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Presentation of the Content

As a first article we present, *Validation of ring bending machine*, by FLORES-SÁNCHEZ, Verónica, MOJICA-ESPINOZA, Ángel, VALLEJO-HERNÁNDEZ, Arely and VENTURA-DE LA PAZ, Carlos Alberto, with adcription at the Universidad Tecnológica del Centro de Veracruz, as a second article we present, *Rare-earth zirconate pyrochlores A2Zr2O7 (A3 + = Nd, Sm, Pr, and Er) used as potential candidates for thermoelectric performance and for high temperature applications*, by QUIROZ-RODRÍGUEZ, Adolfo, GALINDO-MENTLE, Margarita, ORTEGA -PATRICIO, Javier, SANDOVAL-HERNÁNDEZ, Marco Antonio and BONILLA-JIMÉNEZ, Luis Antonio, with ascription in the Universidad Tecnológica de Xicotepec de Juárez, as the third article we present, Crushing equipment for the recycling of polyethylene terephthalate (PET), by GARCÍA- RIVERA, Josué Armando, CUCA-MENDOZA, Jorge Alberto, LÓPEZ-CHACÓN, Ana Cristina and HERNANDEZ-SANCHEZ, Alejandro Uriel, with adscription at the Universidad Tecnológica del Centro de Veracruz, as fourth article Inspection System with Neural Network and Vision Techniques for the Manufacture Industry, by MEDINA-MUÑOZ, Luis Arturo, LOPEZ-VALENCIA, Gabriel Antonio, MAYORQUÍN-ROBLES, Jesús Antonio and RODRIGUEZ-ESPINOZA, Indelfonso, with ascription in the Universidad Tecnologica de Nogales Sonora.

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Validation of ring bending machine

Validación de máquina dobladora de anillos

FLORES-SÁNCHEZ, Verónica*†, MOJICA-ESPINOZA, Ángel, VALLEJO-HERNÁNDEZ, Arely and VENTURA-DE LA PAZ, Carlos Alberto

Universidad Tecnológica del Centro de Veracruz, Av. Universidad No. 350 Loc. Dos Caminos, Carretera Fed. Cuitláhuac-La Tinaja, Cuitláhuac, Ver. C.P. 94910

ID 1st Author: *Verónica, Flores-Sánchez /* **ORC ID:** 0000-0001-7899-4592, **Researcher ID Thomson:** O-2622-2018, **CVU CONACYT ID**: 344279

ID 1st Coauthor: *Mojica, Espinoza-Ángel*

ID 2nd Coauthor: *Arely, Vallejo-Hernández/* **ORC ID:** 0000-0001-9249-5458, **Researcher ID Thomson:** O-3653-2018**, CVU CONACYT ID**: 664144

ID 3rd Coauthor: *Carlos A., Ventura-De la Paz*

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Abstract

The manufacture of metal rings for the construction of buildings in Mexico has been done by hand and over time has been improving with new techniques and better technology. These elements of construction were previously manufactured entirely manually, the workers (or craftsmen) used only 2 poles of small size to support the wire rod and be able to deform it. This process causes excess tiredness to the worker and the execution time is long and it is not very effective. Then machines emerged, which performed the bending with a lever and two bearings. Nowadays there are tube machines that work automatically, however these machines are very expensive and not manageable, another disadvantage is the difficulty to operate them. In order to overcome the aforementioned deficiencies, a portable ring bending machine is designed. The prototype deforms the material using a lever and a bearing, the above is done to give a better shape to the wire rod.

Prototype, Validation, Bending Machine

Resumen

La fabricación de anillos para construcción se ha hecho de forma artesanal y a lo largo del tiempo ha ido mejorando con nuevas técnicas y mejor tecnología. Estos elementos de construcción se fabricaban anteriormente en su totalidad de forma manual, los obreros (o artesanos) utilizaban solamente 2 postes de dimensión pequeña para apoyar el alambrón y poder deformarlo; este proceso, aparte de ser muy cansado y lento, dejaba los estribos con una forma muy irregular, y en general era muy difícil trabajar con ellos. Después surgieron quienes los hacen con una maquina simple, que consta de una palanca y dos baleros. En la actualidad existen maquinas que los hacen de forma automática, sin embargo estas máquinas son muy costosas y de dimensiones poco manejable, otra de las desventajas es la dificultad para operarlas. Con el fin de superar las deficiencias antes mencionadas se plantea el diseño de una máquina dobladora de anillos de dimensiones aptas para mover en construcciones no tan grandes y que además satisfaga la demanda actual de la construcción. El principio de funcionamiento del prototipo propuesto es muy similar a los antes mencionados, la diferencia radica en que para deformar el material utiliza una palanca con un balero, esto es para darle una mejor forma al alambrón aunque continua siendo un proceso bastante lento. El presente documento contiene el diseño y construcción de una máquina dobladora de anillos útil en la construcción de edificios, se incluye las recomendaciones y conclusiones basadas en la validación del prototipo.

Prototipo, Validación, Dobladora

Citation: FLORES-SÁNCHEZ, Verónica, MOJICA-ESPINOZA, Ángel, VALLEJO-HERNÁNDEZ, Arely and VENTURA-DE LA PAZ, Carlos Alberto. Validation of ring bending machine. ECORFAN Journal-Ecuador. 2018, 5-8:1-7.

*Correspondence to Autor (e-mail: calidad.utcv@gmail.com)
† Researcher contributing as first author.

Introduction

The decorative works with iron have been used since the Iron Age, the main technique was the forge. This technique consists in the heating of the pieces and their shaping with hammer blows, it was widely used to build doors, rails, balconies, furniture and ornamental objects, where you can distinguish twisted bars, spirals, rings, pineapples, shells and other figures.

During the middle ages the demand for weapons and iron armor increased due to the continuous wars, so much so that specialists began to emerge that achieved greater precision and quality.

With the industrial revolution the occupation of smith, was forced to change his work system, where the priority was serial production. However, until 2018 some craftsmen still subsist.

As part of the construction activities, is the manufacturing that is made to the rod and rod, the process is called torsion and involves twisting circularly to the profiles, plates or wire rod.

The above is done to form the castles that will be the support of the construction, figure 1 shows some types of castles or arms that are manufactured, to achieve the arillo that holds the rods, the wire rod is folded.

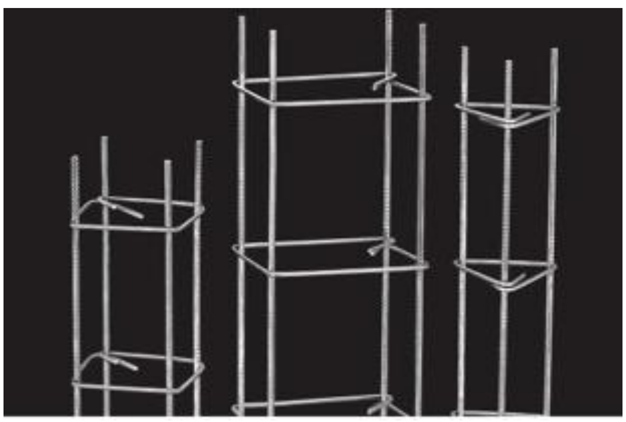

Figure 1 Castles or armes used in construction

For the manufacture of armes there are construction work tools that are very useful. In the market is a significant sum of manual machines for the realization of the bend of rods, the drawback of these machines is the time that is used in the realization of the fold due to the need to employ the labor force in this process.

The prototype presented in this document decreases: the range of error generated by the operator and the time used in the development of a bend of the rod; facilitates machine handling and increases worker productivity.

Methodology

As part of the first stage, the properties of the materials and how they can be affected were investigated. The chemical properties of the metal are modified due to the addition of various chemical elements, while the physical properties are affected by external forces such as heat, density, conductivity or melting temperature. Finally the mechanical properties tend to change due to the rolling, forming, stretching, bending, welding and machining of the material.

Fundamentals of metal bending

In figure 2 it can be seen that the bending of metals is a process that occurs when applying to a straight surface metal forces greater than the elastic limit or point of cadence, in a direction different from the neutral axis of the material, thus achieving a deformation permanent plastic curve (Doyle, 1980).

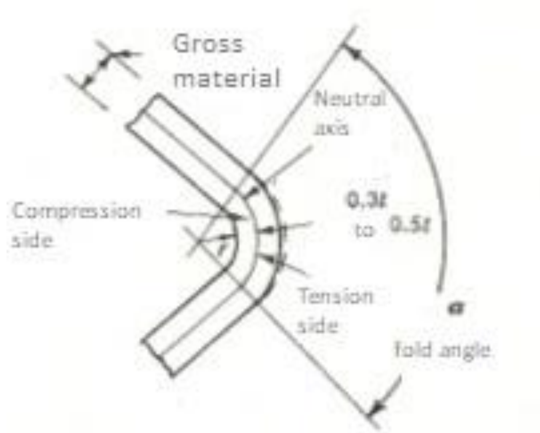

Figure 2 Nature of a metal fold

It is important to emphasize that when a metal is applied to effort beyond the elastic limit, it is able to manifest a certain amount of elastic recovery; therefore when it is doubled there is a possibility that it will return between 2º and 4º.

The bending process must be done at room temperature, avoiding heating the material, because when the temperature increases, the internal structure of the element is affected, crystallizing it, which causes a decrease in the mechanical strength of the element.

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On the other hand bending the cold metal causes that as the work increases more force is required and the hardness of the material increases, however, special care must be taken not to exceed the breaking stress of the material because from this effort the metal breaks, see figure 3, (Hibbeler, 1997).

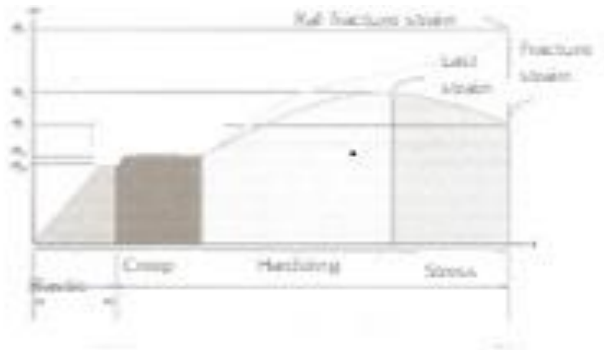

Figure 3 Unit strain deformation diagram for steel

Minimum bend radius

The quality of the curves obtained when bending a tube depends largely on the relationship between the outside diameter of the tube to bend, (Øe), and the radius of curvature obtained after bending the tube, (Rc). This relationship is known as the curvature factor (Fc).

$$Fc = \frac{Rc}{fe} \quad (1)$$

By means of the curvature factor, the minimum radius of curvature that can be given to the tube is determined in order that it does not present any achataduras, wrinkles or cracks.

Fc values between 1 and 2, indicate that the bend is of high difficulty, therefore it is necessary to heat the tube or use filler elements such as mandrels, resin, tar or dry sand to avoid quality defects.

The recommended value of the curvature factor is in a range of 2.5 to 3.5, in which the bend is considered simple.

Table 1 shows different pipe diameters, with their respective thicknesses and radii of curvature for a curvature factor 3.

Ø Nominal tube (in)	Ø Real Tube (mm)	Wall thickness (mm)	Minimum radius of curvature (mm)	Minimum radius of curvature (in)
0.5	20,63	2,5	61,9	2,4
0.75	25,05	2,5	75,2	3,0
1	**32,64**	**2,5**	**97,9**	**3,9**
1.25	42,16	2,5	126,5	5,0
1.5	48,26	2,5	144,8	5,7
2	59,24	2,5	177,7	7,0

Table 1 Minimum radius of curvature for different diameters and thicknesses with FC = 3

Bending techniques

In the second stage the different bending techniques are identified: bend by stretch, bend by tensile, bend by compression, bend in press, bend by rollers and roll extrusion.

Bent by stretching

The tube is clamped against a forming block or die that rotates and pulls the metal against the bend. The work piece that enters the bender is supported by a pressure bar. This method is widely used for working with thin-walled tubes and for small bend radii (Doyle, 1980). This process is shown in figure 4.

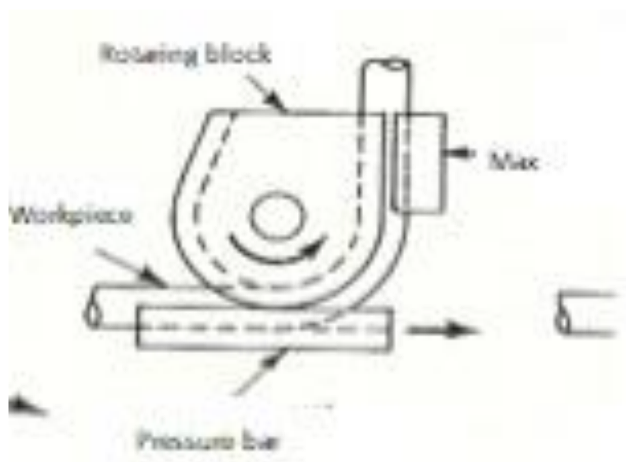

Figure 4 Bent by stretching

The maximum radius of curvature using this method is 180 degrees.

Bent to traction

Traction is exerted from both ends of the tube, while bending over a forming block, this technique is limited to large radius bends but is appropriate for curves that are not circular (Doyle, 1990). Figure 5 shows a diagram of the tensile bending.

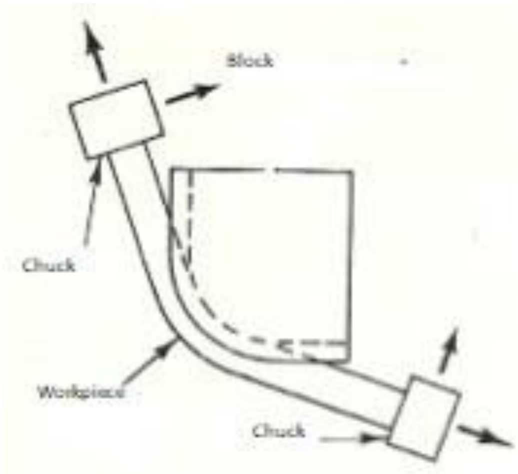

Figure 5 Bent to traction

Bent by compression

The working tube is fixed with a clamp and forced to wrap around a fixed forming die using a sliding clamp. This technique allows to make series of folds that almost do not leave free spaces between them, see figure 6 (Doyle, 1980).

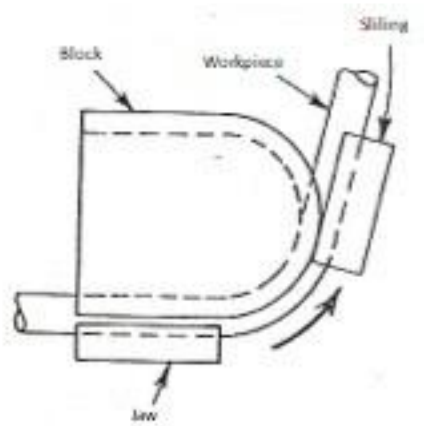

Figure 4 Bent by compression

Figure 5 Double in press or by pure flex

Figure 7 shows bending in press or pure bending. A curve is created by pressing a forming die on the tube in one movement. The tube is supported by a pair of separate dice, which rotate as the former moves toward the center by pushing the tube.

This movement wraps the tube around the former, allowing the end dies to support the tube on each side. This process is very fast and is excellent for high productions. However, the dice or their distribution must be changed to generate different varieties of curves. The maximum curve radius is 110 degrees. (DOUBATUBOS, 2008)

Bent by rollers

This technique uses three cylindrical dice to form the curve. This style of bending is typically used to develop large radius curves and to wind pipe (coils).

Bent by rollers. This technique uses three cylindrical dice to form the curve. This style of bending is typically used to develop large radius curves and to wind pipe (coils).

Figure 6 Bent by rollers

Extrusion by rollers. A head with wide push rollers on one side and a narrow work roll on the other side is rotated inside the tube.

The tube is surrounded with work rings on the outside of the head. The work roll is moved in and out by means of cams while rotating the head in order to apply pressure to extrude metal into the pipe wall laterally, to force it to bend. As the material is worked, the tube is advanced through the head.

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This technique is mainly used to bend pipes larger than 5 inches (127 mm) in outside diameter and with thicknesses greater than 5/8 inch (15.8 mm). The outline of this process is shown in figure 9 (Doyle, 1980).

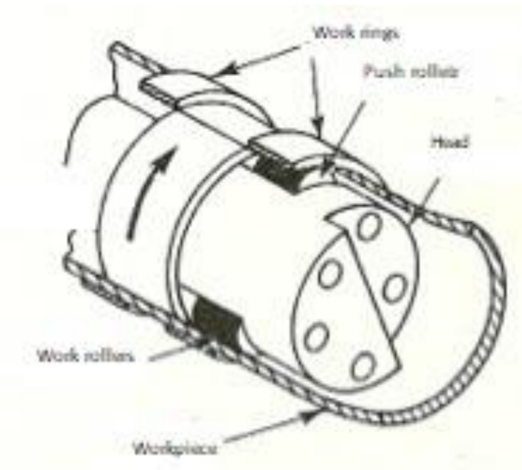

Figure 7 Roller extrusion

Benders available in the market

In the third stage some of the different bending machines available in the market are studied.

Manual benders

Figure 10 shows the Baileigh manual bending machine, has a unique die mechanism that allows you to easily bend when pulling a lever and with each movement delivers 10 degrees of curvature. It has the maximum capacity to bend 1-inch pipes - schedule 40, and 1-inch and 1-inch rectangular tubes. It is designed to bend round or square pipe, pipe, profiled angle in low carbon steel and solid rod (Fabricating Equipment Company, 2008).

Figure 8 Baileigh Bender Bender: RDB-100

The JD2 Model 3 Tubing Bender manual bending machine is shown in figure 11, accurately bends round and square tubes up to 180º, is easy to operate (Van Sant Enterprises, 2008).

Figure 9 Manual bender JD2 Model 3 Tubing Bender

Hydraulic benders

JD2 hydraulic bender model 4. The JD2 model 4 is a hydraulic machine that is easy to assemble and operate, with an anti-lock fuse that prevents the material from being returned. The dice changes are made in a fast way.

The bending capacity for round tube up to 2-½ inches (0.120 inches of wall), for square tube up to 1-½ inches and for pipes up to 2 inches - schedule 40 and 1-½ inches - schedule 8010, see figure 12 (Van Sant Enterprises, 2008).

Figure 10 Hydraulic bender JMR Air / Hydraulic Tube Bender

JMR hydraulic bending machine. The bending machine comes with dies available for 120º and 240º bends. It has aluminum and bronze bushings at the turning points, and its surface finish is black. It has been built for industrial work and is economic. It has a lifetime guarantee against dice breaks. Its round tube bending capacity is up to 2-½ inches, square tube up to 2 inches and pipe up to 2 inches - schedule 40. See figure 13.

Figure 11 Hydraulic bender JD2 model 4

Hydraulic bender Pro-Tools HB 302. The design of the machine is special to facilitate the change of the dice and tubes. It has been built to last for life. Its maximum capacity for pipes is ¾ of an inch. It has auto blocking to enable repetitive bends, see figure 14 (PRO-TOOLS, 2008).

Figure 12 Hydraulic bender Pro-tools HB 302 - 15 Ton

Hydraulic bender Huth Heavy Duty Tube & Pipe Bender. The machine is designed to bend heavy duty pipe, which uses industrial hydraulic cylinders. Folds round tube up to 3 inches, and has a maximum capacity for 2-inch pipe - schedule 80 and for square pipe up to 2 ½ inches. It has the option of auto parada13, see figure 15 (Van Sant Enterprises, 2008).

Figure 13 Hydraulic bender Huth Heavy Duty Tube & Pipe Bender

Once the mechanisms of the commercial benders were reviewed, the best practices of these mechanisms were identified. In stage 4, the design and construction of a manual bender prototype is presented (figure 16, 17 and 18), which allows to generate a curvature of 100 degrees, to bend rod and wire.

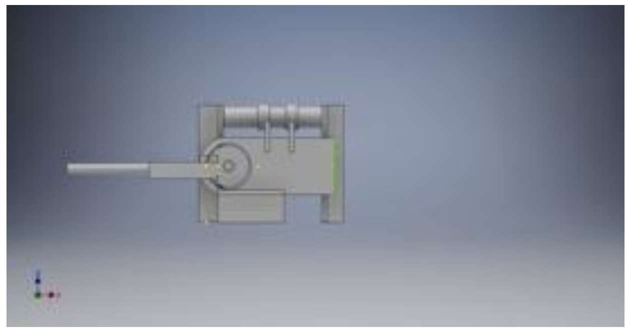

Figure 14

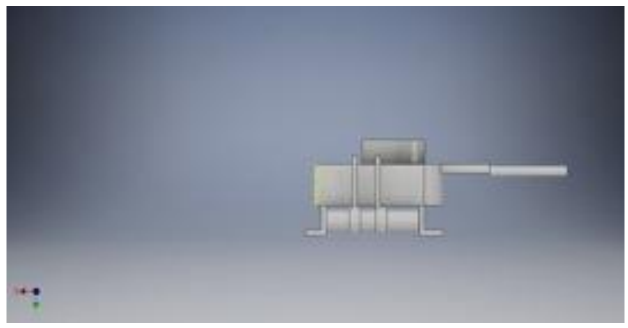

Figure 15

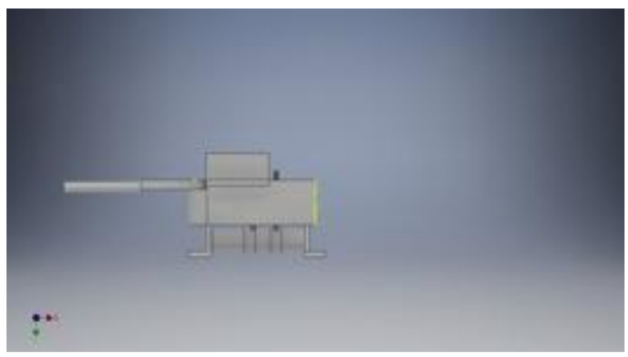

Figure 16

Figure 17 Finished prototype

For the construction, 3 "PTR was occupied, a date of 1", rolling bearings, which will measure the ring, the production cost of the prototype is seven hundred Mexican pesos. Finally the prototype is validated, the variable object of study is the number of armed rings per minute.

Results

The study of the number of rings folded manually in a construction is made, the time of 3 different people is measured in equal conditions, to avoid factors outside the process affecting the result. Table 2 shows that in one minute approximately 0.97 rings are made manually, in order to validate the prototype the test is repeated but now occupying the bending machine and it takes a minute to make 2.03 rings (table 3).

Time (min)	Rings made manually (Piece)			
	1 Test	2 Test	3 Test	Average
1	1	2	1	1.33
2	2	3	3	2.67
3	4	5	4	4.33
4	6	7	6	6.33
5	7	8	8	7.67
6	9	10	9	9.33
7	11	12	11	11.33
8	12	14	12	12.67
9	13	15	13	13.67
10	15	17	15	15.67
12	16	18	16	16.67
14	17	21	17	18.33
16	18	22	18	19.33
18	19	23	19	20.33
20	21	25	21	22.33
22	22	26	22	23.33
24	24	27	24	25
26	26	29	26	27
28	27	30	27	28
30	28	31	28	29
Pieces made per minute				0.97

Table 2 Rings made manually

Time (min)	Rings made with the bending machine (Piece)			
	1 Test	2 Test	3 Test	Average
1	2	3	2	2.33
2	4	6	5	5
3	7	11	8	8.67
4	8	14	9	10.33
5	11	16	12	13
6	12	19	14	15
7	15	21	15	17
8	17	23	17	19
9	18	24	19	20.33
10	20	26	22	22.67
12	24	29	27	26.67
14	28	33	31	30.67
16	31	37	36	34.67
18	35	41	39	38.33
20	39	45	43	42.33
22	43	48	47	46
24	47	51	50	49.33
26	52	55	54	53.67
28	55	59	57	57
30	59	63	61	61
Pieces made per minute				2.03

Table 3 Rings made with the bending machine

Conclusions

The results show that the machine has the capacity to duplicate the manufacture of rings, besides being comfortable and easy to use as it compiles the best of existing bending machines. Torsion of square rods mechanically means that operator safety is not affected by muscular exhaustion or injury.

References

Barrera, M. A., (2004). Diseño de una máquina para ranurar tubos protectores en la perforación de pozos para extracción de agua. Trabajo de graduación de Ing. Mecánico, Universidad de San Carlos de Guatemala, Facultad de Ingeniería.

Bendix, F., (1973). Alrededor del trabajo de los metales. Editorial Reverté, México. 1973.

Castillo, E. G., (1998). Diseño de una máquina selladora de tapones plásticos. Trabajo de graduación de Ingeniero Mecánico, Universidad de San Carlos de Guatemala, Facultad de Ingeniería.

Charchalac, C. A., (2004). Diseño y fabricación de una máquina espiraladora para el aumento de la productividad en una línea de carcasas para camas de resortes. Trabajo de graduación de Ing. Mecánico Industrial, Universidad de San Carlos de Guatemala, Facultad de Ingeniería.

Dobladoras de tubo digitales electricas electrohidraulicas para uso con mandril. (2018). Retrieved from https://www.dobladorasparatubo.com/dobladoras_para_tubo.html

Doyle, L., (1980). Proceso de manufactura y materiales para ingenieros. México D.F.

Erdman, A. G. & Sandor George N., (1998). Diseño de mecanismos: análisis y síntesis, 3 ed. México: Prentice Hall.

Exco Colombiana (2007). Nuestros procesos. Formado de tubos. Bogotá. Retrieved from http://www.doblatubos.com.ar/emtd.html

Van Sant Enterprises, (2008). JD2 Model 3 Tubing Bender. JD2 Model 4 Tubing Bender. JMR Air / Hydraulic Tube Bender. Baileigh RDB-150 Tubing Bender Retrieved from http://www.doblatubos.com.ar/emtd.html

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Article
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Rare-earth zirconate pyrochlores $A_2Zr_2O_7$ (A^{3+} = Nd, Sm, Pr, and Er) used as potential candidates for thermoelectric performance and for high temperature applications

Pirocloros de zirconato de tierras raras $A_2Zr_2O_7$ (A^{3+} = Nd, Sm, Pr y Er) utilizados como posibles candidatos para el rendimiento termoeléctrico y para aplicaciones de alta temperatura

QUIROZ-RODRÍGUEZ, Adolfo*†, GALINDO-MENTLE, Margarita, ORTEGA-PATRICIO, Javier, SANDOVAL-HERNÁNDEZ, Marco Antonio and BONILLA-JIMÉNEZ, Luis Antonio

Universidad Tecnológica de Xicotepec de Juárez, Ingeniería en Mantenimiento Industrial, Av. Universidad Tecnológica No. 1000, Col. Tierra Negra, C.P. 73080, Cd. Xicotepec de Juárez, Pue., México

ID 1st Author: *Adolfo, Quiroz-Rodríguez* / **ORC ID**: 0000-0002-9685-9455, **Researcher ID Thomson**: S-9189-2018, **arXiv Author ID**: adolfo-79, **CVU CONACYT ID**: 105471

ID 1st Coauthor: *Margarita, Mentle-Galindo* / ORC ID: 0000-0001-5390-5960, **Researcher ID Thomson**: S-9202-2018, **arXiv Author ID**: MargaritaG, **CVU CONACYT-ID**: 160164

ID 2nd Coauthor: *Javier, Ortega-Patricio* / ORC ID: 0000-0003-3751-4163, **Researcher ID Thomson**: S-9791-2018, **arXiv Author ID**: javierotega, **CVU CONACYT-ID**: X_ORTEGA73

ID 3rd Coauthor: *Marco Antonio, Sandoval-Hernández* / **ORC ID**: 0000-0003-4919-9682, **Researcher ID Thomson**: S-9199-2018, **arXiv Author ID**: marcoutxj, **CVU CONACYT-ID**: 93311

ID 4th Coauthor: *Luis Antonio, Bonilla-Jimémez* / **ORC ID**: 0000-0001-9753-1833, **Researcher ID Thomson**: S-9181-2018, **arXiv Author ID**: lubonji, **CVU CONACYT-ID**: 947690

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Abstract

The increasing interest in ecological aspects related to the reduction of harmful emissions to the atmosphere and, at the same time, the need to achieve higher efficiencies of energy production are the driving forces that justify the current development of advanced ceramic materials for high temperatura applications, namely those associated to energy and transportation industries. Ceramic matrix composites (CMCs), thermal barrier coatings (TBCs), environmental barrier coatings (EBCs) and solid oxide fuel cells (SOFCs) are increasingly used to work under the new demanding conditions. In this review, the recent progress and trends in the research and development of CMCs, TBCs, EBCs and SOFCs based on ceramic materials for high temperature applications are highlighted.

Solid-state reaction, Pyrochlore compounds, Crystal structure

Resumen

El creciente interés en aspectos ecológicos relacionados con la reducción de emisiones nocivas a la atmósfera y, al mismo tiempo, la necesidad de lograr mayores eficiencias en la producción de energía son las fuerzas motrices que justifican el desarrollo actual de materiales cerámicos avanzados para aplicaciones de alta temperatura, es decir, los asociados a las industrias de la energía y el transporte. Los compuestos de matriz cerámica (CMC), los recubrimientos de barrera térmica (TBC), los recubrimientos de barrera ambiental (EBC) y las pilas de combustible de óxido sólido (SOFC) se utilizan cada vez más para trabajar en las nuevas condiciones exigentes. El progreso y las tendencias recientes en la investigación y el desarrollo de CMC, TBC, EBC y se destacan las SOFC basadas en materiales cerámicos para aplicaciones de alta temperatura.

Reacción de estado sólido, Compuestos de pirocloro, Estructura cristalina

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*Correspondence to Autor (e-mail: adquiroz@hotmail.com)
† Researcher contributing as first author.

Introduction

Nowadays, the development and use of ceramic materials for high temperature applications has two main driving forces in the worldwide context, which can be summarized in two concepts: ecology and energy. The first driving force is related to the conservation of the natural environment, minimizing the damage of the ozone layer through the reduction of emissions to the atmosphere. The second driving force is associated with economical benefits derived from the saving of energy, which at the same time, is also connected with the preservation of the current fossil fuel stocks.

The researchers have focused their efforts in achieving higher efficiencies of energy production in parallel with a marked decrease in harmful emissions, mainly in CO_2 and NOx. This can be done, for instance, by increasing the operating temperature of engines and turbines combined with a reduction of the weight of their components. A higher operating temperature with little or no cooling air system will lead to superior thrust, less fuel consumption and reduced noxious emissions. Up to now, the materials employed in those applications were superalloys. However, the requirements to work under those new demanding conditions are over the limit of their capabilities, ceramic materials being excellent candidates to fulfill them.

They present good mechanical (strength, fracture toughness, creep, thermal shock resistance), tribological (erosion and wear resistance), chemical (oxidation and corrosion resistance), and physical properties (density, thermal conductivity, thermal expansion coefficient), which may be kept during long time at the service temperature. In this way, ceramic matrix composites (CMCs), thermal barrier coatings (TBCs) and environmental barrier coatings (EBCs) are increasingly used in high temperature applications in the energy and transportations industries.

Within this type of energy devices, solid oxide fuel cell (SOFCs), which are based on ceramic materials, are of great interest because their high operating temperatures (800 – 1000 ^oC) allow them to be powdered by hydrogen or light hydrocarbons, giving rise to almost clean energy production.

Numerous investigations are carried out the electrolyte the properties of their ceramic components, such as the ionic conductivity of the electrolyte or the chemical stability of the electrodes, in order to increase the efficiency of the device [M. Belmonte, 2006]. Recent studies performed by ionic bombardment on zirconate pyrochlores of general formula $Ln_2Zr_2O_7$ where Ln = lanthanide have shown a good resistance against radiation damage when compared with equivalent titanates [J. Lian, *et al*., 2007].

The aim of this work is to structural and morphological properties study of rare-earth zirconate pyrochlores compounds $A_2Zr_2O_7$ (A^{3+} = Nd, Sm, Pr, and Er) synthesized by solid state reaction method. Towards the goal of a more directed and effective search for high-performance metal–oxide thermoelectric materials, we introduce this compounds that can be used potential candidates for thermoelectric performance and for high temperature applications.

Materials and Methods

Polycrystalline samples of the $A_2Zr_2O_7$ (A^{3+} = Nd, Pr, Sm, and Er) compounds were synthesized by solid-state reaction at ambient pressure in air. The starting materials were ZrO_2 (Riedel-de Haën pure), Nd_2O_3 (Aldrich, 99.9 %), Sm_2O_3 (Aldrich, 99.9 %), Pr_2O_3 (Cerac, 99.9 %), and Er_2O_3 (Aldrich, 99.9 %). Structure and purity of the starting materials were determined by XRD. The stoichiometric mixture of the starting materials was done in air during 30 minutes, grinded with an agate mortar, resulting in homogenous slurry.

The resultant $A_2Zr_2O_7$ mixture was compressed into pellets (13 mm diameter, 1.0-1.5 ± 0.05 mm thickness) by applying a pressure of 3 tons/cm^2 during 5 minutes under vacuum. The resulting compacted specimens were then sintered in air at 1400 ºC during 3 days and then cooled down to room temperature following the natural cooling of furnace to 7 h. The thermal behaviors of $A_2Zr_2O_7$ compounds were studied from 25 to 1200 ^oC through differential thermal analysis (DTA), thermogravimetric analysis (TG) and differential thermal analysis using measuring equipment SDT Q600, TA instruments.

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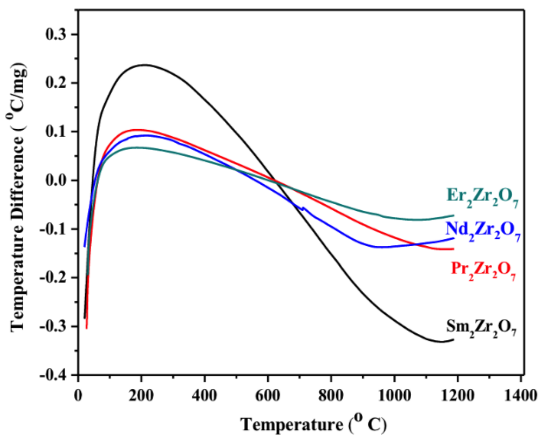
The powdered samples were characterized by X-ray powder diffraction (XRD) using an APD 2000 diffractometer with Cu Kα radiation (λ = 1.5406 Å) and a graphite monocromator. Diffraction patterns were collected at room temperature in air, over the 2θ range 10º- 90º with a step size of 0.025º and a time per step of 15 seconds. Changes in morphology and grain size were induced in the samples by performing different heat treatments during all the process of the samples preparation and examined by scanning electron microscopy (SEM) on a Hitachi S-3400N-II System. The 15.00 K.X micrographs were taken with a voltage of 15 kV, a current intensity of 1000 pA and WD = 4.5 mm. Energy Dispersive X-Ray (EDX) was performed on the same SEM system, which is equipped with an EDAX 9900 device.

Results and Discussions

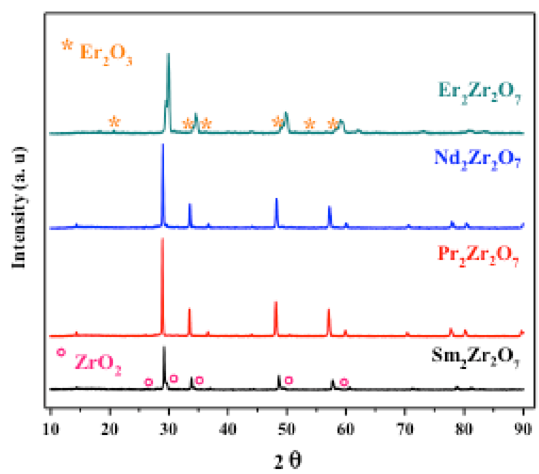
The DTA curves for $A_2Zr_2O_7$ compounds, with A^{3+} = Er, Nd, Sm, and Pr are presented in Graphic 1. All the samples present a first endothermic effect at around 100 °C, it is associated with a minimal loss of weight. The exothermic effect observed between 200 °C and 700 °C, together with the loss of weight in the same temperature range, could be attributed to the oxidation of the compounds. For temperatures higher than 700 °C, endothermic effects are observed that are important to understand the stability in the solid solution formation mechanism as its thermal stability, except for the $Sm_2Zr_2O_7$ compound that reaches its formation stage more quickly that others compounds (Ciomaga-Hatnean *et al.*, 2015), (Rodríguez-Carvajal *et al*., 1993), (Matsuhira *et al*., 2009), (Ciomaga Hatnean *et al.*, 2014), (Koohpayeh *et al.*, 2014), (Ferro, 2011), (Raghuvanshi *et al.*, 2013), (Surble *et al.*, 2010), (Zhang *et al*., 2008), (Shannon, 1976).

Graphic 2 presents the X-ray diffraction patterns of the sintered $Er_2Zr_2O_7$, $Nd_2Zr_2O_7$, $Pr_2Zr_2O_7$ and $Sm_2Zr_2O_7$ compounds. Pyrochlores $A_2Zr_2O_7$, with A^{3+} = Nd, Sm, and Pr have a cubic polycrystalline structure with Fd$\bar{3}$m (No. 227) spatial group and hexagonal rhombus with R-3 (No. 148) spatial group for $Er_2Zr_2O_7$. In addition, we can see that there is a peaks shift small of the $Er_2Zr_2O_7$ compound with respect to the peaks of the $Nd_2Zr_2O_7$, $Pr_2Zr_2O_7$ and $Sm_2Zr_2O_7$ compounds.

This is because the ionic radius of Er^{3+} = 0.890 Å is smaller than the radii ionic Nd^{3+} = 0.983 Å, Pr^{3+} = 0.99 Å and Sm^{3+} = 0.958 Å) (Shannon, 1976) and also has a structural change. For the $Er_2Zr_2O_7$ sample, it detected two phases that are identified as $Er_2Zr_2O_7$ and Er_2O_3 compounds. The solid line corresponds to a hexagonal rhombus phase with Fd$\bar{3}$m (No. 227) space group and it is identified as $Er_2Zr_2O_7$ compound with PDF (01-071-1024). The phase marked with an asterisk (*) corresponds to the Er_2O_3 compound, PDF (03-065-3175). The presence of this very small amount of Er_2O_3 compound indicated that occur an overload of the reagent in the compound.



Graphic 1 Differential thermal analysis curves of pyrochlores $Nd_2Zr_2O_7$, $Sm_2Zr_2O_7$, $Pr_2Zr_2O_7$ and $Er_2Zr_2O_7$ compounds



Graphic 2 XRD Patterns evolution of pyrochlores $A_2Zr_2O_7$ compounds, with A^{3+} = Nd, Sm, Pr, and Er

We performed an EDX analysis on all samples to verify the chemical composition. The results are present in Table I. The error range of the analysis is between 1 and 6wt% (Beaman, 1972); therefore it can said that the experimental and theoretical atomic percentages of the elements resemble each other.

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Figure 1 shows the SEM image of the *$Nd_2Zr_2O_7$, $Sm_2Zr_2O_7$, and Pr_2Zr_2O* samples. The image shows the effect of heat treatments and processing route on the grain morphology of the compounds. Considerable variations in sizes, very few phases and shapes of polycrystals can be observed from the micrograph.

Elements					
Compounds	Nd	Pr	Sm	Zr	O
$Nd_2Zr_2O_7$	52.55			24.35	23.11
$Pr_2Zr_2O_7$		50.26		29.35	20.39
$Sm_2Zr_2O_7$			53.05	24.30	22.66
$Nd_2Zr_2O_7$	52.55			24.35	23.11

Table 1 EDX analysis of the $A_2Zr_2O_7$ (A= Nd, Pr, and Sm) Compounds

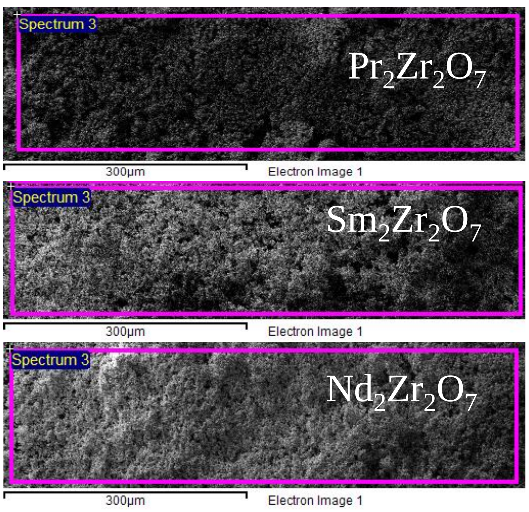

Figure 3 EDX of the $Nd_2Zr_2O_7$, $Sm_2Zr_2O_7$, and Pr_2Zr_2O compounds

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Conclusion

In this work, we obtained polycrystalline compounds of $Nd_2Zr_2O_7$, $Sm_2Zr_2O_7$, $Pr_2Zr_2O_7$, and $Er_2Zr_2O_7$ by solid-state reaction method in air at atmospheric pressure. The crystal structure of the compounds and final product $A_2B_2O_7$ is a mixed, were determined by X-ray powder diffraction and Scanning electron microscopy. SEM micrographs shows the effect of heat treatments and processing route on the grain morphology of the compounds.

Perspectives

As future considerations, we can expand the determination of the thermoelectric, electrical properties and the calculation of the Seebeck coefficient. This has attracted a renewed interest as a fundamental technology for environmentally friendly energy conversion. In particular, thermoelectric power generation has been now considered as a possible renewable energy resource.

References

Beaman, D. R., Isasi, J.A. (1972). Electron Beam Microanalysis, Special Technical Publication American Society for Testing and Materials. 506 23.

Belmonte, M. (2006). Advanced Ceramic Materials for High Temperature Applications. Advanced Engineering Materials. 8(8): 693-703
Ciomaga Hatnean, M., Decorse, C., Lees, R. M., Petrenko, A. O., Keeble, S. D., and Balakrishnan, G. (2014). Structural and magnetic properties of single crystals of the geometrically frustrated zirconium pyrochlore, Pr2Zr2O7. Materials Research Express 1 026109.

Ciomaga Hatnean, M., Lee, M. R., and Balakrishnan, G. (2015). Growth of single-crystals of rare-earth zirconate pyrochlores, $Ln_2Zr_2O_7$ (with Ln = La, Nd, Sm, and Gd) by the floating zone technique, Journal of Crystal Growth, 418 1–6

Ferro, S. (2011). Physicochemical and Electrical Properties of Praseodymium Oxides International Journal of Electrochemistry. 2011 1-7

Koohpayeh, M. S., Wen, J.-J., Trump, A. B., Broholm, L. C., and McQueen, M. T. (2014). Synthesis, floating zone crystal growth and characterization of the quantum spin ice $Pr_2Zr_2O_7$ pyrochlore, Journal of Crystal Growth 402 291–298.

Lian, J., Zu, T. X., Kutty, G. V., Chen, J., Wang, M. L., and Ewing, C. R. (2002). Ion-irradiation-induced amorphization of $La_2Zr_2O_7$ pyrochlore. Phys. Rev. B, 66(5): 054108-1-054108-5.

Matsuhira, K., Sekine, C., Paulsen, C., Wakeshima, M., Hinatsu, Y., Kitazawa, T., Kiuchi, Y., Hiroi, Z., and Takagi, S. (2009). Spin Freezing in the Pyrochlore Antiferromagnet $Pr_2Zr_2O_7$. J. Phys.: Conf. Ser. 145 012031.

Raghuvanshi, P., Thakur, A. N., and Rani, P. (2013) Characterization, Electrical and Magnetic Properties of $Nd_2Zr_2O_7$ Compound, Asian Journal of Chemistry; Vol. 25, No. 8, 4237-4241.

Rodríguez-Carvajal, J. (1993). Recent advances in magnetic structure determination by neutron powder diffraction, Physica B, 192 55–69.

Shannon, D. R. (1976). Revised effective ionic radii and sytematic studies of interatomic distances in halides and Chalcogenides. Acta Crystallographica Section A32, 751-767.

Surble, S., Heathman, S., Raison, P. E., Bouëxieère, D., Popa, K., Caciuffo, R. (2010). Pressure-induced structural transition in $Ln_2Zr_2O_7$ (Ln = Ce, Nd, Gd) pyrochlores, Physics and Chemistry of Minerals. 37:761–767.

Zhang, X. F., Lang, M., Becker, U., and Ewing, C. R., and Lian, J. (2008). High pressure phase transitions and compressibilities of $Er_2Zr_2O_7$ and $Ho_2Zr_2O_7$. Applied Physics Letters 92, 011909.

Article

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Crushing equipment for the recycling of polyethylene terephthalate (PET)

Equipo de trituración para el reciclado de polietileno tereftalato (PET)

GARCÍA-RIVERA, Josué Armando†, CUCA-MENDOZA, Jorge Alberto, LÓPEZ-CHACÓN, Ana Cristina and HERNANDEZ-SANCHEZ, Uriel Alejandro

Universidad Tecnológica del Centro de Veracruz, Ingeniería en Mantenimiento Industrial, Av. Universidad 350, Cuitlahuac, C.P. 94910, Veracruz, México

ID 1st Author: *Josué Armando, García-Rivera* / **ORC ID**: 0000-0003-3442-1199, **Researcher ID Thomson**: Q-2983-2018, **CVU CONACYT ID**: 939329

ID 1st Coauthor: *Jorge Alberto, Cuca-Mendoza* / **ORC ID**: 0000-0001-7840-6236, **Researcher ID Thomson**: Q-2985-2018, **CVU CONACYT ID**: 939333

ID 2nd Coauthor: *Ana Cristina, López-Chacón* / **ORC ID**: 0000-0003-3242-7431, **Researcher ID Thomson**: Q-2910-2018, **CVU CONACYT ID**: 509850

ID 3rd Coauthor: *Uriel Alejandro, Hernandez-Sanchez* / **ORC ID**: 0000-0003-1488-3601, **Researcher ID Thomson**: Q-2907-2018, **CVU CONACYT ID**: 482289

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Abstract

Nowadays one of the materials most used by humans is polyethylene terephthalate (PET), or better known as plastic. However, its high demand causes a large production and waste capacity, which combined with its long resistance to degradation makes it last in the environment for much longer, causing great damage to the ecosystem and becoming a terrible ally for the environmental pollution. In Mexico, we are the second consumer of PET containers for packaged beverages in the world using approximately 450 thousand tons; and the first for bottled water containers, where in 2014 alone, 21 million PET bottles were produced per day, of which only 20 were recycled by the way. The main objective of this project is to build a medium-cost polyethylene terephthalate (PET) crushing dequipment that contributes to the reduction of waste and promotes the recycling culture. This with the idea of being able to replicate it later and implement it in different areas of the region.

Crusher, Recycling, Polyethylene Terephthalate

Resumen

Hoy en día uno de los materiales más utilizados por el ser humano es el polietileno tereftalato (PET), o mejor conocido como plástico. Sin embargo su gran demanda provoca una alta capacidad de producción y desecho, que aunado con su larga resistencia a la degradación hace que perdure en el medio ambiente por mucho más tiempo, logrando causar grandes daños en el ecosistema y convirtiéndose en un aliado terrible para la contaminación ambiental. En México, somos el segundo consumidor de envases de PET para refrescos en el mundo, empleando 450 mil toneladas de este plástico, aproximadamente; y el primero para recipientes de agua embotellada, en donde tan sólo en el 2014 se generaron 21 millones de botellas PET al día, de las cuales solo se reciclaron el 20 por ciento. Es por ello que el principal objetivo de este trabajo es construir un equipo de trituración de polietileno tereftalato (PET) de mediano costo que permita contribuir en la disminución de residuos y lograr incentivar la cultura de reciclaje. Esto con la idea de poder replicarlo más adelante e implementarlo en diferentes zonas de la región.

Trituradora, Reciclaje, Polietileno Tereftalato

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† Researcher contributing as first author.

Introduction

Currently, plastic has become a threat to the entire ecosystem and also to society. It is deteriorating our planet and the lives of people as they are products whose manufacture is intended to last hundreds of years without realizing that in most cases they are only used a couple of minutes to then be discarded quickly.

A world without plastics, seems unimaginable nowadays, however, its production and use on a large scale dates back to 1950. Although the first synthetic plastics appeared at the beginning of the 20th century, the widespread use of plastics outside the armed forces was not produced until after World War II. The rapid growth resulting in the production of plastics is extraordinary, surpassing most other man-made materials. (Geyer 2017).

There are several classifications of pollution, but certainly the pollution generated by the activities of man is the most serious. (Arellano 2015). In Mexico, the Environment and Natural Resources Commission estimates that 90 million bottles of soft drinks and water, made with polyethylene terephthalate (PET), are thrown into public roads, roads, forests, beaches, rivers and seas.

At present, the oceans are filled with eight million tons of plastic per year; it is estimated that by 2020 it will be 500 million tons, due to the accelerated production of plastics and that the degradation process of PET in the oceans is slower than in the earth. Derived from the above, the average apparent national consumption (CNA) of PET in Mexico amounts to 745 thousand tons per year. In addition, we are the second consumer of PET containers for soft drinks in the world and the first for containers of bottled water.

	Thousands of tons				
	2012	2013	2014	2015	2016
CNA of PET in Mexico for packaging	715	710	700	722	745
Representation of our associates	64%	64%	64%	67%	60%
Total partners sent to the market	460	457	448	482	450
Recycled post-consumer PCR resin	-	54	76	72	74
Total recovered as a country	414	428	405	364	425
Recovery rate	57.90 %	60.30 %	57.80%	50.40%	57%

Figure 1 Registration of the PET CNA in the last years
Source: ECOCE Magazine 15 years

On the other hand, it should be noted that although Mexico is a leader in the American continent in PET collection and recycling, with 50.4 percent of the material reused and 14 recycling companies is not enough to stop this great waste.

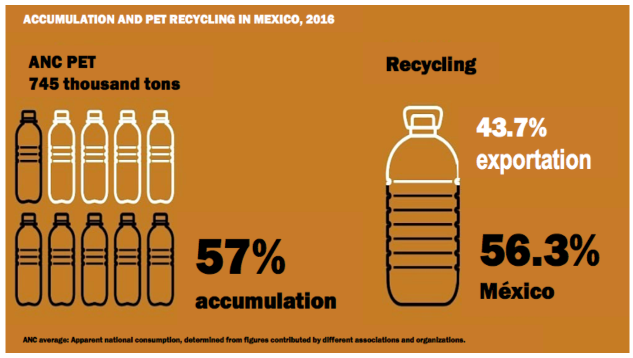

Figure 2 Collection and recycling of PET in Mexico, 2016
Source: Magazine ECOCE 15 years

Keep in mind that all the plastic that is around you is a resource, not a waste. (Hurtado 2012).

Through the valuation of post-consumer PET packaging waste in pesos / kilogram, the mass collection of these has been promoted and increased, year after year. In 2001, PET waste in bulk was worth $ 0.30 / kg, while in 2017 they reached values of $ 3.50 / kg in bulk. Therefore, it can become a source of income and an educational tool for our community. Recycling represents a frontier in the development of society, as technology advances, consumption levels accelerate. Now it is essential to consider the design of the cities and plan the techniques that will be used to reduce this problem. (Szécsi 2006)

With this project we want to show the importance that the plastic waste have to reduce or eliminate the existing pollution by this material. By reducing the demand for new virgin plastic and closing the cycle of materials, we can improve the lifestyle of people around the world, especially due to the growing environmental impact and the rising generation of waste produced by human consumption today. (Davis 2005)

Methodology to be developed

The following research work seeks to solve the problem of waste reduction, by means of a crushing equipment. This device is an important part of the process of recycling PET bottles.

For the development of this technology, descriptive research is applied and the main stages of its development are mentioned:

1. Selection and assembly of three-phase motor-reducer for the required power.
2. Design and manufacture (plasma cutting) of the blades to be used contemplating the final assembly.
3. Design and manufacture of base and equipment supports. This activity also includes the assembly of the insulation box for PET reduction.
4. Purification and adjustment of the equipment. This section includes the coupling of the motor, adjustments in the blades and insulation box and finally the visual presence of the equipment.

Selection and Assembly of Motor-Reducer

The main problem of this equipment is to find adequate cohesion between the reducer and the engine, which provides the expected revolutions to achieve the torque required 85 - 95 RPM. The motor gives a speed of 1410 RPM and a power $P = 1.5\ KW$ which is coupled to a reducer with ratio 1:15 giving an output speed of 94 RPM.

Output speed:

$$\omega s = 94\ rpm \qquad (1)$$

Being a one-stage reducer, the axles rotate at the input and output speeds, respectively, these being 1410 rpm for the input shaft and 94 rpm for the output shaft. In addition, the torque on each axis is calculated with the following formula:

$$T(Nm) = P(w)\ \omega(rad/s) \qquad (2)$$

$$Te = (1500 \cdot 60) / (1410 \cdot 2\pi) = 10.15\ Nm \qquad (3)$$

$$Ts = (1500 \cdot 60) / (94 \cdot 2\pi) = 152.38\ Nm \qquad (4)$$

Since the axes must transmit a uniform power, the torsional deflection is limited to 1.5º / m in length.

The rotation produced by a torsion moment T, on an axis of diameter d, on a length L as it is a circular section is:

$$\theta / L = (32 \cdot T) / (\pi \cdot d\ 4 \cdot G) \qquad (5)$$

All known data being known that the modulus of torsional stiffness G of steel is $G = 7.92 \cdot 1010 N / m^2$. Obtained through the analysis of the following data:

– Young's Module E = 206000MPa
– Poisson module (elastic) $\vartheta = 0.3$

$$d = \sqrt{32 \cdot T\ \pi \cdot 7.92 \cdot 1010} \qquad (6)$$

$$d = \sqrt[4]{(32T)/(\pi(7.92)(10^{10})(2.62)(10^{-2}))} \qquad (7)$$

From the previous formula the minimum diameters of the input and output axes are obtained.

$$de = 0.0205m = 2.26cm \approx 2.5\ cm \qquad (8)$$
$$ds = 0.0270m = 2.97cm \approx 3\ cm \qquad (9)$$

Design and manufacture of the blades

The machine parts (crusher) were designed in AutoCAD for assembly. The area is subject to the cutting characteristics provided by the motor-reducer torque.

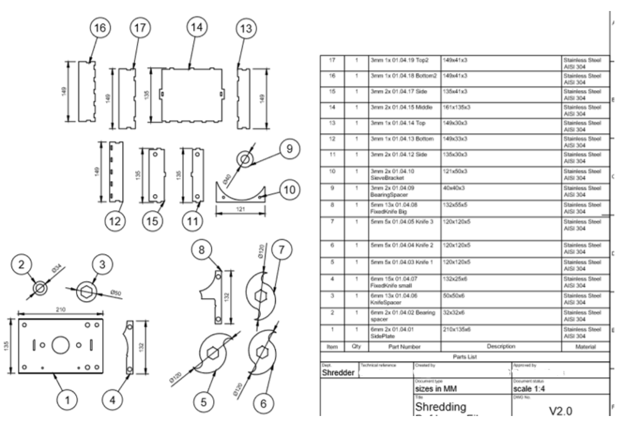

Figure 3 Blade design

Figure 4 Blade manufacturing

Design and manufacture of base and equipment supports

In this stage the structure was designed where the crusher machine will go along with the motor and reducer. The total weight of the equipment and the dimensions of the devices used were taken as reference. Likewise, ergonomics for human-machine interaction was endeavored.

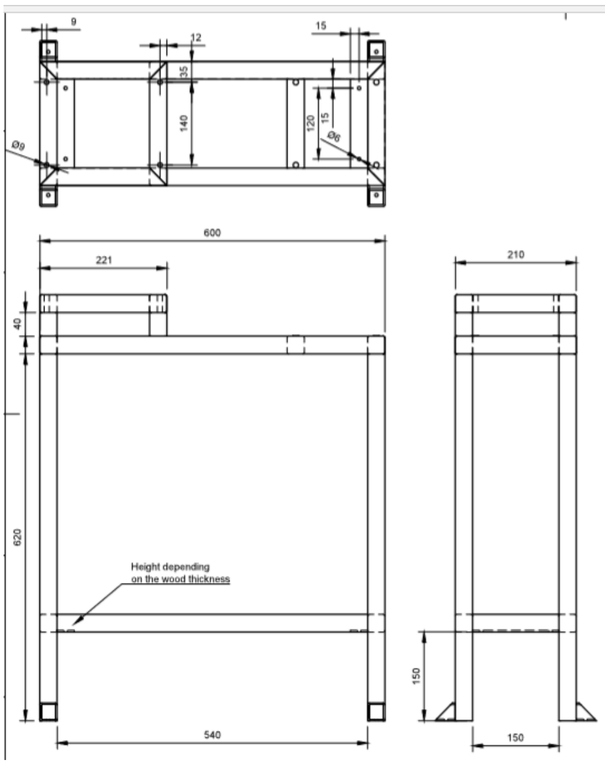

Figure 5 Structure design

Figure 6 Structure manufacture

Tasks were performed such as cutting and welding metal parts for the base, the crusher insulation box was assembled to protect the operator and was fixed to the supports of the metal base.

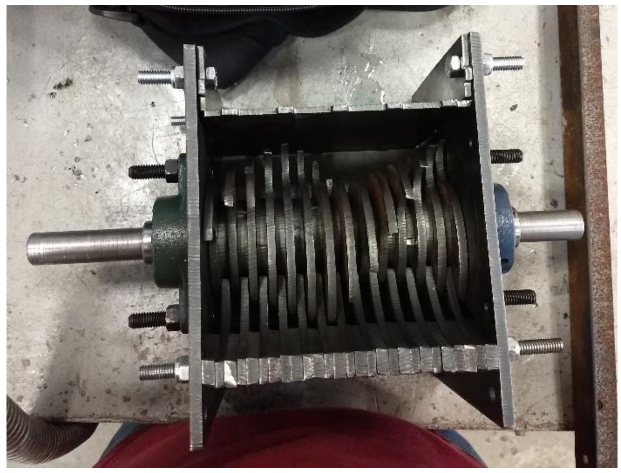

Figure 7 Assembly of blades to the structure

Purification and adjustment of equipment.

Once all the devices have been assembled, excess and imperfections to the base are eliminated and the couplings for the motor, reducer and arrow are machined.

Figure 8 Manufacturing of couplings for the engine

Figure 9 Manufacture and assembly of bearings to the arrow

Results

The proposed mechanical design for the construction of the structure of the crushing equipment worked properly, complying with the basic technical specifications that should cover this type of machines.

On the part of the electrical system had some complications at the time of making the first tests, since not all the engines that were counted could be coupled with the motor-reducer, for which adaptations were made in the size of the arrow and it was adjusted for its correct functioning. Obtaining in this way a reduction in the number of revolutions granted by the engine and a greater torque, which translates into PET being crushed in a more efficient and faster way; otherwise, when increasing the speed, the blades were not able to press the bottles and they went to the sides, not being able to be crushed at the first attempt.

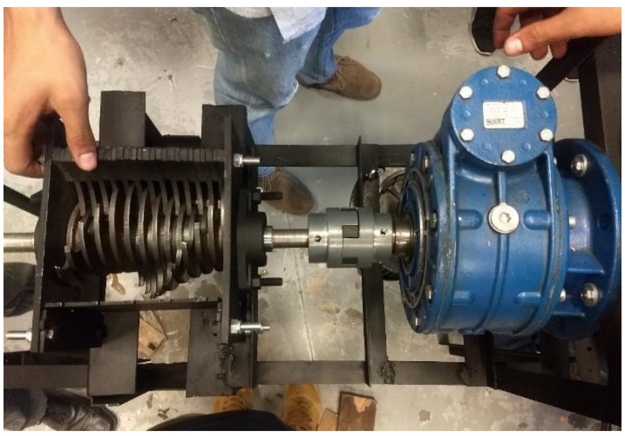

Figure 10 Engine alignment

Once stabilizing the crushing system, we continued to adapt a hopper and a lid with which it is ensured that the bottles to be crushed remain in place without running the risk that some surplus or excess of plastic could jump towards the user that is operating the machine. With all of the above already well assembled and secured, the final tests were continued, from which the following data were obtained:

Amount of PET crushed in one minute:

50 bottles of 20 grams each
(1 kilogram)

Amount of PET crushed in one hour:

3000 bottles of 20 grams each
(60 kilograms)

Conclusions

The present project beyond a pilot team is an initiative with the premise of helping to implement viable solutions for the conservation of our environment and environment, since the development of economic and efficient technologies will make a positive impact on society.

The project has areas of opportunity, such as seeking to improve the crushing control and monitoring system to allow better management and production of the recycled material; as well as looking to be able to handle in the future another type of waste material that is feasible to be used in recycling.

References

Arrellano Díaz J., Guzman Pantoja J. (2015) Ingeniería Ambiental. ALFAOMEGA mexico D.F.

Davis M.L, y Masten.S.J. (2005). Ingeniería y ciencias ambientales. McGraw–Hill. México, 705 pp.

Geyer R., Jambeck J.R. (2017) Production, use, and fate of all plastics ever made. Science advances – Research article. 17 de Julio 2017. Washintong, D.C.

Hurtado Moreno, J. J. (2012). Aprovechamiento de la Basura Doméstica Como Medio de Sustentabilidad en la Ciudad de México. 1er Foro Interdisciplina y Espacios Sustentables 25 al 27 de Mayo 2011 Universidad de Guanajuato, Guanajuato, México.

LGEEPA (2007). Ley General del Equilibrio Ecológico para la Protección al Ambiente. México. Diario Oficial de la Federación 5 julio 2007.

LGPGIR (2007). Ley General para la Prevención y Gestión Integral de los Residuos. México. Diario Oficial de la Federación 19 junio 2007.

Szécsi, A. E., & e-libro, C. (2006). Reciclado de ciudades: Nuevas herramientas de planificación y diseño urbano para intervenir en ciudades existentes. Buenos Aires, Argentina: Nobuko.

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Article

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Inspection System with Neural Network and Vision Techniques for the Manufacture Industry

Sistema de inspección con redes neuronales y técnicas de visión para la industria manufacturera

MEDINA-MUÑOZ, Luis Arturo†*, LÓPEZ-VALENCIA, Gabriel Antonio, MAYORQUÍN-ROBLES, Jesús Antonio and RODRIGUEZ-ESPINOZA, Indelfonso

Universidad Tecnologica de Nogales Sonora / Mecatronica

ID 1st Author: *Luis, Medina-Muñoz* / **ORC ID**: 0000-0001-9598-1451, **Researcher ID Thomson**: H-4735-2018, **CVU CONACYT ID**: 454558

ID 1st Coauthor: *Gabriel, López-Valencia* / **ORC ID**: 0000-0001-9274-395X, **Researcher ID Thomson**: H-5383-2018, **CVU CONACYT ID**: 883105

ID 2nd Coauthor: *Jesús, Mayorquin-Robles* / **ORC ID**: 0000-0002-3438-2098, **Researcher ID Thomson**: H-4071-2018 y **CVU CONACYT ID**: 471236

ID 3rd Coauthor: *Indelfonso, Rodrìguez-Espinoza* / **ORC ID**: 0000-0001-6405-9886, **Researcher ID Thomson**: I-1513-2018, **CVU CONACYT ID**: 346230

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Abstract

The inspection of components with vision systems is a task that can be achieved with different methods, in this project the problem is solved applying artificial neural networks. This project uses the technique of image erosion against a mas-ter picture (connector) and neural network pattern recognition after erosion. The acceptability of connectors (Shells) is achieved using the recognition of elements by means of artificial vision, on this work explains how we can extract the key features of the image and we convert these to numbers and feed the neural net-work to determine if a connector meets the requirements or is a defective con-nector. The system was tested in the inspection area of receipt in local manufac-ture factory, where the first inspection of the components is carried out, against their drawing. The validation results of the vision system show that the wrong components, oval and those that did not have the angular guides on the position expressed in the supplier's drawing and established as necessary by design were rejected.

Inspection System, Manufacture Industry, Neural Network, Visión System

Resumen

La inspección de componentes con sistemas de visión es una tarea que se puede lograr con diferentes métodos. En este proyecto, el problema se resuelve aplicando redes neuronales artificiales. Este proyecto utiliza la técnica de erosión de imagen contra una imagen maestra (conector) y el reconocimiento de patrones de redes neuronales después de la erosión. La aceptabilidad de los conectores (carcasas) se logra mediante el reconocimiento de elementos por medio de visión artificial. En este trabajo se explica cómo podemos extraer las características clave de la imagen y las convertimos en números y alimentamos la red neuronal para determinar si Un conector cumple con los requisitos o es un conector defectuoso. El sistema se probó en el área de inspección de recepción en la fábrica local de manufactura, donde se realiza la primera inspección de los componentes, en contra de sus planos. Los resultados de la validación del sistema de visión muestran que se rechazaron los componentes incorrectos, el óvalo y los que no tenían las guías angulares en la posición expresada en el dibujo del proveedor y establecidas según sea necesario por diseño.

Sistema de Inspección, Industria de Manufactura, Red Neural, Sistema Visión

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*Correspondence to Autor (e-mail: lmedina@utnogales.edu.mx)

† Researcher contributing as first author.

Introduction

The lower labor cost in developing nations compared with that in developed economies often results in difficulty in justifying automation machinery. While such technology can improve the quality of product, and productivity as well as reduce the cost of the products, in developing and emerging economies there is often a need for manufacturing companies to ask for support to research center as the universities, address students to support the local industries [1].

Artificial Vision (AV) uses images that are captured by an industrial vision camera and later processed through the specific software. In this way, AV is able to measure, count, verify, select and identify faults and anomalies and, based on this processing, the technology also has the ability to make decisions such as expelling a determined product of the production line when this does not meet the quality standards required. These decisions are made based on pre-established parameters, so that everything that does not comply with these parameters, it is considered wrong [2].

In a local manufacture industry, 4000 harnesses are manufactured per day. The harnesses have a mean of two (2) connectors each, and a verification of these connectors is made daily. Due to a strict quality criterion, all cables are subjected to a double visual inspection. Even with these activities, there are losses of around 50,000 USD per year for rework and defects. Price of a vision system in the market tend to range of 2,000 to the 100,000 USD. The local manufacture industry has an area of inspection of receipt, so the cost for the system of vision could be as high as 60,000 USD.

The system would be expected to have inspection machine programmable optics, and also require the hiring of specialized personnel in the field or hiring support companies which would represent up to another 15,000 USD per year. The cost would be justified on the grounds that in certain applications the teams need to be constantly adjusted or retrained, due to the changing nature of the environment where they work.

The aim of this paper is to propose to develop a low-cost automatic inspection system using vision techniques and artificial neural networks trained with the backpropagation algorithm capable to reduce the human errors.

The inspection system would need to be fast and reliable, able to detecting orientation, diameter and defective machined keyways of connectors used in the automotive and military industry.

Background

Artificial Neural Networks (ANN) have been developed as generalization of math-ematical models of human cognition and have shown promise for solving difficult problems in areas such as pattern recognition and classification. A neural network consists of a group of simple elements called neurons which process input infor-mation. Using neural networks as a classifier requires a training phase and a testing phase. In the training phase, the neural network makes the appropriate adjustment for its weights (W) to produce the desired response. When the actual output response is the same as the desired one, the network has completed the training. In the testing phase, the neural network is asked to classify a new set of images and its success is evaluated [3].

In [11] the authors addressed the task of identifying surface defects or imperfections in foundry processes such as inclusion, cold lap and misruns. The authors used a segmentation method that marks the region affected by some of the defects, and then applied machine learning techniques to classify the incorrect regions. The researchers used the weka tool to perform the classification task with the algorithms NaiveBayes, SVM, J48 KNN, and RandomForest (RF). With RF, with a sample of 50 they achieved an approximately 95% accuracy. In a similar way, our work seeks to identify defects in a connector through the method of erosion to later predict using a neural network. In our work, the acuracy was 97%.

Maintaining quality standards is important in any company due to the rotation of employees in the inspection area. At work [12] the authors propose a neural network model to help industrial practitioners make decisions in the area of inspection with binary inputs.

The experimentation was carried out using 70% of the data for training and 30% for testing. The authors conducted a two-stage evaluation. In the first, a neural network was allowed to decide if the product was a rejection. In the second stage, a second neural network model decided if the piece could be reworked or it was definitely scrap.

Unlike our work, the authors used input from experts, while this work takes information from the pieces through a camera. In phase 1, they reached 97% of pieces correctly classified and in phase 2 accuracy was 98%. Unlike our work, the authors used input from experts, while this work takes information from the pieces through a camera.

Development

Due to the strict quality requirement and lack of artificial vision inspection, it is necessary the inspect 100% of connectors. The company uses double inspection of connectors. During the manufacture process and final inspection by quality control, but still with double inspection the company rejected 16,000 connectors and 300 defective harnesses that were accepted by manufacture and quality control by January and March of 2017. The cost of bad quality has been estimated in 50,000 USD.

Our systems use the inspection camera Mighty Scope. The camera has integrated 6 high intensity LEDs; the LEDs help in 85% of cases to avoid the low illumination factor. Moreover, the camera was designed to inspection task. For this reason, the lens in dedicated to capture details on the picture, this is of helpful to obtain images for processing. The camera specifications are shown in Table 1.

Signal Output	USB 2.0
Magnification based on a 17" monitor	Resolution: 640 x 480 (Max. ~ 95X), Resolution: 1024 x 768 (Max. ~ 150X), Resolution: 2048 x 1536 (Max. ~ 300X)
Video format	AVI
Gain Control	Automatic
Snap Shot Mode	Hardware & Software controls
White Balance	Automatic
Power Source	5VDC through USB port
O/S	Windows XP, Vista, 7, 8, & 10 | Mac OSX 10.6 or above
Power Consumption	260mA (AVG)
LED Lighting	6 White LEDs
Working Distance	At 10x (112mm), At 20x (42mm), At 30x (19mm), At 40x (8.5mm)

Table 1 Camera Avent Mighty Scope specification

To obtain the image of the connector, the camera must remain stable. For this rea-son, it was necessary to use the camera stand " Migthy Scope View Stand". The design of fixure to place the connectors in the same position. This action helps to avoid the false rejection on the inspection. Figure 1 shows the camera and fixture together.

Figure 1 Inspection camera

Figure 2 shows the flowchart of our systems

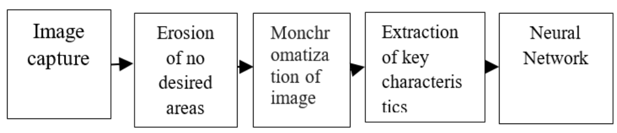

Figure 2 Flowchart of the system

Capture Interface: An application was developed in MATLAB which iterated with the camera and obtain the image as is shown in Figure 3.

Erosion of not desired areas: The erosion technique was used to obtain the clear and defined area of connector keyways, the area to be inspected, the erosioned image is show in Figure 4.

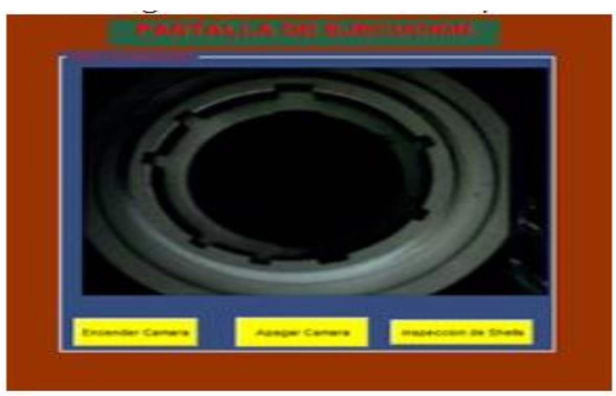

Figure 3 Workspace of the system

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Monocromatization of image: Figure 5 shows an image monocromatic of the connector under insepction, the keyways to be analyzed are shown in white.

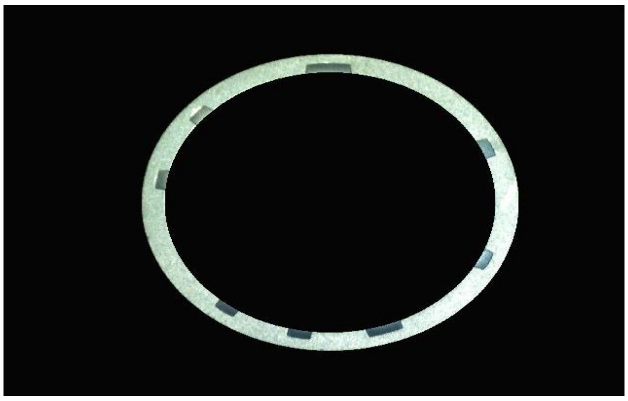

Figure 4 Aplication of erosion technique to original image

The extraction of the key characteristics, in our case the position of the keyways of the connector is achieved by sweeping 360° on the diameter of the connector. It requires sweeping the keyways position as a cicle. The output data of key characteristic extraction, are expressed as ‘1,’ where it detects that the space is found and a ‘0’ where it does not exist, Table 2 provides the information obtained.

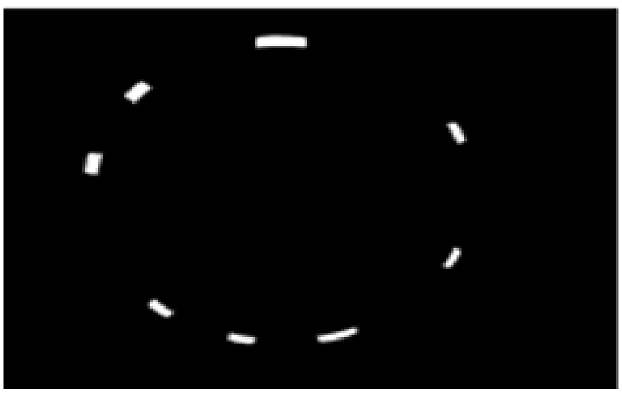

Figura 5 Monocromatic figure of conector, view of key characteristics

0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	1	1	1	1	1	1
1	1	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	1	1	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	1	1	1	1
1	1	1	1	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	1
1	1	1	1	1	1	1	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	1	1	1	1	1	1	1	1	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	1	1	1	1	1	1
1	1	1	1	1	1	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	1	1	1	1	1	1
1	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0

Table 2 Reading of 360 degress sweep binarizated

Artificial Neural Networks: As a result of the experiment, implementing an ANN trained with the backpropagation algorithm, such as the one shown in Figure 7, is proposed. A neuronal structure of this type gave the results with a higher degree of success.

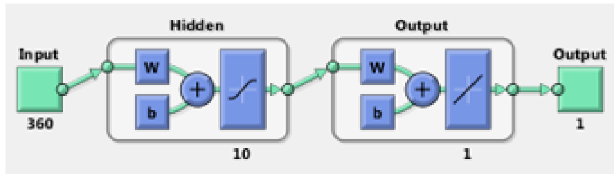

Figure 7 ANN structure

Results

The developed interface, which contains the capture process, image processing using artificial vision techniques and neural networks as an intelligent technique for image classification is shown in Figure 3. A multilayer perceptron RNA with a training back-propagation algorithm was used, with 10 neurons in hidden layer. The decision on the use of this type of neuronal structure is based on a test analysis of different topologies with a set of training and test data that satisfy the company's quality policy. Overall, 97% accuracy was obtained, using cross validation. Table 3 shows the number of connectors for the training and the test vector.

Descriptión	Quantity
Acceptable connectors	230
No acceptable connectors	50

Table 3 RNA Training set

Finally, a complete batch of the product was used as test vector. In this case, the connectors under test were used, which corresponded to the amount of 2,412 connectors in incoming area. Table 4 shows the results of the test inspection.

Lot of Connectors	Test Results
2,412	2,412 successful identifications
	0 rejections

Table 4 Inspection Results

The inspection time required was dramatically reduced, showing a great improvement when this proposed automatic process is implemented, as shown in Table 5.

Inspection type	Time of Inspection
Manual	150 seconds
Automatic	8 seconds

Table 5 Comparative of inspection

After training different models of ANN with the same amount of data, we can see that the proposed model performs well, classifying without errors of inspection the number of connectors shown in Table 4, with a success rate of 100%. The results shown in Table 5 show a fast process, reducing the inspection time by 95%. One of the proposed objectives has been achieved in that we have a fast and reliable inspection system. This model also shows that it is possible to reduce the costs of implementing the system by 94%, making the comparison in what an industrial system costs and the development of the application. This proposed inspection device can be used to check the quality of other products using only the appropriate training data for the ANN and the results can be compared with each other.

Results and Conclusions

After training different models of ANN with the same amount of data, we can see that the proposed model performs well, classifying without errors of inspection the number of connectors shown in Table 4, with a success rate of 100%. The results shown in Table 5 show a fast process, reducing the inspection time by 95%. One of the proposed objectives has been achieved in that we have a fast and reliable inspection system. This model also shows that it is possible to reduce the costs of implementing the system by 94%, making the comparison in what an industrial system costs and the development of the application.

This proposed inspection device can be used to check the quality of other products using only the appropriate training data for the ANN and the results can be compared with each other. The use of high level programming languages facilitates the elaboration of interfaces that match or exceed the characteristics of the products of the industrial type used to visualize information. In addition, with the development of computing they facilitate the incorporation of artificial intelligence algorithms and vision processing techniques that, when used with comercial video cameras, we can desing automatic inspection systems.

Future work involves expanding learning and recognition with connectors that correspond to other models and implementing a set of automated inspection equipment throughout the manufacturing plant.

References

[1] Oppenheimer.: El impacto de la automatización en países de ingresos medios. www.semana económica.com. Junio del 2018.

[2] https://recursos.infaimon.com/hubfs/ebooks/MON_-_eBook

[3] Banumathi, P., Nasira, G.M. : Fabric Inspection System using Artificial Neural Networks. International Journal of Computer Engineering Science (IJCES). Volume 2 Issue 5 May 2012

[4] Saravanan, A.: Artificial Neural Intelligent Visual Inspection for Process Improvement International. Journal of Innovative Research & Development, Annamalai, 2013, 768-778.

[5] Mogatti, M.: Automatic PCB Inspection algorithms: A Survey, Elsevier, Rolla, 2007, 287-313.

[6] Diab, S.L.: Designing a Visual Inspection System for Quality Characteristics Dimensions. In: 9th International Proceedings on Proceedings. pp. 1–2. Publisher. (2010).

[7] Hunter, D., Hao, Y., Pukish, M.: Selection of proper neural network sizes and architectures. IEEE Transactions on Industrial Informatics. Volume: 8, Issue: 2, May 2012.

[8] Hernández, R., Medina, L.: Red neuronal artificial para detección de partes por color con visión artificial en industria médica local. Nogales, Sonora, Mexico: ITN. 2015.

[9] Patel, V.C., R. W.: Color Computer Vision and Artificial Neural Networks for Detection of Defects in Poultry Eggs. Artificial Intelligence Review, 163-176. 1998.

[10] Pastor, I., Santos, I., De la Peña, J., Salazar, M., Santamaría, A., Bringas, P.: Collective classification for the detection of surface defects in automotive castings. Industrial Electronics and Applications (ICIEA) 2013. 8th IEEE Conference on. pp. 941-946, 2013.

[11] Kesharwani, R., Dagli, C., Sun, Z.: Application of Neural Network in Shop Floor Quality Control in a Make to Order Business. Procedia Computer Science Volume 95. Pages 209-216. 2016.

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* Correspondence to Author (example@example.org)
† Researcher contributing as first author.

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General explanation of the subject and explain why it is important.

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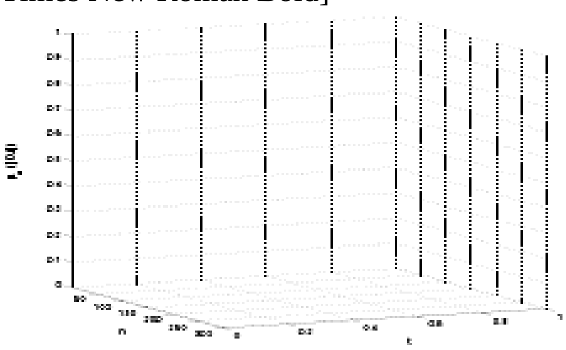

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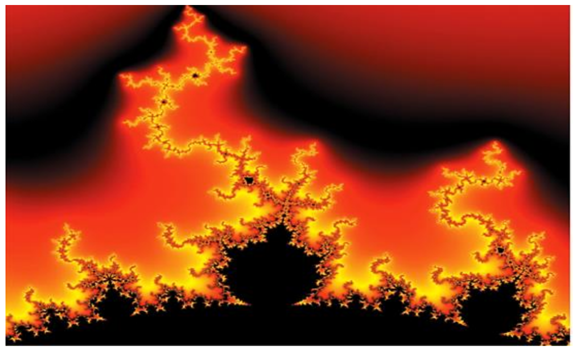

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Methodology

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