is chopped into 6 pieces.
- Grinding: Only 3 pieces of the olote are placed in the blender with 1/4 litre of water, a thick mixture with lumps will be obtained.
- Cooking: Pour the mixture into a saucepan and keep stirring constantly over medium heat. When it has reached boiling point, turn off the cooker.
- Filtration: The previously cooked mixture is placed in a sieve while it is still hot. Through this process, the solid part of the suspension is removed, while the liquid part can be left to cool and then poured over the plants.
- Drying: The solid element is spread on a tray and placed in the sun for 2 days, under constant observation.
- Pulverisation: Once the solid part is dry, it is pulverised using a blender.
- Sifting: Finally, the powder is sifted to obtain a fine consistency, which is useful to avoid lumps.

Bioplastic production

The elaboration of the bioplastic was carried out taking into account the methodology described by Guzmán (2013) using corn stover powder instead of corn starch and with an additional input, grenetin.

- To begin, hydrate the grenetin, add 7g with 3ml of distilled water and mix until the elements are incorporated.
- Place the mixture in a bain-marie and whisk continuously until it becomes liquid. Set aside for a few minutes.
- In another pot, place the 17 ml of distilled water together with 5 g of the corn powder, stirring constantly until homogenised and making sure that the temperature does not exceed 70°C at all times.
- Subsequently, 1.7 ml of glycerine is added dropwise with constant stirring, noting a change in the consistency of the mixture.

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- Add the 3 ml of vinegar while continuing to stir, until no more vapour is visible in the mixture.

- Add the previously hydrated grenetin and continue mixing until the suspension is homogeneous.

- At the end of this process, it is poured into the mould and the seed is placed in it.

- The previously filled moulds are placed strategically and then secured with elastic netting.

- Finally, for drying, the cutlery is exposed to the sun for 5 days, after which time the bioplastic obtained is removed from the mould.

Experimentation

Olote: It was hydrothermally treated to modify its recalcitrant form and obtain a solid fraction composed mainly of cellulose and lignin, in addition to a soluble fraction rich in xylose. Lignin in combination with low glycerol content favours intermolecular interactions and as the plasticiser content increased, intra-molecular interrelationships were favoured. Its brown pigmentation and lumpy texture to the touch contributed to its appearance.

Distilled water: It is the main solvent for the formation of natural polymers, its contribution is its capacity for synthesis by means of its exposure to heat, combining the reagents used in a homogeneous way to obtain the final mixture.

- Glycerin: Contains plasticising properties due to its ability to reduce the interaction of hydrogen bonds. It also provides the bioplastic with flexibility and tensile strength.

- White vinegar: Provides stability to the substance, contains plasticising properties and helps to maintain its functionality in the time scale of its expected durability. It performs an important preservative action thanks to its degree of acidity, this aspect slows down the growth of microorganisms, although it does not eliminate them.

- Grenetin: Increases the rigidity of the bioplastic by solidifying it. The granules swell, absorbing up to 10 times their weight, then the temperature rises to dissolve the swollen particles and form the solution. This solution gels when cooled to room temperature in this case.

- Seed: Add to the bioplastic the characteristic of germinability, as the seed degrades it can take its rightful place in the soil; it is with the help of the other reagents that the soil will be nourished to receive and germinate the plant.

Evidence

To obtain the ideal prototype, two procedures were applied with variable inputs and quantities in order to have more options and to determine which result was of better quality. It should be noted that from procedure number two, the last test recorded was the one chosen. The details and results of the tests are presented below:

- Procedure 1.

The procedure used is to include all the ingredients mentioned below in a saucepan, place over high heat and mix all the ingredients with a spoon, when half of the lumps disappear, reduce the intensity of the heat (low). Continue mixing. This stage is finished when the lumps are completely dissolved. Finally, the mixture is poured into moulds and left to dry for 5 days.
Note: For the procedure with grenetin, the first step is to dissolve it in water and then place the dissolved mixture in a water bath until it is free of lumps. At the end of this process, the suspension is added to the other ingredients in the saucepan.

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Insumos utilizados	Resultados	Imagen
20g de polvo de olote con bicarbonato 158ml de agua destilada 11g de glicerina 15g de vinagre blanco	Presenta una consistencia húmeda y arenosa, no se observa compacta ni rígida	
20g de polvo de olote con bicarbonato 20g de maicena 158ml de agua destilada 15g de agua destilada 15g de vinagre blanco	Al tacto presenta endurecimiento; se observa compacta y flexible, se observa una reducción de su tamaño original y fracturas.	
20g de polvo de olote con bicarbonato 7g de maicena 7g de polivinilo 158ml de agua destilada 15g de agua destilada 15g de vinagre blanco	Su consistencia es húmeda, arenosa, no compacta ni rígida. Al desmoldarse se desmorona	
20g de polvo de olote con bicarbonato 140ml de agua destilada 10g de bicarbonato 140g de agua destilada 15g de vinagre blanco 7g de grenetina	Presenta muy poca rigidez, es frágil al tacto y como resultado se desmorona.	
20g de polvo de olote con bicarbonato 20g de maicena 140ml de agua destilada 10g de bicarbonato 140g de agua destilada 15g de vinagre blanco 7g de grenetina	La consistencia que presenta es medianamente rígida, consta de altos niveles de flexibilidad. Se redujo de su tamaño original y la prueba se observa grumosa.	

Figure 3 Results of procedure 1

- Procedure 2.

The procedure used in the following section is what we consider to be the ideal procedure, the methodology can be found in the experimentation section.

Remark: In case of not using grenetin, the initial step is omitted.

Insumos utilizados	Resultados	Imagen
5g polvo de olote sin bicarbonato 5g de maicena 17ml de agua destilada 1.7ml de glicerina 3ml de vinagre	Su aspecto es seco, presenta fracturas ya que es frágil, sin embargo, también presenta rigidez. Al secarse se curveó y redujo su tamaño.	
5g polvo de olote sin bicarbonato 5g de maicena 5g de polivinilo 34ml de agua destilada 1.7ml de glicerina 3ml de vinagre	No presenta rigidez, es frágil, por lo cual presentó una fractura. Su consistencia es húmeda y al desmoldarse se desmorona.	
5g polvo de olote sin bicarbonato 5g de maicena 17ml de agua destilada 1.7ml de glicerina 3ml de vinagre 7g de grenetina	Presenta un grado funcional de rigidez, sin embargo, se deformo al secado, presenta curveado hacia arriba.	

Figure 4 Results of procedure 2

The tests presented below are those that were tied to the mould with elastic mesh to prevent deformation during drying, and were carried out as follows:

Figure 5 Use of elastic netting

Insumos utilizados	Resultados	Imagen
5g polvo de olote sin bicarbonato 5g de maicena 17ml de agua destilada 1.7ml de glicerina 3ml de vinagre 7g de grenetina	Presenta un buen grado de rigidez, al secado se redujo su tamaño y se mantuvo en el molde sin deformación alguna. Sin embargo, su aspecto es muy seco y es un poco frágil.	
5g polvo de olote sin bicarbonato 17ml de agua destilada 1.7ml de glicerina 3ml de vinagre 7g de grenetina	Presenta reducción al secado, consta de un grado funcional de rigidez y se mantuvo en el molde sin deformarse.	

Figure 6 Results with elastic mesh.

Results

Once the experimentation process was carried out, 10 tests were carried out, starting from procedure 1 in which 5 tests were carried out, from which it was concluded that the prototypes presented curves and breakage in their structure, and even reduced in their dimensions.

Likewise, for procedure 2, 3 tests are carried out in which it is obtained that if there has been a resistance to perforation (no fracture) and a decrease in the size of the perforation (no fracture) and a decrease in the size of the perforation.

With the implementation of elastic meshes, the best results are obtained in the tests covered with the following characteristics: greater resistance to fracture, maintains its original size and does not present a deformation in its structure.

- Qualitative characteristics: Its brown pigmentation stands out, in addition, it has a functional level of rigidity as it does not fracture when manual force is applied, it has a basic but useful design with room for improvement.

- Quantitative characteristics: The weight of the cutlery is 16g, which shows that it is light to use, its dimensions are 13.5cm high and 3.2cm wide on the widest side and 0.8cm on the narrowest side, an average length useful for its operation, the thickness of the cutlery is 0.6cm, which guarantees its comfort when used.

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- Composition: The bioplastic is made only from environmentally friendly inputs, furthermore, they significantly benefit the earth. The elements used are not harmful to health. The composition of the disposable utensils seeks to be germinable due to the seed inside and biodegradable due to the inputs used, these last two features continue to be examined, as the results will be obtained after their decomposition time has elapsed.

- Quality: They have quality in terms of resistance, rigidity, lightness, functionality, composition, procedure, ecological inputs and goodness for the soil. We continue to examine biodegradability and germinability, as well as looking for improvements in texture, ergonomics and design.

Discussion

There are several proposals at international, Latin American and national level that show various sustainable alternatives to replace disposable plastics to counteract environmental pollution [5], from the University of Curtin, Malaysia, presents an article on the potential of lignocellulose fibre from corn waste, as reinforced bioplastic components, an alternative source of reinforcements to other natural fibres for bioplastic composites. On the other hand, in Peru, the author Dante Arturo Martin Guerrero (2019) from the University of Piura, carried out a project on the design of the production process of biodegradable trays from corn starch, carrying out experimental tests where the resistance, permeability, hardness, perforation, temperature and biodegradability of the product were evaluated, the expected result was obtained, the appearance of the tray is pleasant for the customer and environmentally friendly. In the national context, students from the Autonomous University of Querétaro proposed "Boltsiri", a project to design a bioplastic obtained from corn and other agro-industrial components. According to Mónica Citlalli García (2018), leader of the project, the purpose is to offer a sustainable and ecological alternative that meets the mechanical and resistance characteristics of plastic to reduce degradation time and thus counteract the impact generated by disposable plastic bags.with a ratio of quantities and units. For example, write "Temperature (K)", not "Temperature/K”.

Conclusion

The final evaluations with regard to the experimentation in the elaboration of the roofing allowed to recognise in some way some important points in the work with biopolymers based on corn stover as a sustainable alternative in the production of inputs for the service industry; these points can eventually be considered as areas of opportunity for a better definition of the prototype according to the demands of quality and efficiency.

From this perspective, the pulverisation process considered nine stages from the first stage, among which softening, chopping, grinding and pulverisation were decisive to make the raw material sufficiently ductile. Subsequently, in the production of the bioplastic that was governed by certain guidelines of the methodology of Guzmán (2013), several attempts had to be made in order to give the right consistency to the utensil; reagents such as polyvinyl, grenetin and glycerin were relevant to test the degree of rigidity and flexibility of the bioplastic. On the other hand, tests with and without bicarbonate also contributed to a better drying and consistency.

Therefore, the results observed allowed us to detect those qualitative parameters (pigmentation, rigidity and basic design) and quantitative parameters (weight and lightness, ergonomic dimensions and a comfortable thickness) that would finally lead to the creation of a cutlery based on environmentally friendly inputs and with a biodegradability still subject to assessment according to its decomposition time; the seed inserted inside the utensil would finally seek to blend organically with the soil and germinate profitably.

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References

[1]. Corporación Universitaria Americana. (2020). Aportes en investigación para la ingeniería (1a Edición) [Libro electrónico]. Sello Editorial Coruniamericana. Recuperado 7 de mayo de 2022, de https://americana.edu.co/medellin/wp-content/uploads/2020/09/Aportes-en-investigaci%C3%B3n-para-la-ingenier%C3%ADa.pdf)

[2]. Organización de las Naciones Unidas. (2019, 11 febrero). La ONU lucha por mantener los océanos limpios de plásticos. Noticias ONU. Recuperado 4 de mayo de 2022, de https://news.un.org/es/story/2017/05/1378771.

[3]. Basura Cero: Gobierno de la Ciudad de México. (2020, 19 julio). SEDEMA y especialistas piden a la ciudadan-a evitar consumo de productos desechables. Basura Cero. Recuperado 27 de abril de 2022, de https://basuracero.cdmx.gob.mx/comunicacion/nota/sedema-y-especialistas-piden-la-ciudadania-evitar-consumo-de-productos-desechables#:%7E:text=Ornela%20Garelli%2C%20especialista%20en%20consumo,tambi%C3%A9n%20da%C3%B1a%20la%20salud%20humana .K. Elissa, “Title of paper if known,” unpublished.

[4]. Greenpeace. (2019). Estudio sobre el impacto de la contaminación por microplásticos en peces de México. Recuperado 3 de mayo de 2022, de https://www.greenpeace.org/static/planet4-mexico-stateless/2019/10/01f918b5-estudio-sobre-el-impacto-de-la-contaminacion-por-microplasticos-en-peces-de-mexico.pdfY. Yorozu, M. Hirano, K. Oka, and Y. Tagawa, “Electron spectroscopy studies on magneto-optical media and plastic substrate interface,” IEEE Transl. J. Magn. Japan, vol. 2, pp. 740–741, August 1987 [Digests 9th Annual Conf. Magnetics Japan, p. 301, 1982].

[5]. Chong, T. Y., Law, M. C., & Chan, Y. S. (2020, 22 septiembre). The Potentials of Corn Waste Lignocellulosic Fibre as an Improved Reinforced Bioplastic Composites. SpringerLink. Recuperado 1 de abril de 2022, de https://link.springer.com/article/10.1007/s10924-020-01888-4?error=cookies_not_supported&code=4e4587ed-317b-4804-bf66-ad12084896d4.

[6]. García, L. F., García, A. C., Olaya, P. C., Rosas, G. P., Vignolo, D. N., & Guerrero, D. A. (2019, 16 diciembre). Diseño del proceso productivo de bandejas biodegradables a partir de fécula de maíz. Repositorio Institucional de la Universidad de Piura. Recuperado 30 de marzo de 2022, de https://pirhua.udep.edu.pe/handle/11042/4276

[7]. GIBBENS, S. (23 de Noviembre de 2018). National Geographic. Obtenido de Lo que necesitas saber sobre los plásticos de origen vegetal: https://www.nationalgeographicla.com/medio-ambiente/2018/11/lo-que-necesitas-saber-sobre-los-plasticos-de-origen-vegetal

[8]. Thielen, M. (1 de Abril de 2010). Tecnologia del plastico . Obtenido de BENEFICIOS DE OPTAR POR LOS BIOPLÁSTICOS: https://www.plastico.com/temas/Beneficios-de-optar-por-los-bioplasticos+94993?pagina=3 .

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Feasibility and viability analysis in railway system projects

Análisis de factibilidad y viabilidad de proyectos de sistemas ferroviarios

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Abstract

The logarithmic growth of demography generates needs in an ascending spiral for global mobility and places the rail system as the one with the greatest advantages for the coming decades. The objective of this research was to analyze the feasibility and viability factors of the project in its different stages of railway systems in a sustainable development environment, on the other hand, the feasibility and viability analyzes of railway systems are the scientific basis that must be carried out. carried out before decision-making, to materialize it into a reality, however the railway systems with a lack of these, their future is uncertain, and they will not reach the stage of self-sustainability. The methodology was carried out by a mixed analysis, this derives in quantitative analyzes from international databases of the control of parameters of railway systems, in addition, the estimates and predictions were qualitatively analyzed based on reported hypotheses that served as a basis in decision making. The results obtained from this research were a compilation of international analyzes of companies, governments, and experts in decision-making to understand the factors of sustainable development in railway systems and their economic and technological detonation.

Feasible, Viable. Railway

Resumen

El crecimiento logarítmico de la demografía genera necesidades en espiral ascendente de la movilidad global y coloca el sistema ferroviario como el de mayores ventajas para las próximas décadas. El objetivo de esta investigación fue analizar los factores de factibilidad y viabilidad del proyecto en sus diferentes etapas de sistemas ferroviarios en un entorno de desarrollo sustentable, por otro lado, los análisis de factibilidad y viabilidad de los sistemas ferroviarios son la base científica que debe llevarse a cabo antes de la toma de decisiones, para materializarlo en una realidad, sin embargo los sistemas ferroviarios con carencia de estos su futuro es incierto y no alcanzaran la etapa de auto sustentabilidad. La metodología fue llevada a cabo por un análisis mixto, esto deriva en análisis cuantitativos provenientes de base de datos internacionales del control de parámetros de sistemas ferroviarios, además fueron analizados de forma cualitativa las estimaciones y predicciones con base en hipótesis reportadas que sirvieron como base en la toma de decisiones. Los resultados obtenidos de esta investigación fueron una recopilación de análisis internacionales de empresas, gobiernos y expertos en la toma de decisiones para entender los factores de desarrollo sustentable en sistemas ferroviarios y su detonación económica y tecnológica.

Factible, Viable, Ferrocarril

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Introduction

The global demand for transport will generate in the next century a demand for energy and higher air pollutant emissions, the railway has the potential to reduce this growth in urban environments. Transport annually consumes around 50% of world oil production, generating around 25% of the planet's polluting emissions (Network Rail, 2022). Therefore, the implementation of a railway transport in its different energy modalities in trajectories typical of this transport reduces the time of transfers and pollutants, making it an efficient means of transport. Currently, railway systems move around 10% of passengers and goods globally with an energy demand of around 2% of world oil production (Global Railway Review, 2022). The railway sector is the system that has the greatest affinity for electrification due to its infrastructure conditions and that will hardly be matched by the automotive, aeronautical, and maritime sectors in the coming decades. Passenger rail systems present 90% greater electrification than freight systems. The regions with the greatest activity for high-speed electric trains are Europe, Japan, and Russia, while Latin America depends on hybrid systems or fossil fuels in low-speed rail systems of less than 250 km/h on short, medium, and long distances. Conventional railways represent about 90% of world passenger movements, first India with 39%, China 27%, Japan 11%, and the European Union 9% (Sustainability - UIC - International union of railways, 2023).

Rail systems are classified; high-speed trains and metros (which cover long distances operating at speeds greater than 250 km/h), Metrorail (high-frequency and high-capacity urban services, separated from traffic, underground or elevated), and light rails or trams (lower capacity speed and at street level). High-speed rail, an alternative to aviation, and Metrorail offer a solution to congested and polluted cities. The future of the railway is promising as a means of green transport; however, a disadvantage is the high infrastructure and operating costs required until it becomes a self-sustaining means (Dillman et al., 2023).

The objective of this research was to analyze the feasibility and viability factors of the project in its different stages of railway systems in a sustainable development environment. The difference between feasible and viable is that what is feasible is what can undoubtedly be materialized and viable is what, apparently, can be carried out and could be done. Feasibility and viability studies focused on Railway System projects are the basis for decision-making to understand the factors of sustainable development in their economic and technological detonation (Mladenovič et al., 2022). The results obtained from this research were a compilation of international analyzes of companies, governments, and experts in decision-making to understand the factors of sustainable development in railway systems and their economic and technological detonation.

Methodology

This research used a mixed methodology, this derives in quantitative analysis from international databases of the control of parameters of railway systems, in addition, the estimates and predictions were qualitatively analyzed based on reported hypotheses that served as a basis in the decision. of decisions. The objective of this research was to analyze the feasibility and viability factors of the project in its different stages of railway systems in a sustainable development environment. The mixed analysis of the feasibility and viability factors of the railway project determines the variables involved; technical, financial and decision-making in a sustainable development environment such as; commissioning, mobility improvement, impacts; economic, environmental, reductions of; travel times, emission of polluting gases, traffic accidents, improvement of vehicular traffic levels, commissioning of the railway infrastructure, demand analysis, innovative technologies of the rolling system, strategies of the trace and operation of lines, investment estimation, economic-financial analysis, financing sources, parameter estimation, prediction in decision-making from a compilation of international analyzes of companies, governments and experts in decision-making for sustainable development factors in railway systems and its economic and technological detonation.

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Is the railway system a means of urban mobility for integration or displacement?

Population growth in developing and emerging economies in cities is growing exponentially and will require high demand for more efficient, faster, and cleaner transportation, but the need for speed and flexibility tends to favor car ownership and air travel. However, the railway systems have their field of action together with the other means of transport and none will displace another, they will only present an expansion in the coming years, each one in its field with greater performance according to volumes, masses, and speed of transfer.

The railway industry requires strategic investments and sustainable development plans that trigger the subsidy economy of the system and improve commercial competitiveness and technological innovation. The scenario of a future railway system shows growth of around 42% with 4% energy consumption in the next three decades. The advantages of the railway industry over all means of transport are to have a confined lane (which is only used by this means of transport), which generates a second advantage: reduction of transfer times, which implies two more advantages, reduction of energy consumption and generation of pollutants. On the other hand, its disadvantages are compared to other means of transport, it is the railway infrastructure, involvement of other developing sectors such as the generation of electricity to supply the system, long distances, topographic elevations, lack of flexibility of the railway infrastructure, among others (Sustainability – UIC - International union of railways, 2023).

Feasibility and viability of the energy supply of railway systems with traditional and alternative sources

The railway systems industry in the next three decades will experience a stage of radical changes from oil-based energy systems to hybrid systems and from hybrid systems to electric, until the energy sector in electricity generation can detonate its expansion for the supply of different electric means of transport.

The sources of electricity generation at present obey, to generation plants for energies derived from petroleum such as (generation plants based on diesel motor systems, combined cycle and mineral coal), alternative energy sources in the generation of electricity (hydroelectric, wind, geothermal, solar panels, photovoltaic systems, among others) and the generation of electrical energy through nuclear power plants, which in a controlled manner represent green energy sources that alternately satisfy the energy demand of the railway systems.

The stages of evolution of railway systems in the next three decades will not only be limited to energy systems, but they will also experience radical changes in the implementation of railway systems in technology parameters and high speeds (greater than 250 km/h) for trajectories. long enough to interconnect remote cities. Some countries like India do not have high-speed trains, however their mobility is carried out mostly through low-speed trains, due to this, a next stage of evolution proposed for India and countries with similarities is to celebrate a collaboration agreement. with powers such as Japan for the implementation of high-speed trains with state-of-the-art technologies (Yin et al., 2022).

In 2050, according to the diagnosis made by the Energy Technology Policy Division, the Technology and Perspectives Sustainability Directorate, the International Energy Agency and the Agency and the International Union of Railways, it is expected that the railway activity will transfer worldwide to 15 billion passengers in urban areas with large demographics and this exponential growth in demographic areas ensures the high demand for rail systems, which is a very important factor for system subsidies to be reduced and achieve sustainable operation in a sustainable environment (Xuto et al., 2022).

Standardization of railway parameters

The standardization of track gauge in railway systems (that is, the space between rails) is a proposal with a view to 2030, because, in Europe, Asia and North America, international rail system providers have different gauges. of roads and infrastructure with signaling, electrification and technological parameters that are not compatible with each other that limit the integration of the systems.

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On the other hand, Russia and China are developing a high-speed train with adjustable gauge. The independent operational development of railway systems has given rise to a variety of track systems according to the country of origin of the system manufacturer. Due to the type of train and its technical characteristics of use, its gauge is totally different, which in Europe and Eurasia have generated compatibility problems such as networks of a system, where to solve this problem they have created an entire infrastructure for the transfer of goods and passengers from one train to another, which includes corridors and storage warehouses, merchandise changes, and users from one train with one gauge to another with other railway infrastructure. All these merchandise transfers increase the actual transfer time, cost, and generate delays in the systems. Interoperability in North America was quickly achieved due to the relative simplicity of the rail. Cargo operators own their networks and operate only in three national contexts (Canada, Mexico, and the United States), facilitating greater coordination. This is in stark contrast to Europe and Eurasia, where there are many different countries, operators, and infrastructure managers (Five years into the 2030 Agenda: Time to give a big push to railway transport, n.d.).

Feasibility and feasibility of rail use

The leaders of railway systems International Energy Agency, agree that for a railway system to be competitive in its activity as a means of transport, it must be dedicated to a single activity (transfer of passengers or cargo). In the case of passengers, the subclassification is tourist, business, and daily activities. In the case of freight trains, these will be subclassified in mining industry, manufacturing, finished products for perishables, food products, agricultural industry. The classifications of the type of activity will help to optimize the travel time that includes ascent and descent in a logistics that generates optimal strategies according to the type of activity and competitive with other means of transport of the same type. A bad strategy is to share activities in the railway systems, which generate unjustified delays in travel time according to the interests of our clients, who will pay for the different service packages.

Poor logistics will make potential customers of the railway system incline their preferences to other means of transport, putting the sustainability of the system at risk.

Train systems with activities well directed to a transfer sector allow optimizing not only the transfer time, but also involve other factors such as optimizing the useful life of the entire train infrastructure, maintenance in the train infrastructure systems, the continuity of scheduled trips, reduction of transfer maneuvers in the event of a train breakdown to the maintenance workshops that involve the use of track with itinerary delays in other runs. The railway systems are built under the design of each one of its components and oriented so that together they can operate under a certain amount of load, speed, and number of bogies for each convoy. In the countries with the most experience in the railway industry, the companies dedicated to the railway sector in their different business lines and according to reports from the International Energy Agency agree that the rolling coupling in a metal-metal system depends on parameters such as speed , contact area, types of material, contact pressures, friction coefficients, rolling slip, traction, braking, contaminants, slopes among others, which influence the tribology of mechanical contact and the theory of railway system fracture. The mechanical contact of a railway system when there is a variety of uses for the system is a trigger for couplings with different conditions that lead to premature wear in the rolling material, increasing mechanical vibrations throughout the railway system that in the short term will cause speeds programmed in the railway system development plan have to be reduced to avoid derailment. The plastic deformation in the rolling stock of a railway system is directly linked to the useful life of the system made up of the elements involved in rolling, highlighting the railway rails and railway wheels, so the coupling implies wear on both elements. One of the common errors in railway systems is wanting to use the infrastructure of an existing or new freight train for a passenger train, this implying that the higher freight train generates a coupling with a greater plastic deformation of the system and the passenger train. the rolling stock suffers premature wear to couple to the one with the highest load, causing the convoy to reach a displacement synchronization to avoid derailment.

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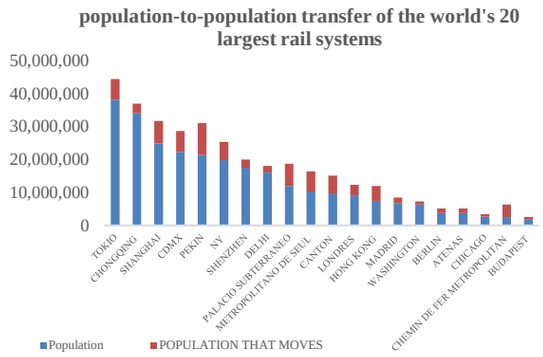
Railway infrastructure in a technology-demographic-user-sustainable development analysis

The high-speed rail infrastructure has two tracks per line. The high-end variant of high-speed rail systems is Maglev (derived from magnetic levitation), whose operation is based on a system of coils and magnetic fields that move the train along the track and allows speeds around the 500 km/h. At the international level there were six magnetic levitation systems during 2018. The best known is the Shanghai Maglev with a maximum speed of 430 kilometers per hour. Japan intends to use Maglev technology to reach speeds of 500 kilometers per hour on a high-speed line. High speed maglev technologies have high power requirements. it faces even higher infrastructure construction costs, and the costs of operation and subsidies increase with respect to all types of railway technologies, hence the limited existence of these systems in countries that are leaders in the development of technologies. The Hyperloop is a railway system that consists of an electromagnetic passenger propulsion capsule operating through a low-pressure tube (SpaceX, 2013). This system is limited to less than 50% in technical parameters with respect to the Magley model, but it is still in the classification of high-speed trains to move many people.

Metro systems have the highest utilization rate of all rail systems measured in train-kilometers or passenger-kilometers) per kilometer of track length. These are used more intensely in Russia and Japan due to the population density where the frequency of occupation is extremely high. The use of the metro within the railway networks is much greater than that of the high-speed train. Followed by the conventional rail network for passenger and freight services which, according to the International Energy Agency report, has hardly grown in the last twenty years. Currently, the longest conventional rail network is in North America, followed by the European Union, Russia, India, and China (see graph 1).



Graphic 1 Population - transfer population of the 20 largest railway systems in the world (Sustainability - UIC - International union of railways, 2023)

The railway systems are designed to supply the transfer of passengers or goods in densely populated areas, because this complex system to be sustainable requires large capital not only for its initial investment in infrastructure, but also for its operation and a railway system. To be profitable, the project must be in a stage of maturity where the payments for services for its use contribute to the total operating resources of the railway industry. However, to reach this point of equilibrium and profitability, it had to go through several stages where the economic contributions by the system services based on demographic growth and cargo services are increasing according to the population growth of the system's impact area. iron, but the economic resources obtained are not sufficient for the sustainability of the project's operation, so they must be accompanied by government subsidies based on the taxes collected. It is worth mentioning that all railway projects are generally supported by the governments of the Nations, due to the initial investment and its sustainability covers different stages, one of them is the short-term operation with the help of subsidies where these contribute a greater economic amount than payments for user services; however, long-term sustainability encompasses a project where, as it matures, subsidies are gradually reduced and income from services is increased as a result of the region's economic detonation.

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The long-term sustainability in its final stage that apart from covering the profitability of the railway company covers the modernization of the system throughout the infrastructure which, to remain within the preference of users, must be competitive with respect to other means of transport offering higher quality of service in a sustainable development program with a vision of reusing useless railway infrastructure for the system that allows obtaining a circular economy program. For this reason, railway system projects must be planned according to the plans and programs of the International Energy Agency for 100 years. If a railway system program is born with defects and does not enjoy the follow-up of the subsidies, it will be destined for bankruptcy in the next administrative change of the government of the nations and will operate with limited budgets until it presents unaffordable major maintenance by the railway company that will return it. inoperative. In the unsuccessful projects of railway systems, the infrastructure is composed of fixed railway lines in the region where it was installed and the trains as parts of the mobile elements. When the railway projects have failed, the sale of the components does not represent even 30% of the recovery of the initial investment in a circular economy with a business model where the largest contribution is made by the sale of the trains (mobile systems).

The creation of railway systems is due to demographic needs accompanied by energy savings, reduced travel time and emission of pollutants, but the opposite case may arise where the railway system is installed in low-demographic areas with limited land use by ecological reserves or protected areas that limit the expansion of urbanization generated by the incorporation of a railway system. In the second case, the railway system will not reach the detonation of the population explosion, nor the economy of large investments of subsidies of different means that allow it to survive.

Business strategies of a railway project

The business strategies of a railway system take as strategies the provision of transfers in densely populated areas with a high frequency of service along the lines, where the average income level creates sufficient demand for trips. Successful rail networks are effective in maximizing capacity utilization with a focus on cost reduction to be less dependent on subsidies.

Subsidy income has as the base of the pyramid the increase in land value with changes in land use for industry, commerce, and high-end housing generation. The revaluation of land close to the railway infrastructure is accompanied by the generation of infrastructure typical of urban areas that will be triggered by private capital that increases the surplus value of the areas surrounding the railway infrastructure.

The environmental impacts of land use are habitat alteration, noise effects, visual disturbance, ecosystem change, displacement of flora and fauna, invasion of ecosystems, water pollution, excessive felling, adaptation, and implementation of ecosystems in areas altered by urbanization, improvement of soil resistance, mineral impacts due to the high demand for concrete and steel, use of pesticides on the train tracks.

The financing of the development of an urban railway system does not only depend on taxes and subsidies: there are additional sources of income that can reach up to 60% of the project under optimal conditions and it depends on innumerable factors within their reach. In a rail system, capturing the benefits of land values in financing plans will offset the high cost of capital investment. “Land value capture” describes actions to benefit from increased commercial property values in the proximity of nodes and stations: Example, network developers must undertake high-return commercial projects within or attached to stations (construction of commercial premises, restaurants and hotels, providing an opportunity for the developer to participate in increasing land values to help finance the high-capacity transport network Tax increase financing is another approach, which involves the use of property taxes to use increased land values in the proximity of high-capacity transportation nodes to finance rail system development.

Other options to finance a railway system are, the taxation of the transport of urban railway systems, registration taxes, fuel taxes (the United States allocates about a quarter of the income from the gasoline tax goes to finance public transport). Pricing policies, road pricing, congestion charging, tolls on specific sections of the road network, parking fees, pricing, vehicle access restrictions in urban areas (peak hours) to promote public transport performance, taxes in private travel operating costs.

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Subsidies can be economically justified, if they do not exceed direct and indirect economic, social, and environmental benefits.

The lack of regulations or the application of regulations on land use is decisive in the way in which private property titles that have been granted for several decades appear. In the best of cases, the land areas before a railway project have private property titles for agricultural land and in the worst case scenarios there are not even owners legally protected by a property title and like the extensions of land in dispute have no rapprochement with an urbanized environment is of little interest to the inhabitants to delimit the properties, because its use is intended for an ecosystem not controlled by man if not by nature. When a project of a railway system is drawn up, it will imply carrying out a whole process of delimitation of properties based on the existing titles and in the case of non-existence, they will be identified by the government authorities and the railway project who, together with the dependencies, are those who issue property titles, taking advantage to become owners of large tracts of land not claimed by the people of small communities. When the railway system project begins to be executed due to its planning, the land surrounding the railway infrastructure already has recently issued owners and title deeds, but which allow the properties to be sold by different real estate consortiums (never known in the region). with different use of land going from reserved-agricultural use to industrial or commercial. This process causes the cost of the square meter of land to increase its value for the sale and resale of properties, which is called the technological explosion and industrialization of the area due to the incorporation of a means of transportation. The areas protected by the identification of species of flora and fauna, so that they can be considered in this exclusive use, must be duly registered in organizations, agencies at the national level and in international organizations, however in most of the global areas they are not counted. with documentation that specifically establishes that it is a protected zone, which is used to make changes in land use and generate a massive destruction of an ecosystem with great negative impacts on the ecological part of the region that generate an imbalance in the factors which constitute sustainable development due to the arrival of a railway system in the region and its technological advances due to private investment from different countries that come to generate an industrialization of the area with great promises of growth and surplus value in an environment that is dragging changes; social, cultural of the region and landscape ecosystem (Sustainability - UIC - International union of railways, 2023).

The train as the main means of transport with trunk auxiliary means of transport

Mobility in large cities that follow models of sustainable development, have as a tendency the mobility models of trunk means of transport, so that different means of transport supply the main system, which is the railway, due to this the sustainability of this does not represent a profitable business model, but it is worth mentioning that sustainable development projects are not exactly profitable in a unique way or in a monopoly way, they achieve their sustainability in a balance that corresponds to the average prices of all means of transport per unit of journey, where sometimes the means that contribute most economically to the business model are those of traditional base energies derived from carbon, but in a commitment of humanity for the balance in sustainable development allows environmental conservation strategies to seek a balance that allows the conservation of the planet with the help of responsible companies and societies.

Discussion of results

Although it is true that developed countries have turned their gaze to the railway, the difference in which the different countries and areas of the world find themselves is very uneven, so the governments of the different countries will have to visualize investment in the industry of your country and areas according to your railway infrastructure and demographic conditions that will make an investment in railway systems feasible-viable-sustainable and sustainable. It is worth mentioning that developed countries have around 23% of the trains in the world and that the predictions of railway system models obey certain specific conditions that involve a railway system with a certain maturity, where the energization of trains is done for the generation of alternative sources, highlighting nuclear, hydrogen, solar, photovoltaic, wind and a combination of the above.

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On the other hand, developing countries must take into account that the acquisition of a railway system from a developed country does not justify that its sustainable-sustainable development model in that potential country will be replicated as it is in underdeveloped countries, in In some cases, third world countries acquire an electric railway system when they do not have electricity generation systems in their infrastructure that can supply the high demands of the train; however, they could acquire a railway infrastructure system, electricity generation plants and all the infrastructure that trains require with a large investment from developing countries, but now within the models of the railway system it is clearly indicated that "it is for highly demographic places and with subsidies in its different stages of the project", but the lack Adequate advice often means that all these specifications that make a railway system sustainable are unknown and the governments of some countries place railway systems in areas of low population and, as underdeveloped countries, subsidies to the railway system may be committed to solve other sectors. of first necessity making the railway systems can be considered not such a good investment alternative that will generate prosperity under certain conditions, but quite the opposite when the development of the countries and the demographic conditions can make the system sustainable in the short, medium and above all in the long term with stages of modernization.

The investments of developing countries in railway systems must be carried out under a very complete analysis of all the factors involved in the different stages of the railway system, with real expectations of the development plans of those countries in an objective manner. In the case of developing countries and their investments in railway systems do not obey their demography in the area of operation of the train, the generation of energy sources, sustainable development models, however the illusion of thinking of having the larger train turns out to be attractive to the governments of the different countries that by acquiring infrastructures that are not suitable for their countries due to the development in which they are, by the sale of railway companies that offer wonders of progress in the purchase of their products as part of your marketing of your products.

It is understood that railway infrastructure companies and subsidiaries live from the sale of their product and are responsible for the quality of their product and operation within the warranty period, but the use and sustainability of the product is the responsibility of the end customer**.**

Conclusions

This investigation, after an analysis of the feasibility and viability of railway system projects, indicates that the incorporation of a railway system can be carried out through an investment project by any of the nations that want and can pay for the system. However, the discipline of compliance with +sustainable development parameters in a responsible manner will make the system sustainable in its different stages of the project with its implications for modernization and technological detonation coupled with changes; social, cultural and landscape ecosystem.

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References

Dillman, K. J., Heinonen, J., & Davíðsdóttir, B. (2023). A development of intergenerational sustainability indicators and thresholds for mobility system provisioning: A socio-ecological framework in the context of strong sustainability. Environmental and sustainability indicators, 18, 100240. https://doi.org/10.1016/j.indic.2023.100240

Mladenovič, L., Plevnik, A., & Rye, T. (2022). Implementing national support programmes for sustainable urban mobility plans in a multilevel governance context. Case studies on transport policy, 10(3), 1686-1694. https://doi.org/10.1016/j.cstp.2022.06.007

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Sustainability – UIC - International union of railways. (2023, 21 abril). UIC - International union of railways. https://uic.org/sustainability/

Xuto, P., Anderson, R. J., Graham, D. J., & Hörcher, D. (2022). Sustainable urban rail funding: Insights from a century-long global dataset. Transport Policy, 130, 100-115. https://doi.org/10.1016/j.tranpol.2022.10.005

Yin, C., Ji, F., Wang, L., Fan, Z., & Geng, S. (2022). Site selection framework of rail transit photovoltaic power station under interval-valued Pythagorean fuzzy environment. Energy Reports, 8, 3156-3165. https://doi.org/10.1016/j.egyr.2022.02.073

Dhaniswara, A. y Muthohar, I. (marzo de 2023). Estudio de viabilidad financiera y económica de la línea ferroviaria urbana Tempel-Yogyakarta-Samas. En Conferencia Internacional sobre Ferrocarriles y Transportes (ICORT 2022) (págs. 39-47). Prensa Atlántida.

25 años de concesiones ferroviarias de cargas en América Latina: ¿Qué anduvo bien? ¿Qué anduvo mal? | Publications. (s. f.). https://publications.iadb.org/publications/spanish/viewer/25-anos-de-concesiones-ferroviarias-de-cargas-en-America-Latina-Que-anduvo-bien-Que-anduvo-mal.pdf http://dx.doi.org/10.18235/0003184.

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Clearly focus each of its features

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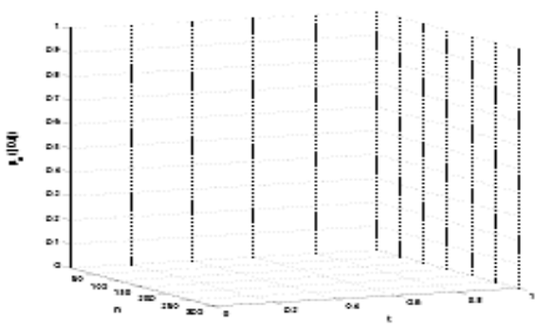

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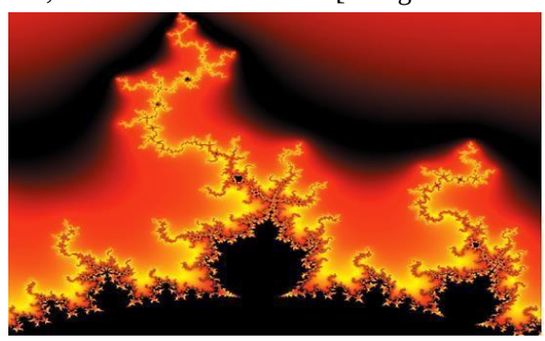

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