Pencil of fire

Lápiz de fuego

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Abstract

The research project seeks to develop its own technology for design and construction of pencils or fire pirógrafos, from ferromagnetic debris burned as are the ballast of the luminaries who operate gas (Fluorescent, hotbeds of neon, etc.) under an architectural design of new and innovative processor architecture is as E-E which allows greater room to add more laps in proportion to the primary and secondary for a better performance. Also, on this research paper seeks to develop an insulator on the basis of the composition of clay- dental plaster and ash to the core of pyrography to reduce the flow of heat and achieve a better insulation to prevent burns on the hands of artists and give them a tool to work safely and reliably.

Fire, Pencil, Woodburning, Core

Resumen

El proyecto de investigación busca desarrollar una tecnología propia para el diseño y construcción de lápices de fuego o pirógrafos , a partir de desechos ferromagnéticos como son las reactancias quemadas de la luminarias que funcionan a gas (Fluorescentes, focos de neon, etc) bajo una arquitectura de diseño de transformador nueva e innovadora como es la arquitectura E-E que permite un mayor espacio para añadir mayor número de vueltas de modo proporcional al primario y secundario y consiguientemente un mayor rendimiento. En este mismo sentido el presente trabajo de investigación busca desarrollar un aislante sobre la base de la composición de arcilla- yeso de dentista y ceniza para el núcleo del pirograbador para reducir el flujo de calor y lograr un mejor aislamiento para evitar quemaduras en las manos de los artistas y dotarles de esta forma una herramienta de trabajo segura y confiable.

Fuego, Lápiz, Pirógrafo, Núcleo

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Introducction

In today's world, whose main characteristic is the permanent change of knowledge and rapid advances in technology, it is necessary to provide solid training and continuous improvement of the human resources that society needs to face the dynamics in which it develops. Therefore, higher education must adapt to the social and economic requirements originated by the accelerated processes of scientific and technological change and world globalisation. Social demands have increased and a more capable, fuller and more humane professional is required, in this sense the University must commit efforts to train competent professionals, with a critical and reflective sense, for that reason the research component in the training of human resources is essential so that the mode of professional action is through scientific research, therefore from the classrooms of the undergraduate, and from the first courses in the Faculty of Technology we intend to impregnate the scientific spirit in our students through end-of-course projects and other types of manifestations, which seek the mastery of the scientific research method by the students and this is how the result of the research carried out during the course of several semesters in the subject of Basic Physics III, which corresponds to the third semester of Engineering, is presented in this scientific fair, which is the development of technology to manufacture pyrographs or fire pencils.

When we put a graphite pencil in the hands of a plastic artist we can admire his drawings with their shades and contrasts typical of this technique, but if we study the laws of Joule, Ohm, Faraday, Lenz, Ampere so beautifully summarised in Maxwell's Equations, and we apply them in the design and construction of a device called a fire pencil or Pyrograph, we will put in the hands of the artist a technological resource that transferred to the dimension of art, can convert simple and simple wood (not admired) in true works of art whose shadows and contrasts can be achieved with the variations of voltage and current and that inspired by the talent of the artist can be worthy works of art. The arts have arisen from the need of human beings to express their thoughts and feelings. In the same way, some craft manifestations have their origins within peoples and cultures as a means of expression, which over time, is transformed into a craft.

In certain parts of the world characterised by the existence of extensive wooded areas and a variety of woods, a special technique of decorating wood with an incandescent piece of wood emerged. This technique is called pyrography.

This forest wealth was exploited during the time of the Spanish colony and the Jesuit missions so that both Europeans and indigenous people could make utensils that were used in everyday life; in response to market demand, they began to be made to order.

And although pyrography seems to be a recent art, in Nazca, Peru, a mate decorated in this technique was found dating from 700 AD, with the design of a flower on the neck and nine hummingbirds around it.

The main tool for the pyrography technique is the pyrograph; This device has a handle into which different tips are inserted depending on the effect to be achieved. The incandescent tip burns the wood, which results in establishing a low heat flow and a high temperature gradient between the tip, which is normally between 400 to 200 °C, and the outer wall of the handle, which must be at an average temperature of 25 to 36 °C so that the artist's hand does not feel the intense heat of the incandescent filaments, This gradient must be achieved in a few millimetres of handle thickness because it cannot be too thick, otherwise it would be uncomfortable when drawing. To solve this problem, in the present work different heat insulating materials are investigated on the basis of mixtures of clay-ash-dentist's plaster that have a good mechanical resistance, as well as the use of resistive tips that glow at the lowest possible current for a lower energy consumption. Fundamental elements for the construction and manufacture of Bolivian brand pyrographs.

Materials and methods

Materials

Various materials were used at different times.

- Clay, dentist's plaster, ash, etc.

- Ferromagnetic waste (burnt-out reactances from luminaires).

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- Copper wires for winding.
- Cardboard for reels.
- Connecting cables.
- Female-male plugs.
- Nickel and nicron resistors.

Instruments:

- Multimeter with thermocouple for measuring temperatures.
- Clamp tester for current measurement.
- Voltmeters.
- Precision balance.

Methods used

We are undoubtedly in the era of the integration of the sciences, which is why we will approach the dialectical paradigm, where a more active role of the subject in the development of knowledge is denoted and which states that the essence of the phenomenon is never known, but only a reflection of it. In this context, dialectics is defined as the science that studies the most general laws of the development of nature, society and thought.

Theoretical methods to be used:

Theoretical methods allow us to penetrate from the phenomenal to the essence of the studied object, to model it and establish its essential relations and to make it concrete in the construction of the nationally manufactured pyrographer.

Documentary research: For the bibliographic study of all the antecedents and references on the development of transformers, their application in pyrographs and fire pencils in the international context.

Modelling: Used to model the functioning of the pyrograph in an idealised and schematic way before its construction and through the theoretical procedure of abstraction it can be recreated, establishing new relations and qualities of the object.

Concrete and abstract approach: To concretise the idealised model in the construction of the pyrograph itself, so that all the research lands in a concrete way in a new pyrography equipment of national manufacture.

Systemic approach: Because it allows the pyrograph to behave as a whole formed by many elements in such a way that each element fulfils certain functions and maintains stable links of interaction between these elements.

Analysis and synthesis: For the mental and material decomposition or division of the pyrograph into its component parts, in order to determine the essential elements that make it up, and for the integration of the previously analysed parts, as well as to discover relationships and general characteristics inherent to the object of study.

Abstraction and Generalisation: To reflect the stable and necessary general qualities and regularities of the pyrographer.

Statistical methods

To determine the differences between the treatments to which the clay-gypsum-ash sample was subjected and to establish the reliability of the results. Parametric statistics will be applied, which will allow us to apply its own scientific methods to collect, organise, summarise and analyse data, as well as to draw valid conclusions and make reasonable decisions based on such analysis. The supporting software used is Mstat (Statistical Software).

Empirical methods

The empirical methods will allow to collect the experimental data in the different tests through instruments designed for this purpose, and then to process them.

Software used

Software for transformer design, created by the students themselves in JavaScript Mstat (Software for experimental design) Spreadsheet (Excel)Microsoft Word

Design and construction of the transformer

An E_E architecture transformer will be designed, i.e. different from the conventional one because there is a greater possibility of more turns entering the primary and secondary circuit in a proportional way, which represents a greater possibility of better power performance.

Design and calculation

This section briefly explains how Ohm's, Joule's, Ampere's and Faraday's laws support the design of the transformer.

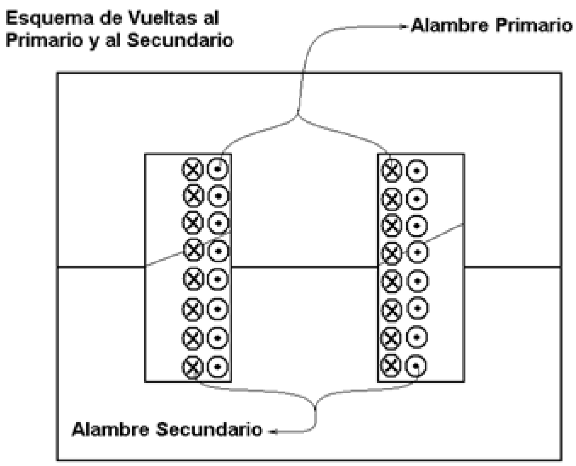

Figure 4

The input voltage is alternating and works with its r.m.s. value Vf which is 220 V.

$$V = V_{MAX} \times Sen(wt) \quad (1)$$

Frequency

$$f = 50Hz$$
$$V_{MAX} = 311V$$
$$V_F = 220V$$
$$V_F = \frac{V_{MAX}}{\sqrt{2}}$$

Application of Ohm's Law

V1 =I1 xZ1

V2=I2 x Z2

Where:

Z1=impedance of the primary circuit in ohm.

Z2=impedance of the secondary circuit in ohm.

The impedance concepts apply because the voltage is alternating.

Application of Ampere's law.

The alternating current of the primary circuit generates a field B also alternating which is calculated with Ampere's law along the path which would be the average perimeter of the core, this field in turn when cutting the core section S, generates the magnetic flux.

$$\oint B.dl = \mu_0 i_1$$
$$B\lambda_p = \mu_0 i_1$$
$$B = \frac{\mu_0 i_1}{\lambda_p}$$
$$B = \frac{\mu_0 \times I_{MAX} \times Sen(wt)}{\lambda_p}$$
$$B = B_{MAX} \times Sen(wt)$$

$$\phi_B = B \times S$$
$$\phi_B = B_{MAX} \times Sen(wt) \times S$$
$$\phi_B = \phi_{MAX} \times Sen(wt)$$

The magnetic flux, being time-varying, then induces an alternating voltage V2 also in the output coil, which turns out to be the transformed voltage, thus fulfilling Faraday's Law as the principle of operation of a transformer.

$$V_2 = -N_2 \frac{d\theta_B}{dt}$$
$$V_2 = -N_2 \times \phi_{MAX} W \times Cos(wt)$$
$$V_{2MAX} = N_2 \times \phi_{MAX} W$$
$$V_2 = -V_{2MAX} \times Cos(wt)$$

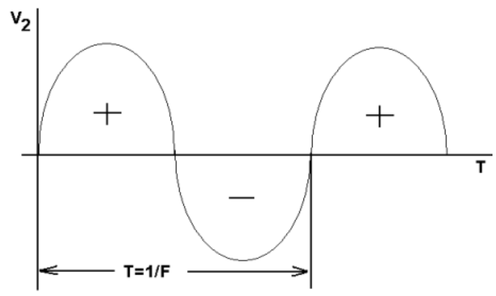

Figure 2

The formulas for the circuit without load and with load are:

$$\frac{V_1}{V_2} = \frac{N_1}{N_2}$$

No load

$$\frac{\sqrt{\eta} \times V_1}{V_2} = \frac{N_1}{N_2}$$

With load

Where n= assumed power efficiency, which in this case is 90%.

Data:

Input circuit

V1=220 V (input voltage)

f= 50Hz. (frequency)

a= 2 cm. (core width)

Output circuit

V2=5 V (output voltage)

f= 50Hz.

P2=30W (output power)

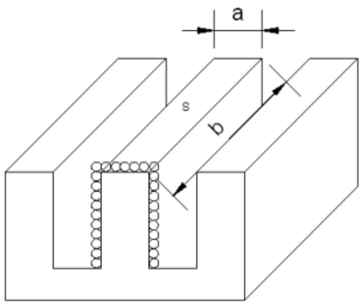

Figure 3

b=? (Core length)

C=0.932 cm (window width)

n=90% (assumed yield)

Incognitas

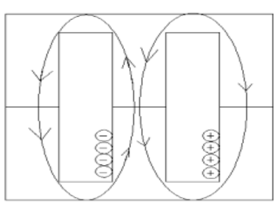

Figure 4

P1=? (input power)

i2=? (Output current)

i1=? (Input current)

S =? (Core cross section)

b=? (core length)

Primary wire size according to AWG standard Secondary wire size according to AWG standard w1=? (Weight of primary)

w2=? (Weight of secondary)

N1=? (Number of turns of the primary)

N2=? (Number of turns of the secondary)

Solution

1. Calculation of P_1:

$$\eta = \frac{P_2}{P_1} \Rightarrow P_1 = \frac{P_2}{\eta} = \frac{30}{0.9} = 33.33W$$

2. Calculation of i_1:

$$P_1 = V_1 \times i_1 \Rightarrow i_1 = \frac{P_1}{V_1} = \frac{33.33W}{220V} = 0.15A$$

3. Calculation of i_2:

$$P_2 = V_2 \times i_2 \Rightarrow i_2 = \frac{P_2}{V_2} = \frac{30W}{5V} = 6A$$

4. Calculation of the average power:

$$P_a = \frac{P_1 + P_2}{2} = \frac{33.33W + 30W}{2} = 31.6W$$

5. Calculation of section(s)

$$s = 1.5\sqrt{P_a}$$

$$s = 1.5\sqrt{31.6}$$

$$s = 8.44cm^2$$

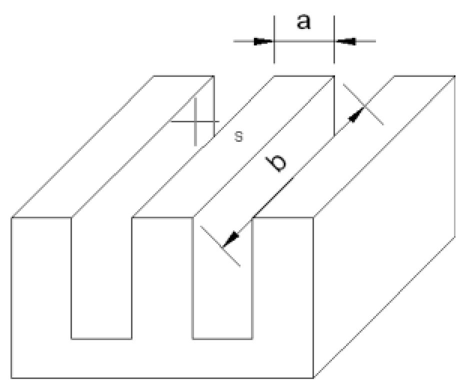

Figure 5

6. Calculation of b:

$$s = a \times b \Rightarrow b = \frac{s}{a} = \frac{8.44cm^2}{2cm}$$

$$b = 4.2cm.$$

To optimise $\Rightarrow b = 5cm.$.

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7) Calculation of No. of turns:

a) For input circuit:

$$N_1 = \frac{10E8V_1}{4.44\times f\times s\times B}; \text{Dato : B} = 900$$

$$N_1 = \frac{10E8V\times 220V}{4.44\times 50\times 8.44\times 900}$$

$$N_1 = 1304.6 Vueltas \rightarrow 1305\, Vueltas$$

b) For output:

$$N_2 = \frac{V_2\times N_1}{V_1} = \frac{5\times 1305}{220} = 29.65 \rightarrow 30 vueltas(\text{sin carga})$$

Optimisation: (for this type of core the correction factor is O. 567 obtained from previous experience with this design) therefore the new number of turns will be:

$$N_2 = \frac{V_2\times N_1}{V_1\sqrt{\eta}}$$

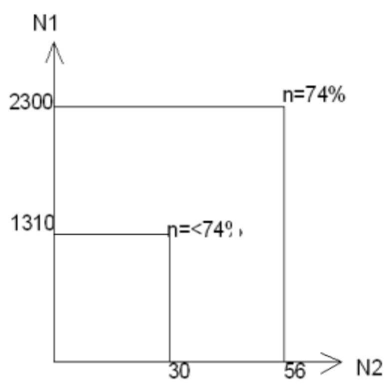

Figure 6

$$N_2 = \frac{5\times 2305}{220\sqrt{0.9}} = 56 vueltas$$

This correction is necessary because the power output with 1305 turns would be much lower than expected, so it is necessary to increase the number of turns up to 2300 for an acceptable power output.

With i1=0.15 Amp according to the table we have a 39 AWG gauge for safety reasons and based on previous experience we increase the thickness to 32 AWG.

ii=6A from the tables we have the 18 gauge, for safety reasons we will take the 15 gauge.

Primary	Secondary
Turns	
Gauge AWG	
Weight per length (gr/m)	

Table 1 Design summary table

8) Calculation of perimeter:

$$l = (2a+2b) = 2\times 2 + 2\times 5 = 14cm$$

$$l = 14cm = 0.14m$$

9) Calculation of weight for purchase:

$$w_1 = 0.2844\frac{gr}{m}\times 0.14m\times 2300 = 91.67gr \Rightarrow por \text{ seguridad } 100\,\text{gr}$$

$$w_2 = 14.67\frac{gr}{m}\times 0.14m\times 56 = 126gr \Rightarrow por \text{ seguridad } 130\,\text{gr}$$

Reel construction

It is constructed of pressed cardboard, taking care that the core plates fit without difficulty.

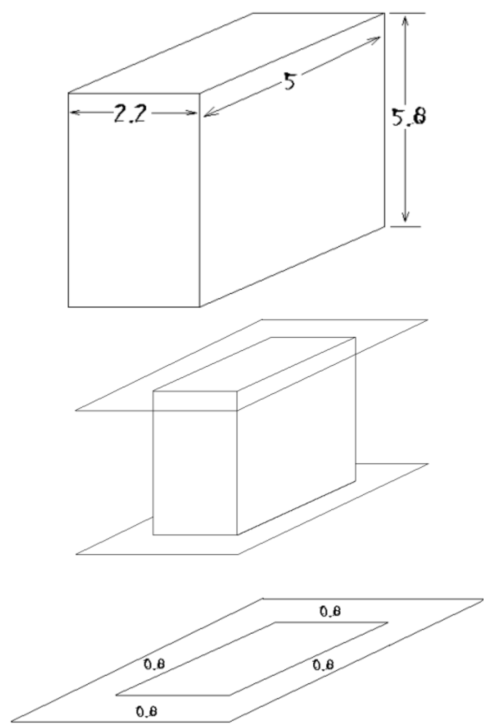

Figure 7

Experimental tests on the transformer

In this circuit no current flows through the tip of the pyrograph, i.e., there is no heat dissipation.

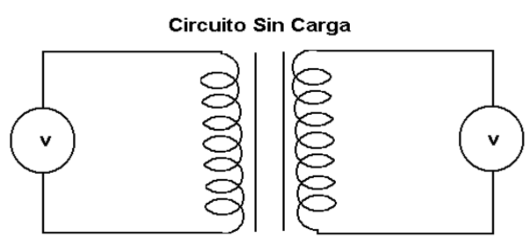

Figure 8

ϕ_1	ϕ_2	V_1	N_1	N_2	V_2(Experimental) (volt)	V_2(Teórico) (volt)	R_1 (ohm)	R_2 (ohm)
32	15	219	2300	40	3.21	3.8	237	0.54
				45	3.62	4.3		
				50	4.05	4.7		
				56	4.37	5		

Table 2 No-load voltage output tests

	Calire primario	N1	V1 (V)	I1 (A)	P1 (w)	Calire secundario	N2	V2 (V)	I2 (A)	P2 (W)	N (%)	obs	Z1 (ohm	Z2 (ohm)
1	32	2300	219	0,16 A	35,04	15	56	2,67	8,45	22,56	65	optima	1368,75	0.32
2	32	2300	219	0,12 A	26,28	15	50	2,63	7,32	19,25	73	Òptima suave	1825	0.36
3	32	2300	219	0,10 A	21,9	15	45	2,49	6,09	17,18	78	suave	2190	0.40
4	32	2300	219	0,08 A	17,52	15	40	2,2	6,37	14,04	80	suave	2737,5	0.35

Table 3

Where:

ϕ1= Rating to Primary

N1 = Number of Turns to Primary

V1 = Input Voltage to Primary

ϕ2 = Secondary Rating

N2 = Number of Turns to Secondary

V2(Theoretical) =Output Voltage to Secondary

V2(Tester)=Output Voltage taken with the Tester

R1 = Primary copper winding resistance

R2 = Resistance to the Secondary of the copper winding

$$V_2 = \frac{V_1 \times N_2}{N.}$$

This formula1 was used to calculate the theoretical output voltage for a no-load circuit.

Interpretation of results. We observe that there is similarity between the experimental value and the theoretical value, the fact that the experimental voltage is lower than the theoretical is due to the fact that in reality the operating efficiency of a transformer can never be 100%.

Experimental tests with the circuit under load: In this test, the nickel tip of the pyro-etching machine goes into incandescence and under these conditions engraves the wood, the data obtained are:

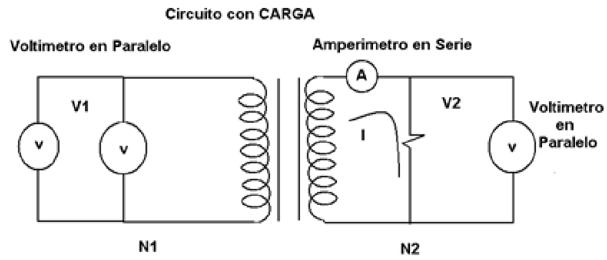

Figure 9

P1=Input power (w)

P2=Output power (w)

Z1=Primary circuit impedance (ohm)

Z1=V1/I1

Z2=Secondary circuit impedance (ohm)

Z2=V2/I2

Results

Interpretation of results and discussion:

- It is observed that the more power consumed the efficiency decreases from 80% to 65%.

- As explained in the interpretation of results, with the E-E structure a better efficiency was obtained than would be obtained with an E-I structure, because the height hE-E is double the height hE-I, which allows a greater number of turns proportionally to both the primary and the secondary, which favoured the project.

- From our point of view, working with a theoretical ŋ of 100 % and not 90 %, it is possible to obtain a higher real ŋ than the one obtained; consequently, P2 would be almost equal to P1.

- An efficiency of 74 % is because the transformer delivers energy to the surroundings in the form of heat (entropy) and because of power losses due to hysteresis, eddy currents in the core and the Joule effect in the copper windings.

- Overall, it was a good project because the test of ŋ > 70 % was passed, a silent and aesthetically optimal transformer was achieved for the two devices (pyrograph and plastocut).

Figure 10 Photos of the transformer designed and built, ready to be attached to the handle of the pyrograph

Measurement of the thermal conductivity k of a clay - ash - gypsum sample.

Aim of the test: To measure experimentally the thermal conductivity of a solid formed by a mixture of clay, dentist's plaster and ash in order to establish the optimum proportions for maximum thermal insulation for the manufacture of pyro-etching tools.

Theoretical basis - Fourier's law indicates that the heat flow (q) in cal/sec depends on the material expressed through its thermal conductivity (k) cal/sec-m-ºC in cal, as well as depending on the temperature gradient (dT/dx) in ºC/m and the heat flow area (A) in m2 according to:

$$q = -kA\frac{dT}{dx}$$

Separating variables

$$\int_0^x q\,dx = -\int_{T1}^{T2} kA\,dT$$

Considering that the test will be tested on cylinders of 1. 7 cm in diameter and 1.8 cm long with different proportions or doses of Clay - dentist's plaster - Ash, then we assume that the heat flow, is constant and that the conductivity k does not vary because it is very much the path, also the cylinder is insulated on the y-axis, in the z-axis so that the heat flow flows in the x-axis. the better insulation we do in simple reality will flow some heat along the y, z axes, considering some margin of error, the integration is performed only in the x-axis (one-dimensional heat flow), the equation will be:

.q x=-kA(T2-T1)

Clearing:

$$q = kA(T1 - T2)\frac{1}{x}$$

On the other hand, the heat generated by the Joule effect in the incandescent filament that is in contact with one end of the cylinder will be:

$$P = VI = I^2 R = \frac{V^2}{R}$$

The power dissipated by the incandescent filament can be calculated, by measuring the voltage V the current I flowing through the filament, by serial connection of ammeter and parallel connection of voltmeter.

As the heat source is the electrical power P, we can match both equations, but the power P is expressed in watts which equals joule/sec, while the heat flux q is in cal/sec. We will have to convert the joule to its equivalent in cal. (1 cal =4.18 Joule) then let Pc be the energy flow in cal/sec.

Pc= P*(1 cal/4.18 julio)

Equating both equations gives

Pc=q

Pc= $q = kA(T2 - T1)\frac{1}{x}$

By subtracting k we finally get

$$k = Pc\frac{x}{A(T2 - T1)}$$

Where:

k= thermal conductivity

Pc= heat flux due to Joule effect heating, in cal/sec

x =length of the cylinder in m

A=flow area (area of the cylinder) in m2

T1= temperature at the hot spot of the cylinder (at the wall in contact with the glowing filament) in ºC

T1= Temperature at the other end of the cylinder in ºC

Area A is calculated by knowing the diameter D of the cylinder:

$$A = \pi \frac{D^2}{4}$$

Practical procedure

- Isolate the cylinder in the y-axis, z-axis and behind the hot spot to force a heat flow in one direction only and in one axis only (x-axis).

- Measure with a thermocouple the temperature T1 at the heat source, and at the other end of the cylinder T2.

- Measure with a ruler the diameter Dy length of the cylinder x

- Measure the current flowing through the filament I and the voltage V of the filament with an ammeter.

- Calculate the power P by Joule effect in watts (joule/sec) and convert to its equivalent in cal/sec.

- Calculate the thermal conductivity k with the formula.

Schematic of the experiment:

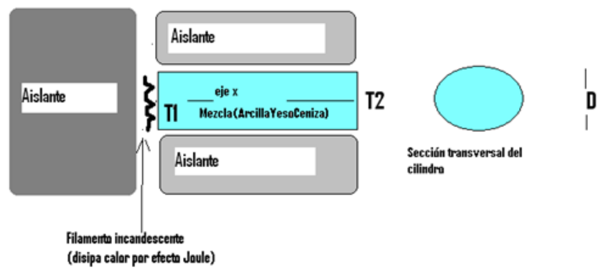

Figure 11

Five treatments were applied (which were the different doses of components) and three replicates, i.e., three samples with the same composition to give greater reliability to the results. The experiment applied was a completely randomised block design, as the samples were heterogeneous, in order to give greater reliability to the test.

The treatments in % by weight are:

T1= 100% clay

T2= 100% dentist's gypsum

T3=10% Dentist's plaster 10%

Ash 80% clay T4=15%

Dentist's plaster 5 % ash 80% clay T5=5%

Dentist's plaster 15% ash 80% clay

No.	T1°C	T2°C	V (volt)	I(amp)	P(watts)	P2(cal/seg)	D(m)	A(m^2)	x(m)	k(cal/seg-m-°C)
T1	217.33	38.67	2.46	8.06	19.828	4.743	0.017	0.000227	0.018	2.1055
T1	210.67	47.33	2.44	8.11	19.788	4.734	0.017	0.000227	0.018	2.2984
T1	234.67	42	2.4	8.12	19.488	4.662	0.017	0.000227	0.018	1.9189
									k(promedio)	2.1076
T2	211	27	2.43	8.08	19.634	4.697	0.017	0.000227	0.018	2.0245
T2	209.5	27.5	2.42	7.95	19.239	4.603	0.017	0.000227	0.018	2.0055
T2	203	29.5	2.45	7.86	19.257	4.607	0.017	0.000227	0.018	2.1057
									k(promedio)	2.0452
T3	205.5	30	2.42	7.63	18.465	4.417	0.017	0.000227	0.018	1.9960
T3	201	31	2.4	7.6	18.240	4.364	0.017	0.000227	0.018	2.0356
T3	196.5	29	2.38	7.61	18.112	4.333	0.017	0.000227	0.018	2.0514
									k(promedio)	2.0277
T4	208	30.5	2.33	7.63	17.778	4.253	0.017	0.000227	0.018	1.9002
T4	206	29.5	2.38	8.34	19.849	4.749	0.017	0.000227	0.018	2.1336
T4	205	29.5	2.35	7.4	17.390	4.160	0.017	0.000227	0.018	1.8799
									k(promedio)	1.9712
T5	205.5	26	2.32	7.44	17.261	4.129	0.017	0.000227	0.018	1.8243
T5	195.15	28	2.29	7.44	17.038	4.076	0.017	0.000227	0.018	1.9338
T5	199.5	27	2.29	7.39	16.923	4.049	0.017	0.000227	0.018	1.8612

Table 4 Experimental data for measuring the thermal conductivity of a clay-ash-gypsum sample

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Casos	Repeticiones	Tratamientos	Conductividad térmica (cal/seg-m-°C)
1	1	1	2.1055
2	1	2	2.0245
3	1	3	1.9960
4	1	4	1.9002
5	1	5	1.8243
6	2	1	2.2984
7	2	2	2.0055
8	2	3	2.0356
9	2	4	2.1336
10	2	5	1.9338
11	3	1	1.9189
12	3	2	2.1057
13	3	3	2.0514
14	3	4	1.8799
15	3	5	1.8612

Table 5 Data prepared for input to Mstatc

Results from MSTATC (Software for Experimental Design)

Heat Transfer

Title: thermal conductivity of solid mixtures Function: FACTOR

Experiment Model Number 7:

One Factor Randomized Complete Block Design Data case no. 1 to 15.

1	2	3	Total
1	*	1.970	9.850
2	*	2.081	10.407
3	*	1.963	9.817
*	1	2.108	6.323
*	2	2.045	6.136
*	3	2.028	6.083
*	4	1.971	5.914
*	5	1.873	5.619

Factorial ANOVA for the factors:

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	0.044	0.022	2.1584	0.1780
2	Factor A	4	0.094	0.023	2.3005	0.1469
-3	Error	8	0.081	0.010		
	Total	14	0.219			

Replication (Var 1: Repetitions) with values from 1 to 3 Factor A (Var 2: treatments) with values from 1 to 5

Variable 3: Thermal conductivity in cal/sec-m-C

Grand Mean = 2.005 Grand Sum = 30.074 Total Count = 15

Interpretation

The value of F tables for 95% confidence based on the ANOVA table, with degrees of freedom of treatment (4) and degrees of freedom of error (8) reads Ftablas=3.84.

As Ftablas is greater than Fcalculated=2.3005 (obtained from the ANOVA table), it is inferred that although there are numerical differences between the thermal conductivities of the different mixtures, there are no statistically significant differences between treatments, which means that it is the same to use any of the compositions.

This means that it is the same to use any composition, therefore the null hypothesis Ho is accepted. This means that there are no differences between treatments.

However, it is observed that the lowest conductivity corresponds to treatment 5 (5% dentist's plaster 15% ash 80% clay) better insulation although not significant compared to the rest of the treatments as revealed by the statistical study, but by having a higher proportion of ash which is a cheap waste and without cost, we decided to recommend treatment 5 in the manufacture of the pyrography core, as it is cheaper and slightly better insulator than the rest due to its lower thermal conductivity.

Construction of the fire pencil or pyrographer

Once the appropriate insulator has been defined (5% dentist's plaster, 15% ash - 80% clay), the core is made with this mixture, where the glowing filament will be, then glass wool is used to insulate the inside walls of the wooden handle. The figure shows the composition of the pyrograph and the temperature profile after construction. The temperature was measured with a thermocouple.

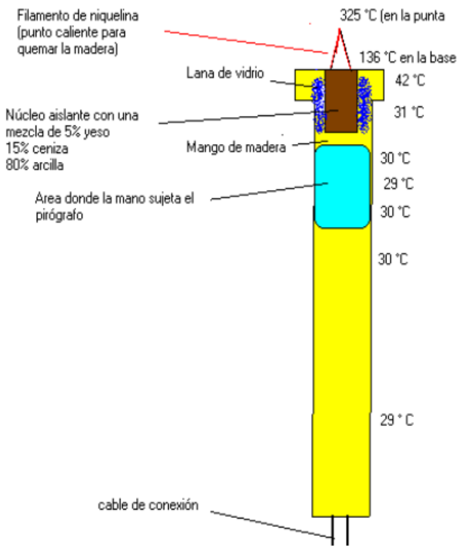

Figure 12

Interpretation. The mixture of 80% clay, 5% dentist's plaster and 15% ash is a good insulator that reduces heat flow.

Conclusions

The tested E - E architecture in the design and construction of the transformer for the operation of the fire pencil was favourable in that a silent, aesthetic, small transformer was achieved with an average efficiency of 74 %, which is considered acceptable. It is possible to improve this efficiency by adding proportionally more turns to both the primary and secondary.

Statistically it was concluded that any treatment or composition of the clay-dentist's plaster-ash mixture gives the same insulation results and therefore the hypothesis has been tested and rejected.

However, it is observed that the lowest thermal conductivity corresponds to treatment 5 (5% dentist's plaster 15% ash 80% clay), although not significantly compared to the rest of the treatments, as revealed by the statistical study, but as it has a higher proportion of ash, which is a cheap and inexpensive waste product due to the economic factor, it is recommended that this treatment be used in the manufacture of pyrography or fire pencils.

The heat flow was significantly reduced with the new insulating material (80% clay, 5% dentist's plaster and 15% ash) of which the core of the pyrography pencil is made and which, together with the glass wool and the wooden handle itself, provides optimum heat insulation, since the temperature at the hot point is approx. 325 ºC, but in the area where the hand comes into contact with the handle the temperature is between 29 and 30ºC, an acceptable range that will prevent the hand from suffering burns.

The objective was achieved because a technology for the design and construction of pyrographs has been developed and one of our own pyrographs has been built as a model.

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