Tekhnê

Tecnología al servicio de la sociedad

Periodicidad

La revista **Tekhnê** posee una periodicidad semestral, coincidente con los semestres académicos de la Universidad Distrital. La publicación se realiza los meses de julio y diciembre. El primer volumen de la revista se publicó el primer semestre de 2003, manteniendo su regularidad hasta la fecha.

Misión

La revista **Tekhnê** tiene como misión divulgar resultados de investigación realizados en el área de la ingeniería, a través de la publicación de artículos originales e inéditos, realizados por académicos y profesionales pertenecientes a instituciones nacionales o extranjeras del orden público o privado. Propende por la difusión de resultados y su acceso abierto y libre.

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Reproducción

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Tekhnê Journal

Tekhnê journal is an institutional publication of the Facultad Tecnológica of the Universidad Distrital Francisco José de Caldas (Bogotá D.C. - Colombia). It has a scientific character and serves the national and international community specialized in the areas of electrical, electronic, mechanical, systems, industrial and civil engineering. It publishes research results in English (original and unpublished articles), and is completely open to specialists from around the world as authors and/or readers. It is arbitrated through a double-blind process, with continuous rotation of arbitrators. The periodicity of the formation of its Scientific and Editorial Committees is subject to the publication of articles in internationally indexed journals by their respective members.

Periodicity

Tekhnê journal is published every six months, coinciding with the academic semesters of the Universidad Distrital. It is published in July and December. The first volume of the journal was published in the first semester of 2003, maintaining its regularity to date.

Mission

The mission of **Tekhnê** journal is to disseminate research results conducted in the area of engineering, through the publication of original and unpublished articles by academics and professionals belonging to national or foreign institutions of public or private order. It aims at the diffusion of results and their open and free access.

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• Tending to the continuous improvement of the Journal.
• Ensuring quality of published material.
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• Prevent commercial interests compromise intellectual standards.
• Post corrections, clarifications, retractions and apologies when necessary.

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The relation between editors, publishers and owners will be subject to the principle of editorial independence. **Tekhnê** will ensure that articles are published based on their quality and suitability for readers, and not for an economic or political gain. In this sense, the fact that the journal is not governed by economic interests, and defends the ideal of universal and free access to knowledge, provides that independence.

Conflict of interest

Tekhnê will establish the necessary mechanisms to avoid or resolve potential conflicts of interest between authors, reviewers and/or the editorial board itself.

Complaints/allegations

Any author, reader, reviewer or editor may refer their complaints to the competent authorities.

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A pocos días para finalizar el año 2017, en la víspera del año nuevo de 2018, el Concejo de Bogotá expidió el Acuerdo 696 de 2017 mediante el cual se ordena la emisión y cobro de la estampilla Universidad Distrital Francisco José de Caldas 50 años. Este acuerdo determina que toda persona o entidad que suscriba contratos con los organismos y entidades del distrito capital deberá pagar a favor de la misma Universidad Distrital y la Universidad Nacional de Colombia, la Estampilla Universidad Distrital Francisco José de Caldas 50 años, equivalente al uno punto uno por ciento del valor del contrato. Este es un impuesto diseñado para ayudar económicamente a las universidades en el pago de su pasivo pensional, para inversión en desarrollo físico, dotación, equipos, e investigación. Esta estampilla se cobrará por un lapso de 30 años, y se espera tenga una fuerte incidencia en el fortalecimiento en cubrimiento, calidad e investigación de las universidades públicas de la capital colombiana.

La inversión adelantada por la Universidad Distrital para el año 2008 y años anteriores no superaba el 6% del presupuesto anual, esto debido a que la mayor parte del presupuesto se destinaba a gastos de funcionamiento (en gran parte pagos del pasivo pensional). Esto no solo evitó el crecimiento institucional, sino que difícilmente sostuvo los gastos de funcionamiento de la institución, reduciendo sus indicadores de calidad y cubrimiento. Este ambiente propició la creación de la estampilla, una figura ya conocida por otras universidades del país. En el año 2001 se autorizó la emisión de la estampilla, y en la actualidad se ha convertido en la principal fuente de recursos de inversión, gracias a lo cual se han construido nuevas sedes, fortalecido las sedes existentes, aumentado programas académicos y cubrimiento en educación, y en general elevar los diferentes indices de desempeño al punto de alcanzar la acreditación institucional en el año 2016.

Los doscientos mil millones de pesos pactados inicialmente en el 2001 se agotaron, razón por la cual se estableció este nuevo acuerdo por 30 años. Estos nuevos dineros garantizan la continuidad de proyectos, un mayor fortalecimiento de la academia, y mejoras en todos sus indices y compromisos, pero también hace consciente a la institución de su dependencia, y de su necesidad de generar fuentes alternas de auto-financiamiento que además de autonomía le permita crecer aún más en el ámbito nacional e internacional.

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Editorial

A few days before the end of 2017, on the eve of the new year 2018, the Council of Bogotá issued Agreement 696 of 2017 by which it orders the issuance and collection of the stamp Universidad Distrital Francisco José de Caldas 50 años. This agreement determines that any person or entity that signs contracts with the agencies and entities of the capital district must pay in favor of the same Universidad Distrital and the Universidad Nacional de Colombia, the Estampilla Universidad Distrital Francisco José de Caldas 50 años, equivalent to one point one percent of the value of the contract. This is a tax designed to financially assist universities in the payment of their pension liabilities, for investment in physical development, endowment, equipment, and research. This stamp will be collected for 30 years and is expected to have a strong impact on strengthening the coverage, quality, and research of public universities in the Colombian capital.

The investment advanced by the Universidad Distrital for the year 2008 and previous years did not exceed 6% of the annual budget, this was because most of the budget was for operating expenses (largely payments of pension liabilities). This not only prevented institutional growth but also made it difficult to sustain the institution's operating costs, reducing its indicators of quality and coverage. This environment led to the creation of the stamp, a figure already known by other universities in the country. In 2001 the stamp was authorized to be issued, and it has now become the main source of investment resources, thanks to which new campuses have been built, existing campuses strengthened, academic programs and coverage in education increased, and in general, the different performance indices have been raised to the point of achieving institutional accreditation in the year 2016.

The two hundred billion Colombian pesos initially agreed in 2001 were exhausted, which is why this new 30-year agreement was established. These new monies guarantee the continuity of projects, a greater strengthening of the academy, and improvements in all its indexes and commitments, but also make the institution aware of its dependence, and of its need to generate alternative sources of self-financing that in addition to autonomy will allow it to grow even more in the national and international arena.

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Mathematical modeling of a DC motor with separate excitation

Modelo matemático de un motor de corriente continua con excitación separada

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This article proposes a model for a direct current motor with separate excitation using speed control by armature current. Based on an understanding of its electromechanical functioning and an adequate conceptualization of both the laws of physics and mathematical structure, this model is constructed as a fundamental exercise for the development of control and simulation schemes. To evaluate the performance of the model, performance curves are presented for a test machine.

Keywords: Control, DC motor, dynamic systems, electromagnetism, electromechanical, modeling, separate excitation

Este articulo propone un modelo para un motor de corriente continua con excitación separada que utiliza control de velocidad por corriente de armadura. A partir de la comprensión de su funcionamiento electromecánico y una adecuada conceptualización tanto de leyes de la física como de la estructura matemática, se construye dicho modelo como ejercicio fundamental para el desarrollo de esquemas de control y simulación. Para evaluación del desempeño del modelo se presentan curvas de comportamiento para una máquina de prueba.

Palabras clave: Control, electromagnetismo, electromecánico, excitación separada, modelado, motor CC, sistemas dinámicos

Introduction

The DC motor is, in short, a torque transducer that transforms electrical energy into mechanical energy (Kuo, 2002). It is an important source of driving energy in today's industrial and technological world, and it also outperforms alternating current motors due to its high controllability of speed and torque (Gordillo & Martínez, 2018).

The superior performance of the DC motor means that it makes it possible to more easily perform some functions that the AC motor does not achieve (Martínez & Galvis, 2006). Two examples of this are the DC motor's ability to develop torque several times greater in magnitude than an AC motor of a similar size and the ability to operate at speeds unreachable by an AC motor.

This document proposes an approximate mathematical model of the DC motor for this purpose of great utility in both education and research (Martínez, Montiel, & Jacinto, 2016). We construct an equivalent circuit of the device, and then we define the set of mathematical expressions that allow linking the physical variables that constitute the proposed model. The constant values of the model were taken from articles with models evaluated for the same type of electric machine in order to compare the result obtained (Alvarez, 2012).

Once the differential expression that relates the variables of interest has been developed, they are taken to the frequency domain through the application of the Laplace transform. Then the expression for the angular velocity ω is solved, the constants are replaced by the reference values, and finally, the inverse Laplace transform is applied to return to the time domain.

The resulting expression will then be the solution of the proposed model, and will, therefore, describe the behavior of the angular velocity of the motor as a function of time.

In the second part of the article, graphical information on the behavior of angular velocity as a function of time is obtained using the SIMULINK simulator, which offers a graphical user interface (GUI) useful enough to build models and to examine how successful the model developed has been. The final part of the article shares the results and builds conclusions.

Background and current status of the DC motor

The Nikola Tesla Alternating Current (AC) induction motor can be considered as the cornerstone of the triumph of alternating current over the direct current system (Brittain, 2005). However, there is one aspect where the contest does not seem to have shifted to alternating current, and that is what has allowed direct current motors to be so important today. Observability and controllability are two essential factors in the analysis of dynamic systems, the latter being the most important advantage of the DC motor over the AC motor, as it allows a greater range and degree of control over speed and torque.

In fact, the development of DC motors continues to advance, as evidenced, for example, by the work of electrical engineer and renowned inventor Frank Julian Sprague, who was recently honored in The History column in the November-December 2015 issue of IEEE Power & Energy journal (Sprague, 2015). Sprague's work pioneered the invention and development of constant speed DC motors, which, in addition to being non-slip, are completely self-regulating, even under variable loads (Kuo, 2002). This certainly expands the frontier of possibilities for the DC motor, and also justifies the objective of this paper.

One of the critical points of the DC motor has been the brushes collector system since the wear of the brushes due to friction, maintenance and the associated cost have reduced the efficiency of the machine. Currently, however, not only are new prototypes of brushless DC motors (BLDC motors) being worked on, but the effectiveness of automatic adjustment with PID controllers (Pongfai & Assawinchaichote, 2017) has even been increased by applying artificial intelligence (AI) algorithms (García, Osuna, & Martínez, 2018; Montiel, Martínez, & Jacinto, 2017).

Description and principle of operation of the DC motor

In the following, we present a schematic description of the engine and a synthesis of its basic operating principle.

As can be seen in Fig. 1, the direct current motor is a machine composed of two parts, rotor **A** which is a sweet steel cylinder mounted on a shaft that can rotate on its axis, and stator or casing **M** where the permanent magnets or electromagnets are located if there are field coils **F** and **F'**. In any case, the stator or inductor guarantees a magnetic field between **P** and **P'** as indicated by the dotted lines.

It should be pointed out that these field lines describe the trajectories indicated as long as the rotor turns counterclockwise as a result of the interaction between the magnetic field of the inductor and the electric field of the armature. This dynamic happens because a current enters through the brushes or carbons to the brush collector and circulates through the **C** conductors.

Fig. 2 shows the front and side views of rotor **A** in Fig. 1. Note that Fig. 1 does not show either the brush collector or the brushes for simplicity. The magnetic flux ϕ comes from the stator.

The first step in modeling a system, in this case, the DC motor, is to understand its operating principle, so below we make a brief description of it.

By means of an excitation source v_a, an electric charge is circulated through the conductor of the armature, generating an i_a current. This current gives rise to an electric field that gives rise to a magnetic field, this phenomenon is
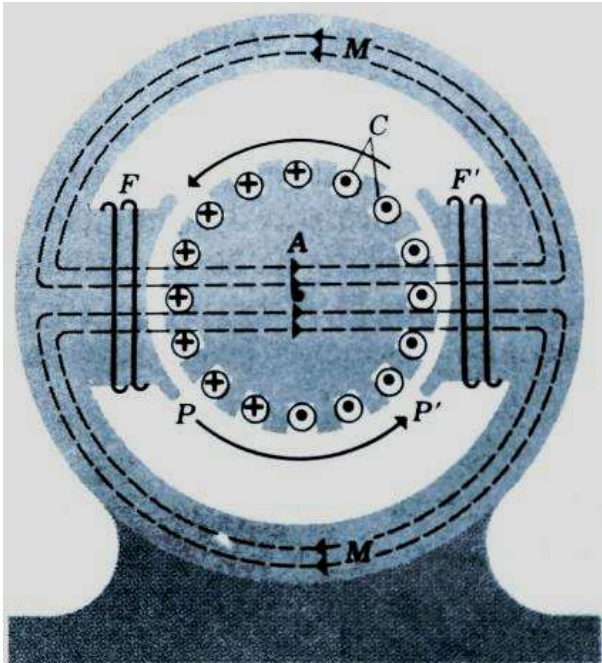
Figure 1. Schematic diagram of the operation of a DC motor (Kuo, 2002).
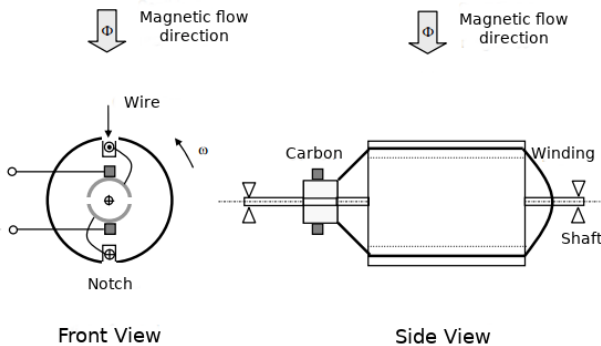
Figure 2. Schematic diagram of a DC motor.

described by Maxwell's equations (Kuo, 2002). When the rotor field interacts with the magnetic field provided by the permanent magnet, the rotation of the armature is generated, a movement called torque. This phenomenon is described by the Lorentz force equation which says that a conductor carrying current experiences a force that tends to move it when placed in a magnetic field (Kuo, 2002) and by Lenz's Law which states that the direction of an induced current is such that it opposes the cause that produces it (Kuo, 2002). It is interesting that according to the above it is possible to infer that the DC motor operates under electromechanical principles and that the torque that is a mechanical variable can be controlled from electrical variables.

Once the principle of operation is understood the next step is to elaborate the approximate equivalent circuit taking into account that:

• The armature winding can be modeled as a series RL circuit.

• In the rotor, a fem or force counter electromotive v_b is induced according to the Faraday induction law (Kuo, 2002).

• A direct voltage source v_a is applied to the armature terminals.

The Kirchhoff tension law can then be applied to construct the first expression that relates the variables v_a, R_a, L_a, and v_b, to the equivalent circuit shown in Fig. 3.
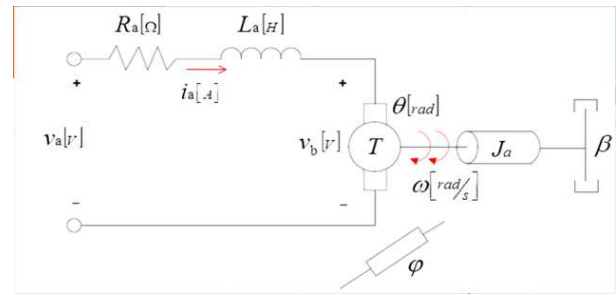
Figure 3. Equivalent circuit of the motor system in direct current, separately excited.

Where:

• R_a represents the natural resistance of the conductor forming the armature winding in ohms.

• L_a is the value of the armature winding inductance in henrys.

• v_a is the DC voltage applied to the armature circuit in volts.

• i_a denotes the current flowing through the armature conductor in amperes.

• v_b represents the counter-electromotive force in volts.

• ϕ represents the stator's fixed magnetic field.

• θ represents the angular displacement of the rotor in radians.

• ω is the rotor angular velocity in rad/s.

• J_a denotes the equivalent rotational inertia of the rotor shaft in kilograms.

• β is the coefficient of viscous friction in N·m·s.

• τ_f is the friction force or viscous damping in Newtons.

• τ_e is the electromagnetic torque in Newtons.

• τ_c is the resulting torque in Newtons.

• k_p is the electromagnetic torque constant in N·m/A.

• k_b is the counter electromotive force constant.

Analysis for choice of variables and construction of the mathematical model

Making use of Kirchhoff's voltage law in the equivalent circuit shown in Fig. 3 relating to v_a, R_a, L_a and v_b can be obtained:

$$v_a(t) = v_{Ra}(t) + v_{La}(t) + v_b(t) \tag{1}$$

Expressing Eq. 1 in terms of the current:

$$v_a(t) = R_a i_a(t) + L_a \frac{di_a(t)}{dt} + v_b(t) \tag{2}$$

The value of the counter electromotive force vb is defined as shown in Eq. 3. Replacing this expression in Eq. 2 results in Eq. 4:

$$v_b(t) = k_b \omega(t) \tag{3}$$

$$v_a(t) = R_a i_a(t) + L_a \frac{di_a(t)}{dt} + k_b \omega(t) \tag{4}$$

Then Eq. 4 is the first differential equation of the model and describes the electrical part of the system.

For the description of the mechanical part, it is necessary to find the second differential expression. As it is a linear system, it is assumed that the torque developed by the motor is proportional to the flow between the iron and the armature current. In other words, it is possible to conceptualize an equation of torques that relates the applied force or resultant torque τ_c, the inertia of the armature τ_e and the friction force τ_f which, said to be a step, depends on the angular velocity ω, and opposes the movement. So:

$$\tau_c(t) = \tau_e(t) - \tau_f(t) \tag{5}$$

In addition τ_c is described by the expression:

$$\tau_c(t) = J_a \cdot \frac{d\omega(t)}{dt} \tag{6}$$

The resulting torque τ_c is generated by the electromagnetic torque τ_e, which in turn depends on the armature current i_a and is defined as:

$$\tau_e(t) = k_p \cdot i_a(t) \tag{7}$$

Where k_p is the electromagnetic torque constant. The viscous damping τ_f, or viscous friction force, is defined as:

$$\tau_f(t) = \beta \cdot \omega(t) \tag{8}$$

Now, replacing Eqs. 6, 7 and 8 in Eq. 5 gives:

$$J_a \cdot \frac{d\omega(t)}{dt} = k_p \cdot i_a(t) - \beta \cdot \omega(t) \tag{9}$$

Solving for $i_a(t)$ in Eq. 9, results:

$$i_a(t) = \frac{J_a \cdot \frac{d\omega(t)}{dt} + \beta \cdot \omega(t)}{k_p} \tag{10}$$

Then, deriving the Eq. 10 is obtained:

$$\frac{di_a(t)}{dt} = \frac{J_a \cdot \frac{d^2\omega(t)}{dt} + \beta \cdot \frac{d\omega(t)}{dt}}{k_p} \tag{11}$$

Which is the second differential equation of the system, and describes the mechanical part of it. Finally, to obtain the differential equation that integrates the electrical and mechanical parts, Eqs. 10 and 11 are substituted in Eq. 4, from where it results:

$$v_a(t) = R_a \left[\frac{J_a \frac{d\omega(t)}{dt} + \beta \cdot \omega(t)}{k_p} \right] + L_a \left[\frac{J_a \frac{d^2\omega(t)}{dt} + \beta \cdot \frac{d\omega(t)}{dt}}{k_p} \right] + k_b \omega(t) \tag{12}$$

It is important to note that this expression relates to electrical variables such as current and voltage with mechanical variables such as torque and friction force, which is consistent because it is an electromechanical system in itself.

Eq. 12 describes the mathematical model of the separately excited DC motor. Before proceeding with the solution of the mathematical model it must be considered that Eq. 12 is a second order differential equation, but it must also be taken into account that the value of L approaches zero in direct current motors with independent excitation, so Eq. 12 can be simplified to a first-order homogeneous, linear differential equation of constant coefficients.

$$v_a(t) = R_a \left[\frac{J_a \frac{d\omega(t)}{dt} + \beta \cdot \omega(t)}{k_p} \right] + k_b \cdot \omega(t) \tag{13}$$

Mathematical model solution

In order to be able to apply the transform of Laplace, it is necessary to establish that $\omega(0) = 0$. Then Eq. 13 is transformed as follows:

$$\mathcal{L}[v_a(t)] = \frac{J_a R_a}{k_p} \cdot \mathcal{L}\left[\frac{d\omega(t)}{dt}\right] + R_a \cdot \mathcal{L}\left[\frac{\beta \cdot \omega(t)}{k_p}\right] + \mathcal{L}[K_b \cdot \omega(t)] \tag{14}$$

$$\frac{V_a(s)}{s} = \frac{J_a \cdot R_a}{k_p} \cdot s \cdot W(s) + \frac{R_a \cdot \beta}{k_p} W(s) + k_b \cdot W(s) \tag{15}$$

Factoring $W(s)$:

$$\frac{V_a(s)}{s} = W(s) \cdot \left[\frac{J_a \cdot R_a}{k_p} \cdot s + \frac{R_a \cdot \beta}{k_p} + k_b \right] \tag{16}$$

By doing:

$$\frac{J_a \cdot R_a}{k_p} = \lambda \quad \text{and} \quad \frac{R_a \cdot \beta}{k_p} + k_b = \delta \tag{17}$$

And rewriting Eq. 16 comes out:

16

$$\frac{V_a(s)}{s} = W(s) \cdot (\lambda s + \delta) \tag{18}$$

Solving for $W(s)$:

$$W(s) = \frac{V_a(s)}{s(\lambda s + \delta)} \tag{19}$$

The partial fraction method is now applied to Eq. 19.

$$W(s) = V_a(s) \cdot \left[\frac{A}{s} + \frac{B}{(\lambda s + \delta)}\right] \tag{20}$$

$$V_a(s) \cdot \left[\frac{1}{s(\lambda s + \delta)}\right] = V_a(s) \cdot \left[\frac{A}{s} + \frac{B}{(\lambda s + \delta)}\right] \tag{21}$$

$$\left(\frac{1}{s(\lambda s + \delta)}\right) = \left(\frac{A}{s} + \frac{B}{(\lambda s + \delta)}\right) \tag{22}$$

$$1 = A(\lambda s + \delta) + B \cdot s \tag{23}$$

$$1 = A\lambda s + A\delta + B \cdot s \tag{24}$$

$$s \cdot (0) + 1 = s(A\lambda + B) + A\delta \tag{25}$$

Then we get that:

$$1 = A\delta \Longrightarrow A = \frac{1}{\delta} \tag{26}$$

$$0 = A\lambda + B \Longrightarrow B = -A\lambda \Longrightarrow B = -\frac{\lambda}{\delta} \tag{27}$$

And Eq. 20 becomes:

$$W(s) = V_a(s) \cdot \left[\frac{\frac{1}{\delta}}{s} + \frac{-\frac{\lambda}{\delta}}{(\lambda s + \delta)}\right] \tag{28}$$

Dividing between λ numerator and denominator of the second term of the bracket, and factoring $1/\delta$ to bring the expression to a known form we obtain:

$$W(s) = \frac{V_a(s)}{\delta} \cdot \left[\frac{1}{s} - \frac{1}{\left(s + \frac{\delta}{\lambda}\right)}\right] \tag{29}$$

Now Laplace inverse transform is applied to return to the time domain and obtain the Eq. 31 which is the solution of the model in the time domain.

$$\mathcal{L}^{-1}[W(s)] = \frac{v_a(t)}{\delta} \cdot \mathcal{L}^{-1}\left[\frac{1}{s}\right] - \frac{v_a(t)}{\delta} \cdot \mathcal{L}^{-1}\left[\frac{1}{\left(s + \frac{\delta}{\lambda}\right)}\right] \tag{30}$$

$$\omega(t) = \frac{v_a(t)}{\delta}\left[1 - e^{-\frac{\delta}{\lambda}t}\right] \tag{31}$$

Table 1
Experimental data of the DC motor.

Armature and load data			
Magnitude	Symbol	Value	Unit
Excitation voltage	v_a	240	V
Electric current	i_a	16.2	A
Resistance	R_a	0.6	Ω
Inductance	L_a	0.0012	H
Counter-electromotive force constant	k_b	1.8	V s
Electromagnetic torque constant	k_p	0.4	N m/A
Rotor rotational inertia	J_a	1	kg/m^2
Coefficient of viscous friction	β	0.2287	N m s

Finally, we return the replacement of δ and λ and replace the values of J_a, R_a, k_b, β, and k_p supplied by the reference article (table 1).

$$\omega(t) = \frac{v_a(t)}{\frac{R_a\beta}{k_p} + k_b}\left[1 - e^{\frac{\frac{R_a\beta}{k_p} + k_b}{\frac{J_a \cdot R_a}{k_p}}t}\right] \tag{32}$$

Finally Eq. 33 is obtained, after replacing the parametric values given in the reference article.

$$\omega(t) = 111.99 \cdot \left[1 - e^{-1.4287t}\right] \tag{33}$$

Simulations

Below are graphs of torque, angular velocity, armature current, and counter-electromotive force obtained with the Simulink simulator. The construction was done using block diagrams (Figs. 4, 5 and 6, Fig. 4 shows the block diagram used in the simulation, Fig. 5 shows the block diagram for angular velocity, and Fig. 6 shows the block diagram for armature current) from the differential relationships obtained by solving $di(t)/dt$ in Eq. 4 and $d\omega(t)/dt$ in Eq. 9.

Fig. 7 shows the behaviour of the angular velocity as a function of time.

Fig. 8 shows the behavior of the armature current as a function of time.

Fig. 9 shows the torque as a function of time.

Fig. 10 shows the counter-electromotive force as a function of time.

Conclusions

The mathematical model of the DC motor with independent excitation can be described by the expression:

$$\omega(t) = \frac{v_a(t)}{\frac{R_a\beta}{k_p} + k_b}\left[1 - e^{\frac{\frac{R_a\beta}{k_p} + k_b}{\frac{J_a \cdot R_a}{k_p}}t}\right] \tag{34}$$

This equation can be easily implemented in simulation software such as Simulink for specific values of machine
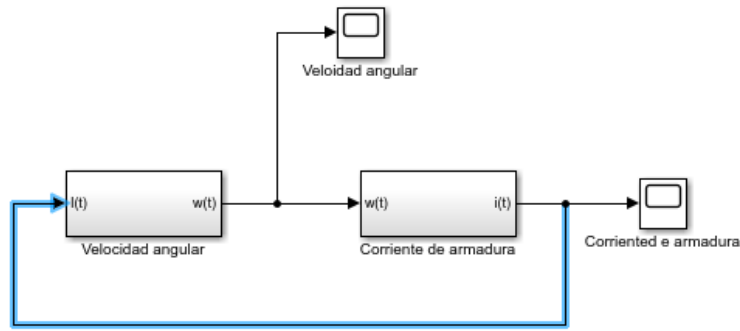
Figure 4. Diagram of blocks and subsystems used in the simulation.
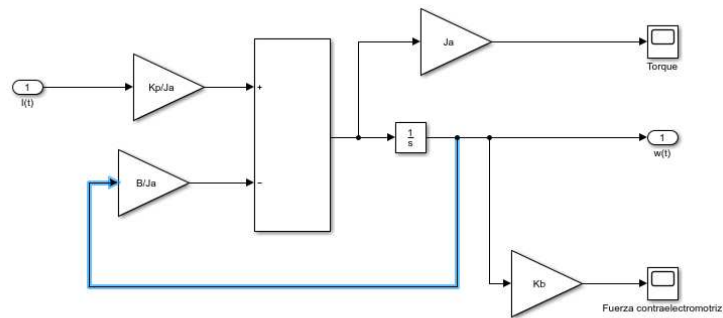
Figure 5. Angular velocity subsystem diagram.
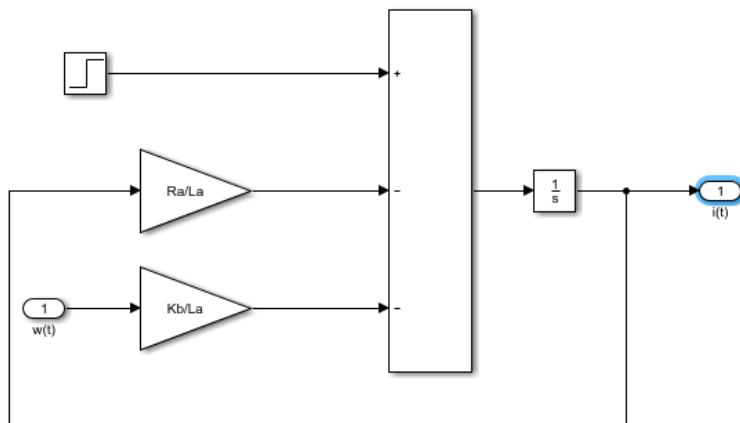
Figure 6. Block diagram for armature current.

parameters, and derive with respect to time the behavior of both the angular velocity and the armature current and torque developed. It is even possible to consider more complex situations, for example, to vary the value of the armature resistance over time as if it were a variable resistance in the machine, or to vary the armature voltage to analyze the behavior of a speed control scheme. The test curves developed for the machine matched those reported in articles for the same machine parameters, validating the behavior of the model.

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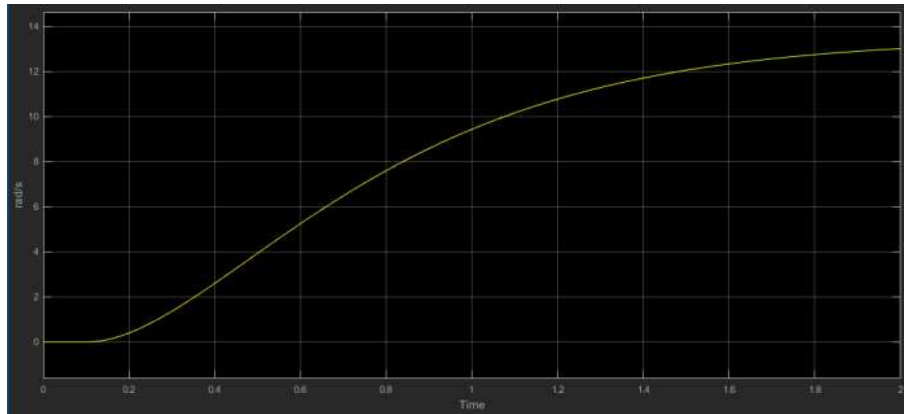
Figure 7. Angular speed.
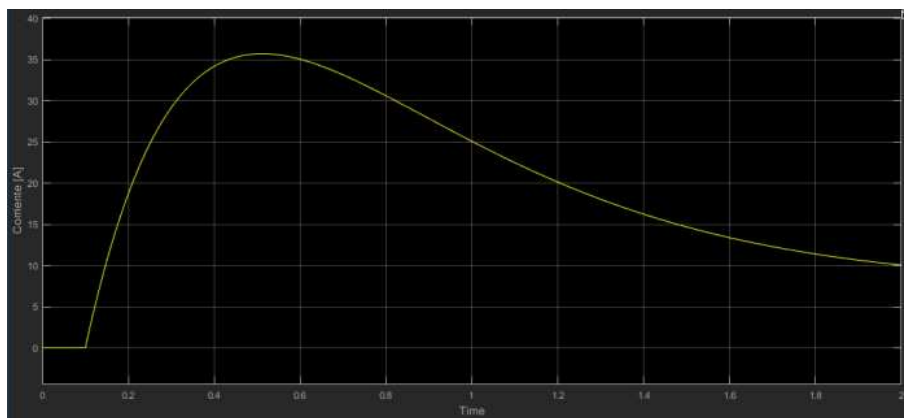
Figure 8. Armature current.
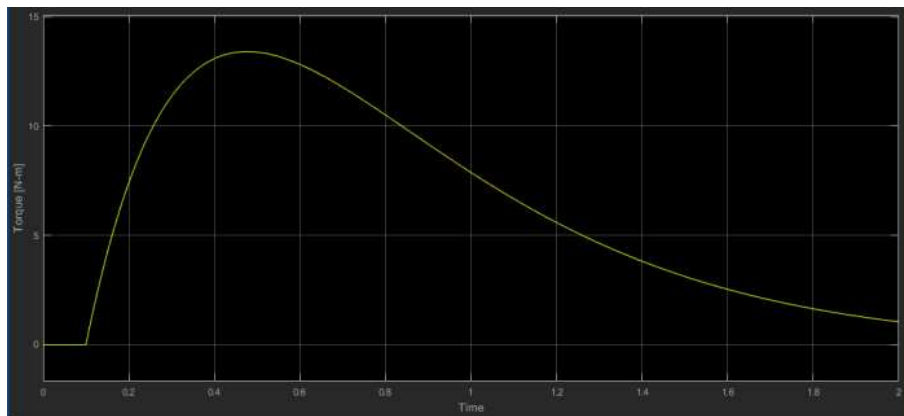
Figure 9. Torque as a function of time.

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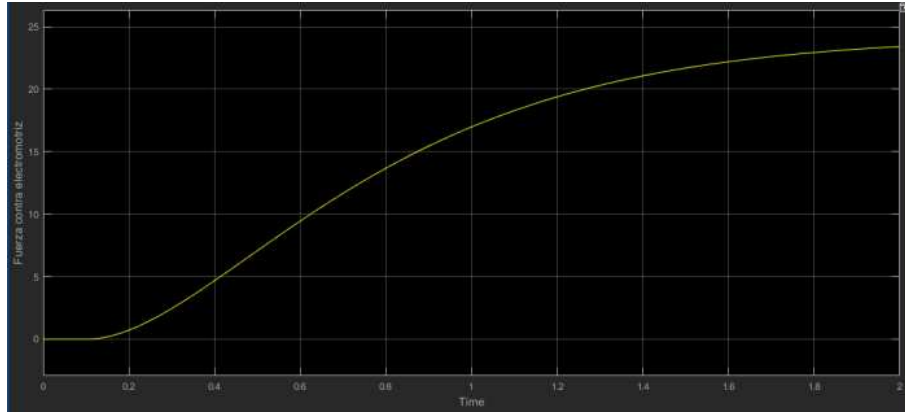
Figure 10. Counter-electromotive force as a function of time.

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Modeling and design of DC/DC converters

Modelo y diseño de convertidores CC/CC

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This paper specifies the type of systems that will be studied, the DC/DC power converters, as well as the type of control that will be applied to them to improve their dynamic response. For this purpose, the mathematical models to be used for the analysis and design of control loops of the Buck/Boost model will be introduced. The history of non-linear control applied to DC/DC converters will also be reviewed and circuit On and Off time analysis and its variation in these states will be established.

Keywords: Average model, closed-loop control, power converter, rectifier, regulator

En este artículo se precisa el tipo de sistemas que serán estudiados, los convertidores de potencia CC/CC, así como el tipo de control que se les aplicará para mejorar su respuesta dinámica. Para ello, se introducirán los modelos matemáticos que se emplearán para el análisis y diseño de lazos de control del modelo Buck/Boost. También se hará un recorrido por los antecedentes del control no lineal aplicado a los convertidores CC/CC y se establecerán análisis de tiempo On y Off de circuito y su variación en dichos estados.

Palabras clave: Control en lazo cerrado, convertidor de potencia, modelo promedio, rectificador, regulador

Introduction

The DC/DC power converters are DC voltage regulator circuits characterized by high-frequency switching operation (at least very large compared to the frequency of the public power grid) which gives them greater efficiency compared to linear regulators but turns their circuit into a non-linear one making their closed-loop control a real design challenge (Bazurto & Martínez, 2015; Li & Parsa, 2018; Ochoa, Rodriguez, & Martínez, 2017).

In this document, an ideal analysis of a DC/DC circuit, the Buck/Boost converter, is made to establish the basic criteria for the design and implementation of analog non-linear controls that improve the dynamic performance of the power converter, particularly when they include the reconstruction of the current waveform (active correction of the Power Factor) (Braslavsky, Plotnikov, & Valtchev, 2016; Callegaro, Ciobotaru, Pagano, Turano, & Fletcher, 2018; Mashinchi Mahery & Babaei, 2013).

The final behavior of the fed back systems is validated both at the simulation level and by performing various physical implementations of the controller and corrector or PFC (Martínez & Gómez, 2004). Preliminary results show that with this basic analysis and design an experimental prototype can be obtained where the presence of noise or disturbances does not significantly affect the waveforms and output regulation levels (Miao, Wang, & Ma, 2016; Takagi & Fujita, 2018; Zhifu, Yupu, & Yinan, 2017).

The document is structured as follows. The following section reviews the general concepts of DC/DC converters, the mathematical models, and the types of control that will serve as a theoretical basis. The results are then presented in the laboratory for a low power prototype (Tan & Hoo, 2015).

Model of the buck/boost converter

The basic topologies of DC/DC converters are buck, boost, and buck/boost. These three controllers are characterized by having a single transistor (controlled switch) and have a single-stage conversion. The output power is usually small, in the order of tens of watts.

The buck/boost converter is a converter commonly used for the inversion of the output voltage polarity concerning the input. Its output voltage to the input can be either reducing or increasing, depending on the desired duty cycle. The topology of this converter is shown in Fig. 1.

The DC/DC converter shown in the Fig. 1 is characterized by the fact that it has a direct electrical connection between input and output. It also has an inductor and a capacitor. The latter serve as energy storage during each switching cycle of the transistor.

The transistor is used as a controlled switch and the diode as an uncontrolled switch to carry out the switching. In an ideal switch, the voltage in the ON position is zero, as is
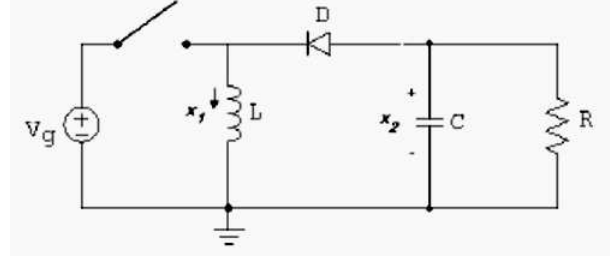
Figure 1. Buck/Boost converter.

the current during the OFF interval. Therefore, ideally, it never dissipates energy because the product $v \times i$ is always zero. Active switches such as the transistor turn on or off in response to an applied signal, and passive switches (diodes) have a non-linear v-i characteristic function that operates according to the polarization of the device. Voltage drops in the switches can be affected when the input and output voltages of the converter are low.

Simplified switching model

The converter is said to have two operating states depending on the control signal on the transistor and its corresponding behavior (Fig. 2). When the activation signal is high, the transistor closes, which together with the choke forces the diode to remain open (Fig. 3). During this interval, the choke absorbs energy, and the current increases linearly. The load current is supplied by the output capacitor, which is why its design considers both the highest T_{ON} value, the size of the load, and the maximum voltage ripple value at the output. During T_{OFF} the control signal opens the transistor and the operation is reversed (Fig. 4). The voltage on the diode is reversed causing it to conduct and transfer energy to the output capacitor and the load. The critical inductance value is related to the amount of energy required during this interval.

Let's analyze the circuit during T_{ON}.

$$V_l = V_{in} - V_{R_{ON}} \tag{1}$$

$$L\frac{di}{dt} = V_{in} - i_L R_{ON} \tag{2}$$

$$\frac{di}{dt} = \frac{V_{in}}{L} - \frac{i_L R_{ON}}{L} \tag{3}$$

$$i_C = \frac{V_o}{R_L} \tag{4}$$

$$C\frac{dv}{dt} = -\frac{V_o}{R_L} \tag{5}$$

$$\frac{dv}{dt} = -\frac{V_o}{CR_L} \tag{6}$$
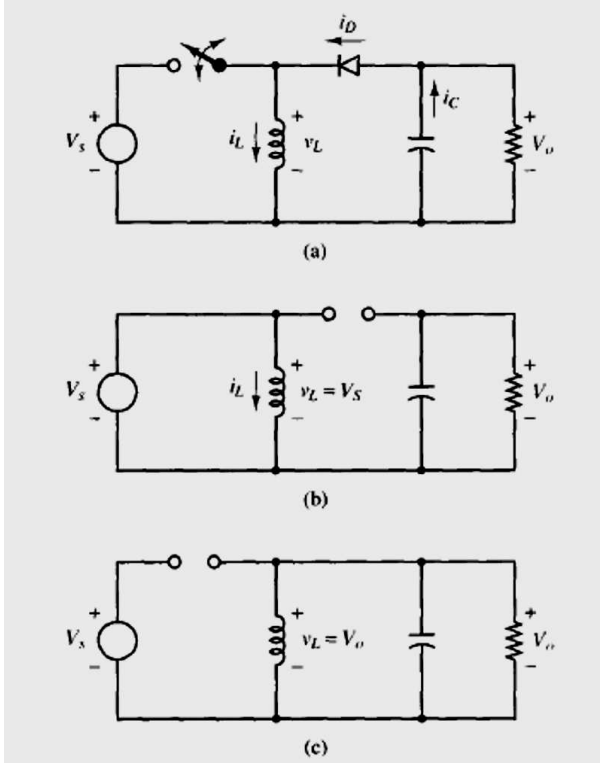
Figure 2. Buck/boost converter models.
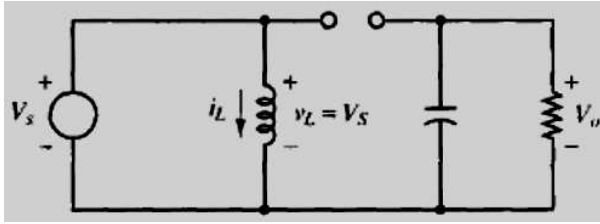
Figure 3. T_{ON} circuit analysis.
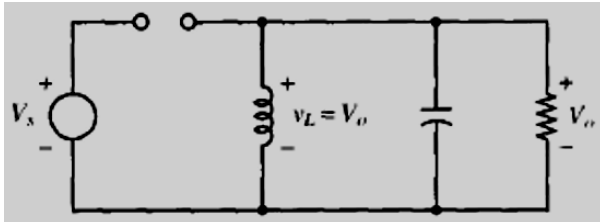
Figure 4. T_{OFF} circuit analysis.

During T_{OFF}.

$$V_l = V_C = V_o \tag{7}$$

$$L\frac{di}{dt} = V_o \tag{8}$$

$$\frac{di}{dt} = \frac{V_o}{L} \tag{9}$$

$$i_C = i_L - i_{R_L} \tag{10}$$

$$C\frac{dv}{dt} = i_L - \frac{V_o}{R_L} \tag{11}$$

$$\frac{dv}{dt} = \frac{i_L}{C} - \frac{V_o}{CR_L} \tag{12}$$

From equations (3) and (9):

$$D\left(\frac{V_{in}}{L} - \frac{i_L R_{ON}}{L}\right) + (1-D)\left(\frac{V_o}{L}\right) = \frac{di}{dt} \tag{13}$$

From equations (6) and (12):

$$D\left(-\frac{V_o}{CR_L}\right) + (1-D)\left(\frac{i_L}{C} - \frac{V_o}{CR_L}\right) = \frac{dv}{dt} \tag{14}$$

Dynamic model

From the definition of the duty cycle we have:

$$T = D + (1-D) \tag{15}$$

For the system of equations:

$$\begin{aligned}
\dot{X}(t) &\approx AX(t) + B \\
\dot{X}(t) &\approx A_1 X(t) + B_1 \\
\dot{X}(t) &\approx A_2 X(t) + B_2
\end{aligned} \tag{16}$$

$$A_1 = \begin{bmatrix} -\frac{R_{ON}}{L} & 0 \\ 0 & \frac{1}{R_2 C} \end{bmatrix} \tag{17}$$

$$A_2 = \begin{bmatrix} 0 & \frac{1}{L} \\ -\frac{1}{C} & \frac{1}{R_L C} \end{bmatrix} \tag{18}$$

$$B_1 = \begin{bmatrix} \frac{V_{in}}{L} \\ 0 \end{bmatrix} \tag{19}$$

$$B_2 = \begin{bmatrix} 0 \\ 0 \end{bmatrix} \tag{20}$$

With the following expression a bilinear model can be obtained, having found that the behavior is linear in both states. This is an approximation of the model applied to the Buck/Boost converter in order to later determine its state-space function.

$$\dot{X} = [A_1 D + A_2(1-D)]X + [B_1 D + B_2(1-D)] \tag{21}$$

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} DR_{ON} & \frac{(1-D)}{L} \\ \frac{(D-1)}{C} & -\frac{1}{RC} \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} \frac{2V_{in}}{3L} - \frac{(3D-1)V_{in}}{3L(3D^2-3D-1)} \\ \frac{DV_{in}(2D-1)}{RC(3D^2-3D-1)} \end{bmatrix} \tag{22}$$

Static model

The static model is based on equations that describe both conduction and non-conduction behavior. The equations are determined by the main energy storage element and in the dynamics of the converter. The analysis is performed on the inductance, which is a constant and can be expressed mathematically in both transistor operating intervals.

During T_{ON}:

$$\frac{\Delta i_L}{\Delta t} = \frac{\Delta i_L}{DT} = \frac{V_{in}}{L} - i_L \frac{R_{ON}}{L} \qquad (23)$$

$$\Delta i_L = \left(\frac{V_{in}}{L} - i_L \frac{R_{ON}}{L}\right) \times DT \qquad (24)$$

During T_{OFF}:

$$\frac{\Delta i_L}{\Delta t} = \frac{\Delta i_L}{(1-D)\,T} = \frac{V_{in}}{L} \qquad (25)$$

$$\Delta i_L = \left(\frac{V_o}{L}\right) \times (1-D)\,T \qquad (26)$$

Performing current balance on the choke.

$$\Delta i_L \times DT - \Delta i_L \times (1-D) \times T = 0 \qquad (27)$$

$$DT \left(\frac{V_{in}}{L} - \frac{i_L R_{ON}}{L}\right) + (1-D)\,T \left(\frac{V_o}{L}\right) = 0 \qquad (28)$$

$$V_o = \left(\frac{D}{1-D}\right)(i_L \times R_{ON} - V_{in}) \qquad (29)$$

Checking through Faraday's law.

$$\int_0^T v_L(t)\,dt = (V_{in} - i_L R_{ON})\,DT + V_o\,(1-D)\,T \qquad (30)$$

$$V_o = \left(\frac{D}{1-D}\right)(i_L \times R_{ON} - V_{in}) \qquad (31)$$

Using the expression found, the behavior of the input and output voltage can be simulated depending on the variation of the signal's useful cycle. This response was simulated and is shown in Fig. 5.

The mathematical DC/DC models shown above can also be classified according to their mode of operation, depending on the continuity or otherwise of the current flowing through the choke. In this way, when the current is always greater than zero during the entire switching period, the converter will work in continuous mode, and discontinuous mode if the current in the choke is canceled for any instant.
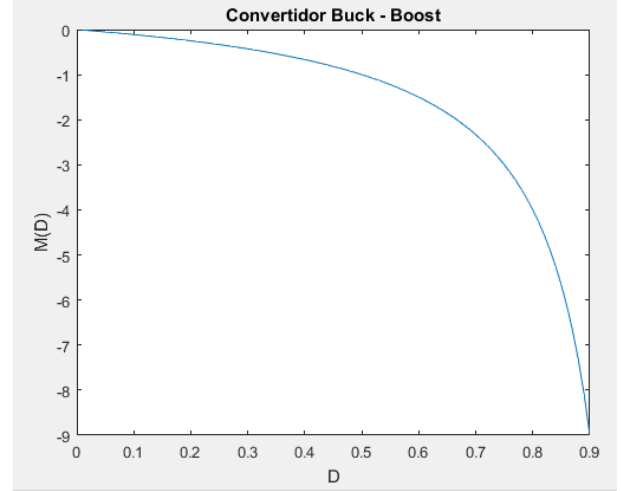
Figure 5. Behaviour curve according to the variation of the duty cycle.

Prototype behaviour

The dynamic behavior of the drive is described in two operating states, which consist of the position of the Q and D switches that are periodically turned on and off from a binary signal. The regulator is capable of maintaining a constant voltage above or below the input voltage according to the duty cycle value D (Figs. 6, 7 and 8).

The figure also reflects the behavior of the input voltage and maximum current variation. The input voltage was assumed for simulation purposes to be $\pm 30\%$. The load regulation is defined as the difference between V_o measured when the load is minimum ($R = R_{max}$) and V_o when the load is maximum ($R = R_{min}$), divided by the nominal V_o.

$$R_C\% = \left(\frac{V_o R_{max} - V_o R_{min}}{V_{o(nominal)}} \times 100\right) \qquad (32)$$

Conclusions

In this article, we analyze the construction and the Buck/Boost model reconstructing integrally the equations of the model that presented the particularity of establishing different design criteria from its conceptual way to its practical way using the simulations. Also, the article studies the stability in the large signal of this switched regulator for the different states analyzed, guaranteeing a steady-state error of zero and demonstrating that it can be easily implemented with analog integrators and multipliers.

The procedure established for the development of this article allowed the basic static and dynamic design for a Buck/Boost converter operating in continuous conduction mode. The response of the simulation shows the dynamic behavior of the state variables of the proposed circuit.
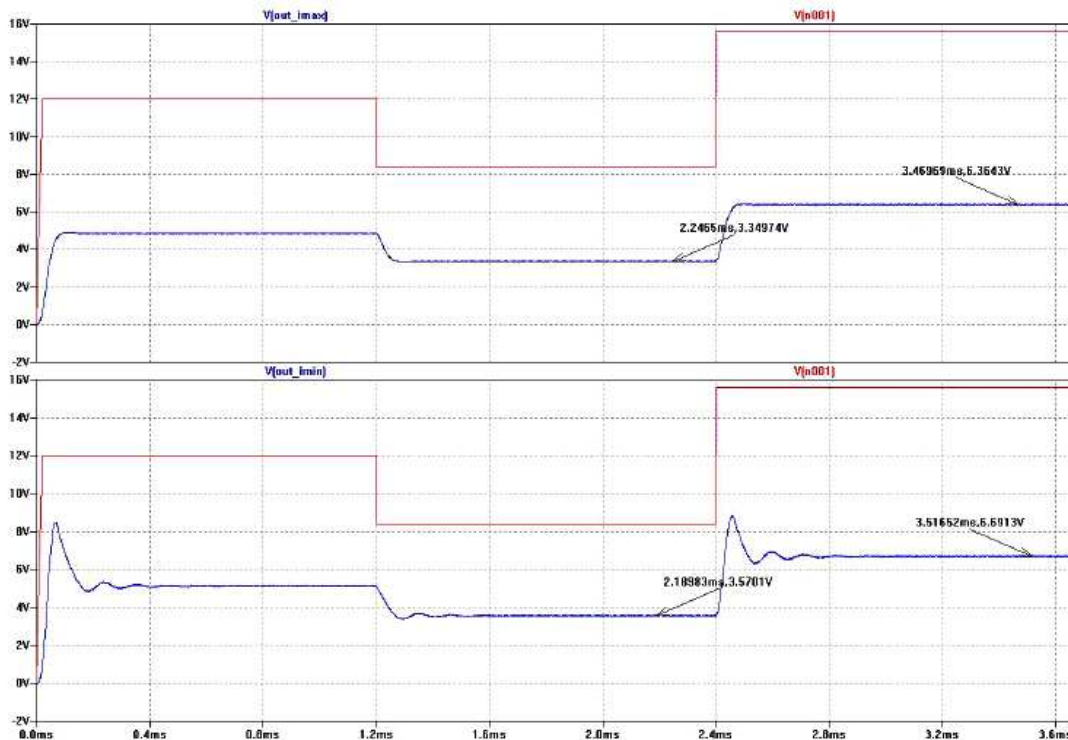
Figure 6. Maximum current and input voltage variation.
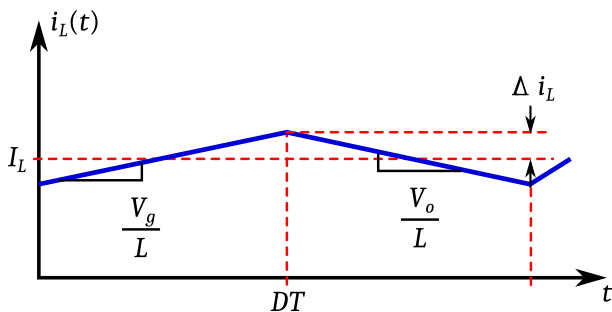
Figure 7. Inductor current waveform.
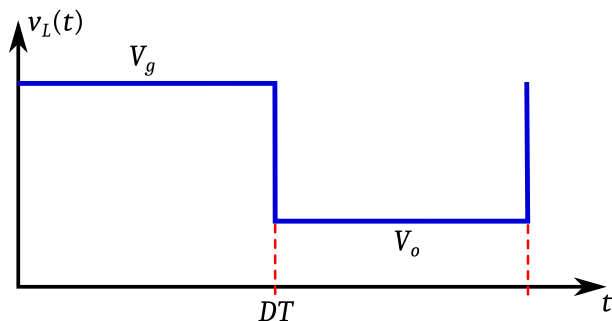
Figure 8. Inductor voltage waveform.

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Civil engineering works, a fundamental basis for social change

Las obras de ingeniería civil, base fundamental para cambios sociales

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Civil works are of vital importance for the development of individuals' lives since they generate changes in the natural environment in response to a specific need of a certain group of people. Each one of these constructions brings with it a social impact in the face of concrete activities. Factors such as the economy, demography, and culture allow us to talk about positive and negative impacts. Finally, the awareness of civil engineers regarding the responsibility of safeguarding the life of other individuals becomes fundamental; executing projects with excellent planning is the first step to avoid the diverse difficulties in which a work may be involved, but more important than this, imparting the premise of a correct exercise of civil engineering seems to be a mandatory need.

Keywords: Building, culture, development, social impact

Las obras civiles son de vital importancia para el desarrollo de la vida de los individuos, ya que estas generan cambios en el entorno natural respondiendo a una necesidad específica de un determinado grupo de personas. Cada una de estas construcciones trae consigo un impacto social frente a actividades concretas. Factores como la economía, la demografía y la cultura permiten hablar sobre los impactos positivos y negativos. Finalmente la concientización hacia los ingenieros civiles en cuanto a la responsabilidad de salvaguardar la vida de los demás individuos se torna fundamental, ejecutar proyectos con excelente planeación es el primer paso para evitar las diversas dificultades en las cuales se puede ver involucrada una obra, pero más importante que esto, impartir la premisa de un correcto ejercicio de la ingeniería civil parece ser una necesidad de obligatorio cumplimiento.

Palabras clave: Construcción, cultura, desarrollo, impacto social

Introduction

Through this article we want to make known to all people the role that civil engineering (specifically its works) plays in society (Murray & Ross, 2014). The intervention of the human being's physical environment originates structural changes both in the daily life of individuals and in their habits, customs and ways of doing their activities; circumstances that have been affected positively and negatively (Bao, Meng, & Seo, 2014; Becerik-Gerber et al., 2014).

Each of the interventions made by this branch of engineering seeks to provide a solution to a specific need of the community, at the level of communication, trade, transport, among others (Johansen, Horney, & Tien, 2017; Uihlein, 2017). For this reason, it is very easy to associate the development of a city in terms of economic and infrastructure benefits, with the completion of a construction project (Armstrong, Baillie, & Cumming-Potvin, 2014; Mostafavi, Huff, Abraham, Oakes, & Zoltowski, 2016).

Civil engineering works are the subject of various writings, some of which refer to the way construction is carried out, the materials, and lately, there is more thought given to writing about the impacts that each of these transformations brings to the environment where people live, but in this writing, it will be mentioned how important it is to know the changes that arise at a social level before, during and after starting a civil construction project (Ahn et al., 2015; Garcia, Castro, Parbole, & Ballester, 2015; Monchau et al., 2014).

The relation that will allow defining which were the modifications in the habits, customs or ways of doing the activities of the members of a society is the urban, economic development and in the infrastructure of the constructions, the change in all the sense of the word because through this it is noticed the influence on the perspective of the reality of each one of the individuals of the place where the project was carried out (Basu, Misra, & Puppala, 2014; Roohnavaz, 2016).

Social impact of a civil work

Social changes generated by civil works

Talking about the impact of civil work has always been of great curiosity for people, it seems obvious to say that before, during and after construction is finished there are always going to be different changes that directly affect their lives, however, these transformations in the natural environment of a population sometimes are not observable at first sight by the individuals of the intervened places and therefore, a little despised.

As a result of the above, several specialized studies have been generated on the subject, to learn about the voluntary or involuntary reactions of men and women to the changes they are involved in as a result of a civil engineering project.

Everyone's perception is very different about the variations in all aspects generated by constructive work, despite being very good for the development of cities, which has a large number of factors and positive and negative aspects that act directly on the community (Martínez, Hernández, & Rendón, 2017). We know beforehand that work arises as a response to specific needs of people in a certain sector, this work will directly affect their environment and daily life, a fact that makes the work of the engineer more complex, who apart from performing the various structural calculations and testing of each material must foresee with his team the inconveniences that will arise to start the construction, these tasks are performed to avoid as much as possible misunderstandings between those responsible for the work and the inhabitants of the sector.

We clarify that the work of the engineer and his workers does not end on the day of completion of the work, the contract may specify maintenance and periodic reviews, but something that is a constant omission by the engineer is the impact of its construction on the people of the place. As mentioned before, changes do not only occur at the beginning of the projects, but the most important moment to define the type of impact is when the new construction begins to be used, which gives rise to their studies. To know how construction has a social impact, methods have been created to make known what happened in a population after its natural environment was intervened, following different parameters to define what the social changes were concerning the execution and completion of the project. Generally, direct questions are asked as a survey or census to individuals in the community about the conditions present in that situation. The results of the studies can have three approaches: economic, demographic, and cultural.

The social impact generated by any type of project (including civil works) can also be measured through SROI (social return on investment). Although the SROI is a tool that serves to measure many things, since it is based on the financial principles of ROI (return on investment), it has proven to be particularly useful in the evaluation and comparison of different social project alternatives.

In this way it is easier to identify which could be the effects of the engineering works in the populations where the construction was established, besides SROI the statistical studies carried out from the collection on the results of the intervention are very useful to analyze the type of impact present in the certain community taking into account key aspects to obtain a good analysis on the social impact such as Indigenous peoples, Resettlement, Impacts on subsistence, social integrity, Labour exploitation, Labour conditions,

health and safety, and non-discrimination, Cultural goods and practices, Gender equity.

Each of these terms is very important to specifically differentiate the contributions or damages that can be created from civil engineering projects or other dependencies.

Generally, the state entities in charge of statistics in Colombia, DANE, have the results of the census carried out to have a better idea of the issues of interest and also of great importance to know what the effects of the phenomenon are. Such as the one carried out at the beginning of 2017 concerning the buildings where the areas in the process of construction are shown (Fig. 1).
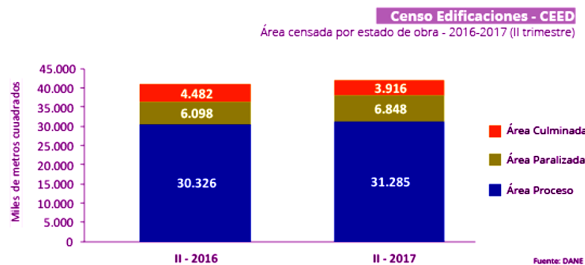
Figure 1. Construction census for the quarter April - June 2017 (31,284,790 m^2 with an annual variation of 3.2%) (DANE, 2015).

However, constructions in cities are carried out by different branches of civil engineering, they fulfill very specific functions for the development of a population and in addition to this, their impact on the approaches already mentioned can be categorized. To understand much better the impact of civil works, the aspects that affect people's daily lives will be described.

Economic Impact

As for the economic impact, it is known that these are the changes or effects created by different activities to increase or reduce investment, productivity, and employment associated with the various jobs sustained in a country's economy. According to the previous contextualization, the civil engineering works reflected in each of the Colombian cities with representations such as buildings, roads, sewers, among others, generally increase the GDP of the country where the value of goods and services produced in a year is located.

During the second quarter of the year, investment in civil works in Colombia increased by 6.4% compared to the same period in 2016. Two of the five groups of civil works grew in the second quarter, led by the group of engineering works such as parks, stadiums, and other sports facilities, as well as constructions for mining, power plants and transport pipes, said the National Department of Statistics (DANE) in a statement (DANE, 2015).

Civil works are a key indicator for the domestic economy, thus showing the role that civil constructions play in the analysis of a country's economic development. But sometimes the construction sector presents decreases in its contribution to the GDP (Fig. 2).
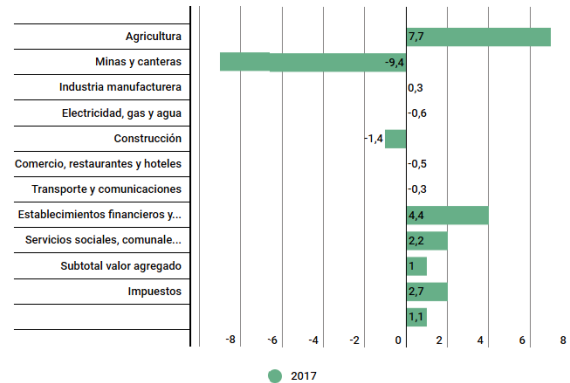
Figure 2. Growth of economic sectors in 2017 (DANE, 2017b).

The economic part in the works of civil engineering has great influence because thanks to them in the country the doors are opened to new national and international markets to obtain greater positioning in the commercial sector, in addition to this for the construction of a project it is very necessary to have personnel in charge in the development of certain functions which generates vacancies thus allowing that the people of that place can accede to work, also, one talks about the costs of intervention, the positive or negative economic consequences that will arise throughout the execution of the construction and the benefits after having finished activities.

Demographic impact

As far as demographics are concerned, it has been shown since previous years that due to the development of new construction, by generating greater job opportunities, people living in places far away from the work site decide to move to the place where the project will be located, contemplating the idea of having better opportunities to undertake their lives due to the direct relationship between the infrastructure systems, development, and financial stability, thus creating the increase of the population in that territory.

This growth in the urbanization of nations is a product of the localization of development, industrialization, and migratory processes. Colombia has an urban population close to 80% (mainly in Bogotá, Medellín, Cali, and Barranquilla), which will increase due to the social and economic gap between the countryside and the city

(Portafolio, 2017a). This generates large increases in the demographic index that occurs every year in the country.

Cultural impact

It is one of the changes that are rarely mentioned, but this type of transformation to the natural environment of the people allows variations in the cultural environment because thanks to the constructive processes as already mentioned the focuses of development are identified which facilitates the acquisition of better knowledge, new perceptions of reality, greater relationship with other individuals in the community.

After referencing the perspectives that will be taken throughout the text to understand the transformations, causes, and possible solutions to the impact generated by civil works, we will continue with the description of the changes generated by each of the branches of civil engineering that promote greater development in society.

Structures

In the case of structures, reference is made to the analysis and calculations that come with it, to use them in the construction of bridges, houses, schools, buildings, etc. economically it helps to manage the commercial sector since using them, referring to the bridges they communicate marine or terrestrial routes with different municipalities facilitating the transport of materials or merchandise which allows developing and powers the financial resources of the country, it is a generator of jobs; the demographic growth is facilitated from these works and in the cultural part thanks to the mobilization of the population it allows to know the diverse places in the national territory acquiring this way different knowledge that enriches the culture of the people, besides with the elaboration of the schools they harness the education of the youngest. It is very important to know that here the impact can be measured utilizing a statistical survey on each situation and by stratification according to the location of the project.

Two of the five groups of civil works grew in the second quarter, led by the group of engineering works such as parks, stadiums and other sports facilities, as well as constructions for mining, power plants, and pipes for transport said the National Department of Statistics (DANE) in a statement.

The sanitary one is in charge of the interventions that have as a purpose the creation of sewers, treatment of residual waters, these works at the moment of initiating require great investments on the part of the state because it must guarantee these services to the society but after its construction it represents very high percentages in the assets of the government, promoting the arrival of new individuals to the cities because thus they improve the conditions (referring to those municipalities that by adverse circumstances do not have this type of services; the cultural part can be demonstrated of a quite clear form in those

populations where this type of work has not been able to be calculated.

A similar treatment is presented in hydraulics, but this one works intending to detect the sources of drinking water, the construction of dams, canals, hydroelectric plants, among others from where the same aspects mentioned in the previous paragraph can be obtained.

In the specific case of hydroelectric plants, they are very good in terms of the economic factor they represent because they provide energy thanks to the mechanical process the water undergoes when passing through the turbines, but to obtain constructions of this magnitude it is very necessary to adapt the site for this type of settlement; this is when the social impact of the work begins to be generated and at the same time cultural changes are created. During the construction phase, the projects use a large number of workers so new job opportunities are possible.

Finally, we will talk about the transport branch in civil engineering because the development of a city is specifically evidenced by the transport routes where mobility is generated in the city, a clear example of this is the construction of railways and races to communicate territories. Economically they are very expensive for the state, but in the same way, they are a great source of income for the state where the processes of mercantile transfer occur generating a significant increase in the commercial sector of the country, this section of civil engineering has the same demographic and cultural impact except the educational issue.

Taking into account the above, to measure the impact on engineering specializations such as sanitary, hydraulic and transport, the processes generated by these works must be analyzed, such as the concepts of efficiency in these three branches and satisfaction of the need, facilitating the carrying out of a survey for this purpose.

Positive social impact of a civil work

Depending on the focus of the impacts, it can also be divided into two large positive or negative groups. In this section, emphasis will be placed on the benefits brought about by civil engineering works themselves because, as previously mentioned, constructions are very important for a country.

Civil works and its relationship with the economy

Firstly, to speak with greater certainty about the relationship between civil works and the economy, it is necessary to understand that construction activity comprises two sub-sectors: buildings and civil works (Fig. 3). The first refers to the construction, repair, adaptation, and maintenance of residential and non-residential buildings. Civil works, on the other hand, include the construction and maintenance of infrastructures such as roads, dams,

long-distance pipelines, constructions for mining, public service networks, and other civil works (El Tiempo, 2015b).

The two previous subsectors are the ones that have boosted development and increased the country's GDP in recent years because a little more is invested in the execution of projects in the construction sector and it is shown with statistical results made by the entities in charge of obtaining this type of information, as registered in one of the bulletins generated by DANE this year.

In the second quarter of April-June 2017, GDP at constant prices increased by 1.3% compared to the same quarter in 2016. An analysis of the result of value added by large branches of activity shows an increase of 0.3% in the value-added of the construction sector. This result is explained by the 7.4% decline in the buildings subsector and the 6.5% increase in the civil works subsector (Dinero, 2006).

This information regarding the Colombian GDP is very variable, so different analyses are made throughout the year, generally by quarters. From the above, it is shown that there was an improvement in the construction sector, which helped to increase its percentage in the GDP; the country's gross domestic product is the most representative form in which it can be observed that the construction sector is an engine of the economy of the Colombian territory. But civil works affect the economy at three levels: family, business, and state because it demands land, capital, labor, machinery, materials, goods, services, technology, public services, telecommunications, and financial resources. It carries out civil works and building works, which generate salaries, income, profits, interest, and taxes (Perez, 2013).

As for the family benefit generated by construction projects, there is a job offer to obtain the large civil engineering works that the territory has, so the real estate and construction activities are those who generate more employment in the country, at the end of 2016 these had an increase with 81 thousand jobs. In December 2016, 3.26 million people were employed in these unions, according to DANE numbers (DANE, 2017a).

It is considered a positive aspect the labor offer of the civil works because in this way it allows the individuals of the community to access formal employment and in this way, it will help substantially to the generation of income to be able to give a better quality of life to the members of their family group, which is related to the decrease of the unemployment of the country. Apart from satisfying the demand for labor, large investments must also be made to design work and in this way affect businesses or the state.

Besides, in recent years the number of people who can acquire a home has increased, as is evident in the year 2016. Housing finance in Colombia, both houses and apartments (new and used), continues to be on the rise and in the first three months of 2016 Colombians bought nearly 30,000 units, an increase of 5.6% over the same period in 2015.

Colombian mortgage banks reported that the total amount of credits for financing new housing reached $1.23 billion, which also shows a significant increase from last year when banks financed loans of $1.18 billion (Portafolio, 2017b).

The capital employed by public or private entities is the engine that moves the other processes such as the hiring of human and physical resources to obtain better results, which will be recognized in the GDP studies and this is where the close relationship between civil works and the country's economy becomes evident.

The construction of places such as shopping malls and other infrastructure used to increase their capital are also taken into account for the economy, but, these places are already located in other sectors of the economy. However, the constructions can also generate another type of relationship with different factors inherent to the culture of the society for which the projects were designed.

Civil works and the use of free time

Thanks to the engineering constructions, variations are made to the culture because from them it is possible to conceive new perspectives on the reality that each individual has, thus promoting cultural and social change, which is an aspect of great benefit to the community. Some projects are very useful in the search for social change through the use of free time.

Recreational parks. This type of construction is very good at the time of using the moments of leisure of the diverse members of the Colombian population because in its facilities the familiar bonds are fortified and the recreation in those places harnesses the interpersonal relations allowing to know more citizens with different ideologies causing this way cultural expansion, besides, it is very important for the human beings the times of leisure to conceive quality of life (El Tiempo, 2017a).

High performance sports centres. As is well known in Colombia the new generations are very involved in sports activities to enjoy their time off and can do so in the facilities offered by the country to meet this need that has brought so many benefits to the country by the achievements of Colombian athletes.

The large coliseums, stadiums, athletic tracks, velodromes, skating rinks, among other places for sports activities are the result of the intervention of civil engineering to obtain this kind of construction. Nowadays, it allows young people to choose these sites to spend their time and improve on a cultural level because in this kind of scenery it is very easy to get to know different customs and cultures from other departments, cities or countries.

There are sporting events that require the construction of new civil works as has been the case since the beginning of

Producto Interno Bruto (PIB) por grandes ramas de actividad económica
Variación porcentual anual
2017^{pr} / 2016^{pr} (II trimestre)

Rama	Variación porcentual
Agricultura, ganadería, caza, silvicultura y pesca	4,4
Establecimientos financieros y seguros	3,9
Servicios sociales, comunales y personales	3,0
Suministro de electricidad, gas y agua	1,2
Comercio, reparación, restaurantes y hoteles	0,9
Transporte, almacenamiento y comunicaciones	0,7
Construcción	0,3
Industria manufacturera	-3,3
Explotación de minas y canteras	-6,0
Valor Agregado	1,1
PIB	1,3

Figure 3. Gross domestic product by major branches of economic activity (Dinero, 2006).

the year on the Colombian coast. The construction of 12 sports venues for the XVIII Bolivarian Games, to be held from November 11 to 25 this year in Santa Marta where the total investment in sports venues will be 150 billion pesos, of which 90 billion are contributed by the National Government, through Coldeportes, and 60 billion by the District (El Tiempo, 2015a).

Libraries and theatres. These works were conceived to be places where the acquisition of knowledge is propitiated to have a culturally enriched society with the objective of generating changes both at a personal and group level; the country has motivated the employment and use of the same, generating more tools for people to consciously use their free time.

Shopping centres. Thanks to the construction of these establishments many families can share pleasant moments and achieve this goal the site must be welcoming.

While the pace of shopping center openings is increasing in the country, the old ones are retouching their facilities and, in some cases, making extensions so as not to be left behind when it comes to attracting visitors.

According to a report by the Association of Shopping Centres of Colombia (Acecolombia), there are currently 16 in 8 cities that are refreshing their image. Six of them will invest about $1.7 billion in the next few years.

In this way, it is possible to evidence the role played by the intervention by the constructions in the cultural and social advance because the civil engineering through its works, in spite of the perspective that is had on the work developed by these professionals, is the motor for the acquisition of knowledge, interpersonal relations, historical appropriation of the country and culture (Melo, 2014).

Civil works and the development of a city

One of the most influential factors when it comes to knowing whether the country is developed or not is generally the infrastructure present in the territory, which is why there are various types of civil works in charge of satisfying specific needs in each of Colombia's places. Below, we will mention the different constructions used in the country to improve the quality of life of the inhabitants of these places.

Transport infrastructure. Here we find three types of works such as land, sea, and air.

• Land:

It corresponds to works that contribute to improving mobility, cargo transport, and mass transport of passengers. These are subdivided into road and rail. Where the first one is carried out to improve security, land interconnection between ports and different cities. These works include the construction of streets, roads, highways, bridges, viaducts, tunnels, and their associated works such as signaling, lighting, ventilation, pedestrian bridges, massive passenger transport systems such as Transmilenio, etc.

The delivery of the first kilometers of the mega road project in the plains allows us to see in broad strokes the potential development that can have the department of the goal through the number of road works that are being built to connect with other municipalities in the country (DANE, 2017c).

In the case of the railway, it fulfills the same function but is focused on the construction of metros, trams, railways, catenary construction and its associated works, passenger train stations, freight terminals, etc.

A clear example of road infrastructure is the design of two completely new roads that would allow the reduction of

travel times between Bucaramanga and Cúcuta. The first, on the Bucaramanga-Pamplona section, and the other, between Pamplona and Cúcuta (Umaña, 2003).

- Port maritime:

Works for construction and expansion of maritime terminals for cargo and passengers, docks, lighthouses, control centers for communications, beacons, buoys, etc.

- Aerial:

It includes the construction and modernization of airports, cargo terminals, control towers, communications, runway extension, signaling, beaconing, building, and parking facilities, security systems, baggage transport system (El País, 2016).

The Government has invested a record amount of almost $6 billion in the expansion and modernization of 71 airports, including those under concession and contracted by Aerocivil. In the last 5 years, 7 airlines entered the market, reaching 27 in total, and the number of routes has increased from 68 to 80.

Projects include runway expansion, terminal modernization, and air conditioning, resurfacing, new parking lots, green areas, construction of new cargo and passenger terminals, new control towers, aircraft maintenance buildings and platform expansion, construction of service centers and the expansion or construction of international, private or cargo terminals, among others (Aguilar, 2000).

- Energy infrastructure:

These constructions seek to supply the territory with energy and for them, there are civil works of electrical networks, renewable energies, and hydrocarbons.

Electricity networks These are works that include the construction of Hydraulic, Thermal, or Combined Cycle Power Plants for the production of energy and the construction of electricity networks to supply and cover the required electricity demand due to population growth.

Renewable energy They include works such as maritime and terrestrial wind farms, photovoltaic farms, thermal solar plants, thermal plants for the production of hot water.

Hydrocarbons These are works built for the exploitation and transport of hydrocarbons from the drilling wells to the storage and processing areas. They include works such as oil pipelines, gas pipelines, refineries, compression stations, petrochemical plants, offshore plants, etc.

- Hydraulic infrastructure:

It includes works that help to improve the quality of life of the citizens allowing them to enjoy the drinking water, channeling, and treatment of their wastewater contributing to the improvement of their environmental and health conditions (El Tiempo, 2017b).

- Building infrastructure:

Here we can talk about urban or industrial infrastructure, the former are works aimed at providing a direct service to citizens and improving their quality of life as hospital infrastructure (hospitals, clinics, health centers), also includes infrastructure for education (university campuses, schools), infrastructure for recreation and sport (sports venues, theme parks, resorts, SPA, etc.), buildings for housing, offices and shopping centers.

As for the industrial one, they are the works of industrial plants, warehouses, and industrial covers for plants such as Cement Factories, Iron and Steel Companies, Agrochemical Industry, Food, Pharmaceuticals, Automobile, Aerospace, Armament, Textile Mechanics, etc (Portafolio, 2017c).

Finally, the infrastructure for telecommunications will be discussed, since it is through telecommunications that new knowledge is acquired and each individual is kept connected to his or her social, family, and cultural environment. Examples of these works are telephone networks, terrestrial and underwater fiber-optic networks, television networks, the Internet, cellular telephony, satellites, repeater antennas, astronomical observatories, telecommunications control centers, etc.

The information provided in this section shows that each of the civil engineering projects in the country has the sole objective of improving the living conditions of the people who live in the places where the constructions will be carried out. It also shows the variety of infrastructure in the country, which tries to bring Colombia to a level of development that is comfortable for both the people and the state, giving priority to some of the specific needs that the different departments of the territory may have. Thanks to the number of works carried out, the relationship between civil works and the development of a city, a department and, why not, the whole country, is a little clearer.

Negative social impact of civil constructions

It is evident the enormous advantages that bring to the community the execution of civil works with the sufficient degree of technical planning, but it is also evident the number of present edges that entails approaching the topic of the social impact of a civil construction; this section will be dedicated to the negative social impact of the civil constructions; beforehand it is important to mention that the sector of the constructions is permeated by a great number of harmful factors that affect the society, the economic and cultural development of the territories and the own constructive system.

Construction, besides being indispensable for the development of society, is also one of the main responsible for the generation of waste, pollution, the transformation of the environment, and considerable use of energy (Acevedo, Vásquez, & Ramírez, 2012). It is no secret that the main negative effect produced by the execution of civil works has the environment as its epicenter. We are aware of the serious effects that transformation without the technical

rigor required to make these changes brings to the territories, but as previously clarified, we consider that articles on this type of problem abound, and it is not the aim of this text to deal with such saturated topics, but it is vitally important to make this type of clarification for a better understanding of our approaches.

We know that touching on this subject requires the greatest rigor and coherence, implementing negative value judgments towards our profession is something challenging and complex, but as an academic exercise, it helps to generate in us a critical and objective position, focusing on the things that must improve the future civil engineering of the country.

It is worth highlighting that due to the scientific nature of civil engineering, it is possible to execute works with the highest degree of planning, perfect execution and minimum negative impact; contrary to this, it is evident that Colombia does not have a very efficient construction system, it is known about all the recent bribery scandals for the awarding of contracts by foreign construction companies to our public officials; subcontracting and diversion of resources by territorial administrations are commonplace in the country's media; This current of analysis, would immediately take us to the scene of corruption and bad management of resources that afflict the country, in contrast to this, we have decided to focus our criticism on the scene of works with deficiencies in planning, and being more concrete, we raise our problem of investigation in the analysis of the plans of territorial ordering POT (seen as potential generators of social changes) pitifully badly executed in the country.

The Land Use Plan (POT) is a technical and normative instrument to organize the municipal or district territory. Law 388 of 1997 defines it as the set of objectives, guidelines, policies, strategies, goals, programs, actions and regulations, designed to guide and manage the physical development of the territory and land use (Cámara de Comercio, 2016). Knowing this definition we can observe the great importance of the POT in the development of the territories and the great influence it has on the relations of the people; besides this, it is pertinent to clarify that to carry out the POT is not a simple task and less so if this is focused on a city as large, diverse and somewhat disordered as Bogotá.

We know in advance that excessive population growth is a reality. The causes of this accelerated population growth are multiple, the main one being a decrease in mortality. The decrease has been produced as a consequence of the sanitary, economic, and technological advances that made possible the disappearance of epidemics and the diffusion of new industrial techniques. The expansion of this progress in developing countries occurred rapidly, parallel to the existence of high birth rates, giving rise to the phenomenon of the population explosion (López, Maca, & Gordillo, 2017; Wikipedia, 2017). These statements immediately generate the thought that wanting to increase the size of the city would be a bad idea for its citizens and the perception they have of their territory; a wrong idea, since, having this as a reference, population growth is an indisputable reality and it becomes evident that we should not ask ourselves whether to grow or not, but on the contrary, we are obliged to ask ourselves the question: where are we going to grow and how are we going to do it?

Bogotá, Colombia (the capital of the country) is a fairly large city, currently has about 8 million inhabitants (according to DANE) and if a detailed analysis of every aspect involving social relations between its inhabitants, we would conclude that many people live in a small space, the transport system of the capital is not the most appropriate (even is one of the worst in the country), its mobility is slow, its health system leaves much to be desired, there are neighborhoods in precarious conditions as public services are concerned, among other things.

The incoming mayor's office, under the command of Enrique Peñalosa, has the challenge and the obligation to design the capital's POT that will be in force for the next 12 years, a not at all easy task due to the accelerated growth in the number of inhabitants of the capital territory. So far, Mayor Peñalosa's administration has had many detractors and the perception that most citizens have is not the best, this, a consequence of the very controversial bidding process of the elevated metro, which discarded important engineering studies conducted in the previous administration, and the also controversial construction in the Van Der Hammen reserve. These events seem to be obscuring the panorama of the future Land Use Plan for the country's capital.

Taking our city as a reference, we have evidenced that the harmful effects originated by bad territorial planning are a reality; entire citadels located to the south of the city are witnesses of the state abandonment, the deficient provision of public services and the seriousness of the consequences that this deficit in planning brought with it (Fig. 4).

To elaborate a discussion about all the harmful effects that bad planning has brought to the capital would be a too laborious and extensive task, each sector of the city would demand a deep technical analysis to determine the mistakes made and the impact that these caused in the social relations; said this, we have chosen to analyze only one case, based on the importance and conjuncture that this one has; the presented case of negative social impact on the capital is the landfill, Doña Juana.

The Doña Juana landfill is the main garbage dump in Bogotá, located in the town of Ciudad Bolivar, near the Doña Juana hill, between the Mochuelo Alto and Mochuelo Bajo sectors. The landfill has suffered some problems since it was put into operation, the most notable being the collapse that occurred on September 27, 1997, when an accumulation of gases and leachates produced a slide of more than 500,000

Figure 4. Bogota's constructive growth (El Espectador, 2016).

tons of waste that obstructed the course of the Tunjuelo River. Another landslide occurred on October 2, 2015, with 550,000 cubic meters of waste at the top of the operation. Likewise, the urban expansion that the city has suffered in recent years has led to the settlement of communities near the landfill, which have been affected by the odors and insects coming from it, especially in the paths of Mochuelo Bajo and Mochuelo Alto (López et al., 2017; Wikipedia, 2017).

The living conditions of the people who live in the areas surrounding the landfill have been quite affected by the poor planning of the work. It is not possible that 40 years have not been enough to understand how to manage a large city and know how to manage its waste. A good measure to mitigate the negative impact of this project would be the total relocation of the inhabitants of the upper and lower Mochuelo villages, a proposal that has already been criticized by the inhabitants of Mochuelo itself; We hope that the management given to this situation will be the most adequate. Civil engineers and town planners must work as a team to provide the best solutions within the reach of a reasonable expenditure of resources, where the inhabitants who have had to endure these unacceptable living conditions are the ones who benefit the most. Bogotá, being the capital of the national territory, cannot allow the management of its waste to continue to be executed in such an inefficient manner. It is time to learn from mistakes and improve for the better, this, through an excellent application of civil engineering when designing our cities.

Conclusions

As already mentioned, civil works have a certain level of importance for the development of a slightly more pleasant life, because each of the constructions that surround human beings anywhere in the world was born as a response to a specific need of them. In addition to this, great interest has been shown in showing the impact on society that civil constructions have.

The construction systems in a community are an indicator of development, culture, and history because through the analysis of a civil engineering project it is possible to deduce the general conditions that a population could have had

before, during, and after the beginning of the construction. This type of impact on society makes the tasks used to achieve a building or civil work more interesting because thanks to this, great changes are generated in people's lives, which can be positive or negative as already mentioned in the content of the previous chapters where we wanted to make known the scope that the constructions could have from their objective.

Infrastructure is a key aspect of a country's economic and social development. Historically, Colombia has found it difficult to interconnect its various regions, due to the country's complex geography. Despite this, in recent times, the country has made significant progress in infrastructure development.

According to Dimitri Zaninovich, the country's infrastructure has become a very important aspect of the government since 2010. There the government realized that the development of infrastructure is a locomotive for the country. In fact, since then, the government has set itself important goals in this area, and various strategies have been implemented to encourage the growth of this sector. Now with the projects that are being carried out, it is expected that we will achieve greater integration at the national level, to be more competitive (El Tiempo, 2015c).

As expected, the construction of infrastructure plays a vital role now in these times because it is being sought to improve the country's productivity. Lately, to achieve these objectives, the Colombian state has invested more capital in the construction of 4G roads to improve its capacity to trade nationally and internationally.

Among the five major investments that must be made to boost the economy, without a doubt, the 4G tracks are consolidated as the greatest hope for generating more jobs; it is estimated, for example, that for this year about 313,784 new vacancies will be opened, which would generate a greater contribution to GDP growth, future reductions in logistics costs and better projections in the trade sector.

But in the progress of the 4G tracks, it seems that the picture has been changing. We were used to hearing widespread congratulations on this ambitious program that

comprises an investment dimension of nearly $47 billion and more than 30 projects.

In the current scenario, there are concerns about the precarious progress of the works, the financial closures, and their impact on the economy. Projects such as Mulalo-Loboguerrero, one of the great feats for the Port of Buenaventura, is paralyzed and thus its economic impact on the region will be delayed. According to figures from the National Infrastructure Agency - ANI, there are four more projects with problems in prior consultation and five in contractual disputes.

At the financial level, the National Development Finance Company plays a very important role in rebuilding the confidence of local investors, strengthening relationships, and seeking more foreign investors and strategic funds; it would also be good to hear that the new fund between BlackRock and Fiduciaria Bancolombia is on its way. The blow to the Odebrecht case from the corruption scandal has been part of the need to energize negotiations and strengthen confidence in the program (Vanguardia, 2015).

The emerging economies of Latin America must project a model of infrastructure development that involves communities, but they must plan for the long term and not with an immediate vision.

To achieve infrastructure, the important thing is not only to put up the money but to have a future-proof infrastructure, how to make the cities grow more sustainably, that allows the cities to begin to spread and not have that disorderly expansion, because then there is no way to order it later, concluded Mr. Ijjás Vásquez.

However, in his diagnosis of what is happening in the country, he highlighted the progress in the development of some projects that are underway for mobility, with projects such as the Fourth Generation, and highlighted the implementation of the Highways for Prosperity project that is currently in the bidding stage in Colombia.

In the development of infrastructure projects for the country, but in particular for the cities, as discussed at the Seventh World Urban Forum UN-Habitat, it is of vital importance that the transport service is attended to and that guarantees of optimum and adequate mobility are considered in the communities, and from them with others. This is what Tomás Elejalde, Planning Manager of Metro de Medellín (Mass Transport Company of the Aburrá Valley), one of the companies with the greatest recognition and requests for information and advice during the Seventh World Urban Forum, considered and explained to Caracol Radio.

The theme of public transport is a very important chapter in the urban issues that have been addressed at this World Urban Forum. Specifically in this chapter, we have identified in the Forum the world current of thought on this subject that could be specified as being important for the cities of the future to generate high density in terms

of the transport lines that are already built to optimize the use of these large investments, the official explained (Clavijo, Alzate, & Mantilla, 2015).

This proves the importance of civil works in the economic development that in turn brings contributions to the culture of the population because of the interconnection between the country and the outskirts of it, the privileges of construction in front of the community for which the project was designed are too many if you think from the social perspective. As a benefit to the people, what it means for them to be able to count on these great civil engineering works in their territories.

Finally, this paper wishes to call attention to those who are generally in charge of development in construction works, which are one of the best indicators that Colombia has compared to other Latin American countries for the increase of GDP. It is very important to know how the work carried out by a group of civil engineers affects at a cultural level, for which it is necessary to dedicate some time to analyze the work carried out and put more effort in understanding which is their role in both cultural and social development because as it was already mentioned, the progress in works of a project generates certain annoying moments for a specific group of people when the project is finished, it must be started with the recognition of the problems that are presented in this text such as the focuses of poverty, the bad distribution of resources, among others.

To improve the scope of a civil engineering project it is necessary to improve the shortcomings that professionals have in this area of knowledge because the biggest difficulty that Colombia presents in the construction sector is the lack of planning or long-term planning that is done halfway thinking that it would not serve much to have a good scheme for the future of that project.

A relevant aspect that would be very good to mention is the planning of a project because thanks to bad execution of this type of work plan, so to speak, the different difficulties for the construction sector arise, making this profession the topic to talk about the common people who due to lack of knowledge misjudge the work of the civil engineer. And it is at that moment when we should think about the impact that civil works cause to the daily life of a certain population because, even though civil projects are born as a response to clear needs of the community when this type of modifications to the people's environment is made, some individuals will open up and dare to refer to the efficiency and the proportionate improvement of the living conditions of the place where the construction was developed, but, at the same time, there will be members of the community who will talk about the negative aspect of the project.

If for engineering students, their main desire is to know and apply their practical and intellectual capacities when working as members of this professional union, the

awareness of these new workers can be given in their training in the higher education institutions available in the country.

A civil engineer must be aware of the important role he plays in the development of a society. A professional of this branch of engineering has the responsibility to keep alive not only one person but more than one hundred people because through the elaboration of a constructive project the value of human life must be taken into account. For this purpose, the civil engineer must present a clearer structural design where the different specifications of the place will be shown with the objective of not having human losses throughout time due to a structural failure.

But the most important thing that a civil engineer must have throughout his professional life is the development of good ethics since it is through the full and correct exercise of this somewhat behavioral doctrine that individuals become more aware of the actions they take to generally obtain personal benefits such as recognition for the accomplishment of excellent work. Perhaps the most gratifying part of this type of work is to define how, from the development of a construction project, new ties are generated with other people, which in principle allows for a little more knowledge of society in certain parts of the country, cultural exchange from the trips made by people through the construction of civil works such as roads, ports, etc, They also play a vital role in enriching the cultural heritage of the members of the community and although changes are generated by the constructions, these can be negative, this helps the professional in charge of the evolution of this construction to decide to analyze the scope and response in the society of each of the processes used to meet the need for which the project was started.

Another factor for the awareness of civil engineers, also referring to professional ethics, is the bad distribution of resources because through the good management of inputs it is possible to reach the proposed objective and, also, more concrete results on the evolution of work will be shown.

The awareness of the work of civil engineering lies in the correct handling of the professional ethics of each one of the students who are currently being trained as engineers because it is from their passage through the educational institutions where the sense of belonging is cultivated and good ethical practice in their professional life will be able to be ethical civil engineers for the society that demands so much the construction of increasingly sophisticated projects.

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What technologies are being applied in La Guajira (Colombia) for the collection and distribution of water?

¿Qué tecnologías están siendo aplicadas en La Guajira (Colombia) para la recolección y distribución de agua?

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Within this article we take a brief look at the water situation in Guajira (Colombia). We talk about the available water resource and its rationing for the support of the community. We also present a small historical review to know the origin of the inconveniences related to water in the territory. The technologies used to obtain drinking water are then discussed. First, we describe the drinking water wells that are not an applied technology, but they are one of the main sources of supply, and are still being installed throughout the region. Secondly we will see the water desalination system, its application in this territory and its different methods and techniques developed, and as the latest technology is the Warka wáter, an ambitious project but little applied due to the climatic and geographical conditions of the territory.

Keywords: Desalination, drinking water, Guajira, Warka wáter, water wells

Dentro de este artículo damos un breve vistazo a la situación del agua en la Guajira (Colombia). Se habla del recurso hídrico disponible y su racionamiento para el sostenimiento de la comunidad. También se presenta una pequeña reseña histórica para conocer el origen de los inconvenientes relacionados con el agua en el territorio. Luego se habla de las tecnologías usadas para la obtención de agua potable. Primero se describen los pozos de agua potable que no son una tecnología aplicada, pero son una de las principales fuentes de abastecimiento, y aun en la actualidad están siendo instalados por toda la región. En segundo lugar veremos el sistema de desalinización de agua, su aplicación en este territorio y sus diferentes métodos y técnicas desarrolladas, y como última tecnología está el Warka wáter un proyecto ambicioso pero poco aplicado por las condiciones climáticas y geográficas del territorio.

Palabras clave: Agua potable, desalinización, Guajira, pozos de agua, Warka wáter

Introduction

The Department of La Guajira is in northwest Colombia (Fabregas, Valencia, & Vanegas, 2017). It is made up of 15 municipalities and has a population of approximately 846,000 inhabitants, of which 54.6% live in urban areas and 45.4% live in rural areas (Ferrero, 2015). Of the 20,848 square kilometers, it covers, 41% is classified as a subtropical desert (Moreno et al., 2015).

The area has characteristics that do not allow it to be served traditionally with a network of aqueducts (Banks, 2017; Ospina, Domínguez, Vega, Darghan, & Rodríguez, 2017). The extension of the territory, the dispersed population, or the nomadic life of many communities forces us to think of alternatives to the problem (Beier, Bernal, Ruiz, & Barton, 2017; Calle et al., 2017; Osorio, Montoya, Ortiz, & Peláez, 2016).

This article describes the current situation of water shortage in La Guajira, the new technologies for obtaining drinking water that is supported and applied in other countries, which are being studied on a large scale and may be possible solutions to the current problems of La Guajira.

Currently, there is the possibility of exchanging information with Israel, which is a country that has managed to position itself as one of the most advanced and innovative countries in the field of water technologies through diplomatic efforts.

The main objective of this article is to inform and raise awareness about the situation that has existed in La Guajira for years, highlighting mainly the neglect of the state that has made it impossible for this territory to obtain drinking water.

Theoretical framework

Water in La Guajira

The issue of water in the territory of La Guajira is developed in a framework of scarcity and drought, especially the Wayuu indigenous community living in rural areas of the department. Factors such as the abandonment of the state, corruption, and misuse of the resource have been causing the population for decades to be at risk from the lack of water, because it should not be forgotten that this is indispensable for human life, for food and health. It also affects the economy because without water it becomes complicated for the inhabitants of the area, the water obtained is often not suitable for crops or livestock.

Historical overview

From the ancient Guajira civilizations that maintained water as the guarantee of life for their communities; a resource that in the first instance was altered by the mining extraction activity that saw its beginning in December 1984 and that was privileged because its promoters claimed that it

would be an engine for the economic growth of the region getting to generate during its first 20 years of gas, coal and salt production some royalties of the department that exceed 5 billion pesos. La Guajira assumed progress, one that in many economic and industrial aspects arrived, but was never reflected in the quality of life of the community. Added to the previous one, another of the main aggravating factors for the region are the corrupt behaviors of the state and the authorities responsible for the distribution of resources in the region because, in the last decades, scandals about education, health, child care, and civil works programs have become a habit in the department. A department that, to top it all, is plagued by droughts that have not stopped for years.

The current situation

The current situation is worrisome, very often there are human victims due to the lack of water in the Wayuu communities and the figures of infant mortality are alarming and heartbreaking. The liquid is scarce about the high temperatures that plague the department and is a problem that to date has not been solved by either the public or the private sector and has also become more important for the national and international agenda due to the climate changes felt in recent years.

The water problem currently contributes to the deterioration of the health of the population, with the spread of disease and malnutrition, which in turn generates stagnation in the agricultural, economic and social development of the department; the community is not in optimal conditions to work, which in turn also generates poverty and social imbalance.

According to the same leaders of the Cerrejón mining area, the Ranchería River supplies 16%. Of the water used, mainly for human consumption by employees, contractors, and inhabitants, and for delivery to neighboring communities, they also state that of the total water we consume each day, 90% is of low quality, i.e. not suitable for human or animal consumption or for irrigating crops. This water comes mainly from coal seams and rainwater and is used for environmental dust control measures, as established in the Environmental Management Plan.

The problem and the new technologies

Drinking water wells

A resident of the Wayuu community can take hours to get a ration of water, this is a routine that is part of their customs but the situation of mobilization of the complicated year after year for this reason since August 2016 the Ministry of Housing installed water sources for communities with supply problems in the form of wells with quality groundwater, these wells but are not considered as a new technology if they are a long-term solution to the problem.

Water desalination

97.5% of the water present on earth is salty, so only less than 1% is available for human use. The situation in recent years, coupled with conflicts on the border and underlying reasons such as extreme poverty in the region and corruption, has aggravated the water crisis in La Guajira. This is why the company Col Energía in alliance with the company MFT created a supply system based on water desalination with the use of solar energy, wind power, and automated plants (Adak & Tewari, 2014; Cardona, Vela, & Martínez, 2015).

Col Energy S.A.S is a Colombian company focused on proposing, designing, and implementing innovative projects, sustainable over time, and with high social and environmental impact within the framework of energy management and water treatment.

How does a desalination plant work?

The first stop in a plant is the collection and cleaning of water. Collection pipes located at the bottom of the sea capture the saltwater and transport it to the pre-treatment area to eliminate the solids in the water and sodium hypochlorite is added to eliminate bacteria and other microorganisms present in the water. After this, it passes through a section where it is filtered by the sand and different coagulants that soften the smallest particles that are in the water (Le Roux, Nada, Khan, & Croué, 2015). Then they are separated by a microfiltration stage where the smallest particles are removed, the filters used contain activated carbon and other products, capable of retaining micro impurities. The most important stage is the passage of the water through the reverse osmosis frames (Abdeljawad, Zaqoot, & Aish, 2016; Sankar, Deepa, Rajagopal, & Karthik, 2015). These are responsible for converting salt water into freshwater by applying mechanical pressure on the container of the most concentrated solution, the water moves in the opposite direction, separating from the salt during the process (Carravetta et al., 2016). A pressure pump makes the saltwater pass through a tube with seven semi-permeable membranes inside, which only allow the water molecules to exit, retaining the salts in porous support. Finally, the water passes to the post-treatment stage where it is remineralized by adding lime and carbon dioxide so that it is suitable for human consumption. The treated water is stored in special tanks, ready for distribution.

Currently, less than 1 percent of the world's population depends on seawater desalination for its daily drinking water supply. There are about 21,000 operating desalination plants, most of which are located in the Middle East.

Alternatives to desalination

Wind desalination. A wind-powered desalination plant was built. The plant consists of the Wind Energy Transformer tower whose rotational energy directly initiates the operation of a compressor through a gear system. Subsequently, the temperature levels are raised and the pressure reaches the appropriate level for the water to evaporate. The evaporation causes the freshwater to condense, leaving the salt behind (Rezaei, Naserbeagi, Alahyarizadeh, & Aghaei, 2017).

In La Guajira, the system promises to be a system where the area is swept almost all year round by the trade winds that blow from the Caribbean Sea in a north-east and south-west direction. The Guajira is home to the only wind farm in Colombia that registers winds equal to or higher than 5 m/s, even reaching 11 m/s these figures sound attractive to implement the model.

Solar desalination. It consists of the evaporation of water to separate salts and other impurities from the water. Thermal desalination imitates the natural process of the water cycle, evaporation from the ocean, accumulation in the atmosphere, condensation in the form of rain or snow, and harvesting. As heat is vital in thermal desalination, the process is often linked to refinery power stations, to use the waste heat (Fig. 1).
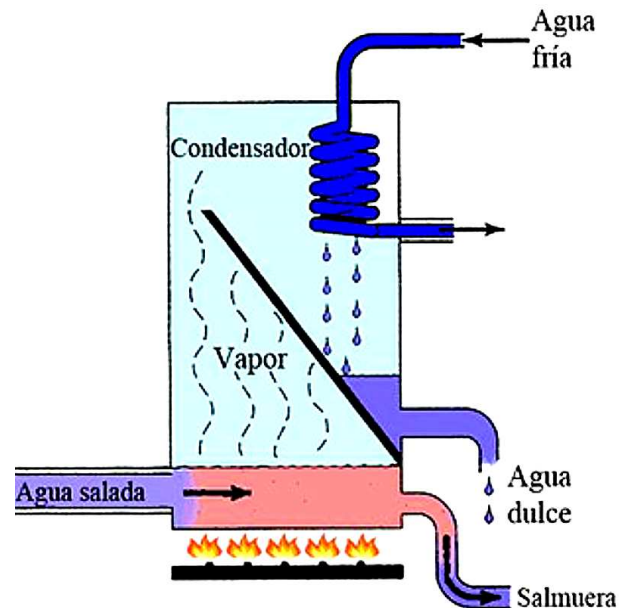

Figure 1. Thermal or solar desalination and its operation (Opex Energy, 2017).

The initiative will benefit 2,975 natives directly and up to 2,275 indirectly. The cost of this proposal exceeds 785 million pesos, of which the Cerrejón Foundation finances 53 percent. This percentage, in figures, is equivalent to more than 415 million Colombian pesos.

Warka Water

Warka Water is a tower made of bamboo and biodegradable plastic that can collect water from rain, fog, and dew. It was developed by the architectural firm Architecture and Vision; the architect Arturo Vittori designed it in 2012 in his laboratory in Italy and a year ago he took a prototype to a villa in Ethiopia where the pilot project is being made. This structure stores rainwater, decanting fog and converting wind humidity into gothic, which then becomes water threads to supply the neediest communities. It is a vertical structure with a perforated fabric inside that hangs to collect water from the air through condensation. The triangular mesh structure is made of natural materials such as reeds and can be built by the villagers. The structure, which weighs only 60 kg, consists of 5 modules that are installed from the bottom to the top and can be lifted and assembled by 4 people, without the need for scaffolding. The tower can obtain up to 100 liters of drinking water per day.

The tower is about 10 meters long, according to the prototype, and can generate up to 100 liters of water per day. It holds about 3,000 liters. Its construction is manual and takes a maximum of 10 days and 10 people.

Warka Water Tower in La Guajira. In February 2016 Arturo arrives in Colombia intending to provide a clean solution for the indigenous people suffering from a delicate water situation, first arriving in La Guajira to make an excursion in which the architect accompanied by a group of engineers and specialists to evaluate the conditions of the land and determine if it is suitable for the installation of the system.

Supporting studies

The average salinity of seawater is 35000 ppm (parts per million), although in warm seas it can reach 42000 ppm. In inland seas, it varies between 5000 and 7500 ppm. There are aquifers with a salinity of 2000 ppm (parts per million) (Arreguín & Martín, 2000).

Desalination systems

Desalinated water is used for human consumption, in industrial processes, and in a very limited way (Fig. 2).

Costs of desalination

The cost of desalination is very variable. This is due to several factors, including the following:
- Source water quality.
- Plant capacity.
- The conditions of the installation site.
- Energy costs.
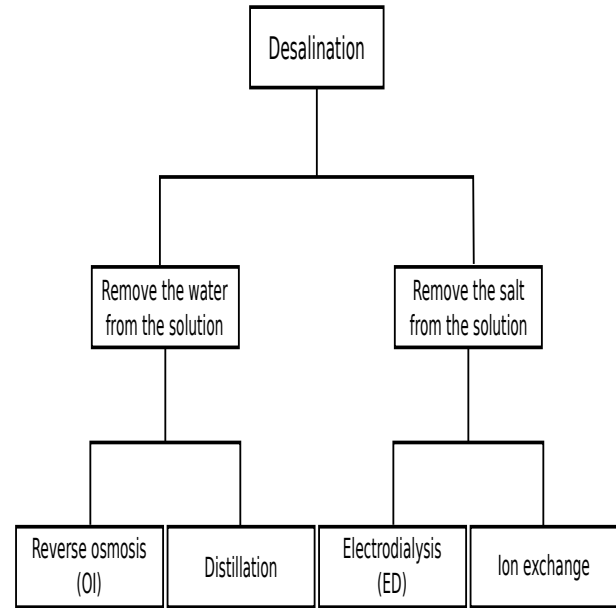
Figure 2. Desalination systems (Arreguín & Martín, 2000).

Environmental impact of desalination plants

The construction of a desalination plant implies the need to prepare the corresponding environmental impact studies, and to propose the mitigation measures following the regulations.

The benefits of water desalination in terms of the uses that can be made of it already in that condition are infinite, as well as its availability. One of the most striking benefits is to achieve the development of cities or towns where there is no drinking water, such as in the Caribbean islands, Spanish islands, Japan, Singapore, and the Arab countries, or in areas of low availability such as Florida and California, in the United States, or Baja California, Baja California Sur and Sonora, in Mexico, and northern Chile and Venezuela (Fuentes, 2007).

Negative aspects

- The initial investment costs are high.
- Operating and maintenance costs are not competitive with good drilling and surface water treatment.
- Desalination is recommended only when there is no cheaper alternative for obtaining drinking water. Besides, specialized personnel is required to operate the equipment, and spare parts are expensive.

Potential solution

Due to the lack of water availability in the world and the desire of most nations to improve their use of existing water sources, find alternative water sources and promote new technologies, Israel is becoming the country

that proposes to the world to collaborate in the transfer of information on existing technologies, the development of new technologies and the preparation of future national and possibly international standardization in this field.

Israel has managed to position itself as one of the most advanced and innovative countries in the field of water technologies and has almost half of the territory is desert. Much of the water used in Israel for drinking, bathing, and daily use comes from the sea.

One solution to the problem La Guajira faces in terms of water shortages could be the implementation of Israeli technologies. Israeli experts and scientists were in several regions of Colombia and learned about the situation of La Guajira, the problems they face in terms of water and food, it is possible that the technologies used in Israel reach the national territory.

For five decades, Israel has facilitated the exchange of knowledge, especially in agricultural matters, to Colombia. There have even been successful examples and in desert areas, they are growing potatoes. An experience recognized in the Middle East.

From now on, it is the diplomatic efforts that will allow progress in the use of Israeli technologies in areas such as La Guajira. A future in which the Caribbean Sea is the main source of drinking water for several regions of Colombia is not so far off. International cooperation could facilitate the resolution of food problems in the poorest areas of the country.

Conclusions

As a first conclusion, it is important to highlight the conditions that the Wayuu community is living, but above all the real possibility that there is a solution to the problem, being an issue that became an international priority because the abandonment of the Colombian state has meant decades of decline for the region, with inhumane living and health conditions. This article, in addition to its academic purposes, has a social sense that invites awareness of the adverse situations of the inhabitants.

The desalination of water is postulated not only as a potential solution for La Guajira and its situation but also for the threat of shortages that will occur in several decades considering the technological advances projected for several years in the future desalination techniques can improve.

The Warka Water Tower model emerges as one of the most attractive alternatives, especially because of its success in Ethiopia where the problems of a small community were solved with the installation of the tower. As it is an economical system, easy to maintain and sustain, it is only necessary that the soil conditions and the climate of the area are optimal.

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Informatics Security - VPN

Seguridad Informática - VPN

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In the following article, the topic of IT (Information Technology) security will be presented, focusing on everything that concerns the implementation of a VPN in a business environment. The type of VPNs that exist, the protocols, requirements, and uses for which this network is used will be addressed, and then the configuration of one of these networks will be explained. In this way, we will evaluate the level of reliability, performance, and traffic control of a VPN and argue why it is the best current IT security solution for a company.

Keywords: Access, computer security, encryption, networking, VPN

En el siguiente artículo se expondrá el tema de seguridad informática, enfocando su contenido en todo aquello que concierne a la implementación de VPN en un ambiente empresarial. Se abordará el tipo de VPNs que existen, los protocolos, requisitos y usos para los cuales esta red se emplea, para luego explicar la configuración de una de estas redes. De esta forma, evaluar el nivel confiabilidad, el desempeño y el control de tráfico de una VPN y argumentar porqué es la mejor solución actual de seguridad informática de una empresa.

Palabras clave: Acceso, cifrado, redes, seguridad informática, VPN

Introduction

It will identify the problem and the question to be solved of, why the implementation of a VPN is the best solution in the IT security of a company, and it will give a brief description of the information gap and how it will be solved (Alshalan, Pisharody, & Huang, 2016; Redžović, Smiljanić, & Savić, 2017).

VPNs are created by the need to keep our data safe when surfing the Internet since we are not exempt from the theft of our information and more without realizing it, also born by companies that need to provide their internal network infrastructure to their workers, when they are in places other than the company and at any time and this method allows a safe way (Olver, 2016; Park et al., 2015; Udayakumar, Thooyamani, & Khanaa, 2014).

They also allow accessing public information from anywhere in the world that due to the laws of different countries many contents are blocked and/or censored, thanks to this security system you can visualize that information and keep protected the trace that the user leaves when surfing the internet, the VPNs can be found in paid versions with great features even for those who cannot pay the premium versions there are the free versions that also satisfy that need but with some limitations (Kuroda, 2017; Massis, 2017).

At the end of the day it is nothing more reassuring than knowing that when surfing the Internet no matter what page you are visiting you can be confident that our data will always be safe, such as when making financial transactions, entering social network passwords, credit or debit card keys, making purchases with cards and so on, companies have the reliability that their customers' data and internal company data are not in danger as more and more new methods are created to manipulate the Internet and sabotage its security to get theirs those unscrupulous people who take advantage of unsuspecting users, to steal their personal information (Shunmuganathan, Saravanan, & Palanichamy, 2014).

The main objective of the article which is to inform about the alternative of computer security (VPN), also to create awareness that having computer security is necessary to protect our data and thus increase the implementation of this security system (Liu & Wang, 2014; Salman, 2017).

IT security and VPN

It will be briefly explained what a VPN is and how it works, to understand in an easy and precise way this effective security method.

VPN

A VPN (Virtual Private Network), is a network that allows a secure connection of data through a public or private Internet network being encrypted for security, and no matter where you are running this technology makes it possible to use the Internet from the original location of the server being used. This means that it is possible to use the Internet as if you were present in the region that has the VPN network.

Types of VPN

• **Remote access VPN**. This type of network allows them to connect to the same VPN network through a fixed IP from other remote locations. It is commonly used by companies with workers in other locations different from their headquarters that need to connect to the company's network and its headquarters temporarily.

To access the secure connection, the user must run the application and authenticate with a username and password. This creates the encrypted channel between the computer and the remote network, for a secure data exchange (Amaya, 2016) (Fig. 1).
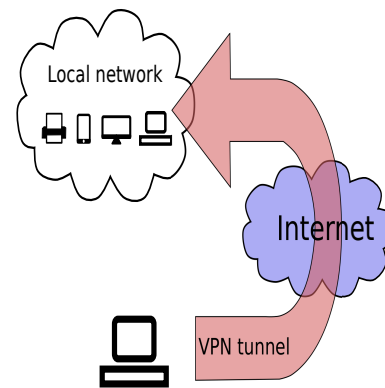
Figure 1. Remote access VPN.

• **Point-to-point VPN**. This scheme is used to connect remote offices to the organization's headquarters. The VPN server, which has a permanent link to the Internet, accepts Internet connections from the sites and establishes the VPN tunnel (Cheng, 2007).

In simple terms, a point-to-point VPN creates a virtual bridge that links networks in different locations to connect them to the Internet and maintain secure and private communication between them. They connect to the Internet using the services of their local Internet provider, typically through broadband connections.

• **Tunneling**. Type of communication is encapsulated using an encrypted network protocol to travel over the communication network, precisely creating a tunnel or encrypted communication channel within a computer network. As important information travels encrypted within the communication protocol data unit (PDU), all intermediate nodes participating in the communication will interact with the packet, but only at the end of the communication can the information be unpacked and decrypted for use.

In this way, data packets are routed over intermediate nodes that are unable to see the contents of those packets. The tunnel is defined by the endpoints and the communication protocol used, which, among others, could be SSH (Secure Shell) (Cheng, 2007) (Fig. 2).
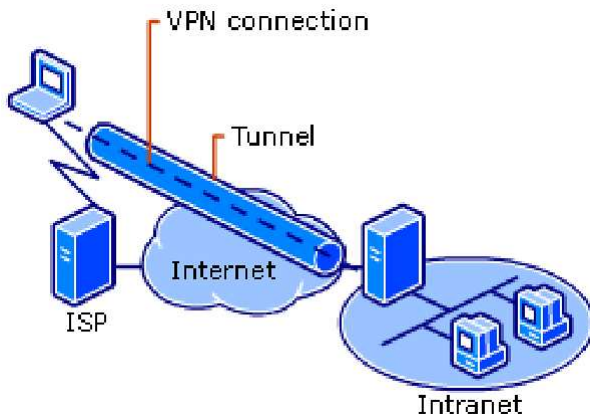

Figure 2. VPN connection.

• **VPN-LAN**. This is a variant of the remote access type but, instead of using the Internet as a connection medium, it uses the same company local area network (LAN) (Cheng, 2007).

It works just like a normal VPN, except within the same local LAN rather than over the Internet. It serves to isolate areas and services from the same internal network. It also serves to enhance the security features of a Wifi wireless network.

• **Firewall-based VPN**. This VPN takes advantage of the firewall's security mechanisms, including restricting access to the internal network, performing address translation, and meeting authentication requirements. The disadvantage of this type of technology is to be able to optimize its performance efficiently without diminishing the applications of the operating system (UNAM, 2017).

Protocols

• **IPsec (Internet Protocol Security)**. It enables improved security through robust encryption algorithms and a more comprehensive authentication system. IPsec has two encryption methods, transport mode, and tunnel mode. It also supports 56-bit and 168-bit (triple DES) encryption.

• **PPTP/MPP**. Technology is developed by a consortium of several companies. PPTP supports various VPN protocols with 40-bit and 128-bit encryption using the Microsoft Point to Point Encryption (MPPE) protocol. PPTP alone does not encrypt information.

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to Point Encryption (MPPE) protocol. PPTP alone does not encrypt information.

• **Symmetric vs. Asymmetric Encryption (Private Key vs. Public Key)**. Symmetric or private key encryption (also known as conventional encryption) is based on a secret key shared by both parties. The sending party uses the secret key as part of the mathematical operation to encrypt (or cipher) plain text to encrypt text. The receiving party uses the same secret key to decrypt (or unscramble) the ciphertext into plain text. Examples of symmetric encryption schemes are the RSA RC4 algorithm (which provides the basis for Microsoft's Point-to-Point Encryption (MPPE)) (UNAM, 2017), the Data Encryption Standard (DES), the International Data Encryption Algorithm (IDEA), and the US government's proposed Skipjack encryption technology (implemented on the Clipper chip).

Asymmetric or public-key encryption uses two different keys for each user: one is a private key known only to that user; the other is a corresponding public key, accessible to anyone. The private and public keys are mathematically related by the encryption algorithm. One key is used for encryption and the other for decryption, depending on the nature of the communication service being implemented.

Basic VPN requirements

Typically, when implementing a remote network solution, a company needs to facilitate controlled access to company resources and information. The solution must allow roaming or remote clients to connect to LAN resources, and the solution must allow remote offices to connect to share resources and information (router-to-router connections). Besides, the solution must ensure the privacy and integrity of data as it travels over the Internet. The same concerns apply in the case of sensitive data traversing a corporate internal network (Microsoft, 2017).

Therefore, a VPN solution should provide at least all of the following:

• **User authentication**. The solution must verify the identity of the VPN client and restrict VPN access to authorized users only. It must also provide audit and accounting records to show who accessed what information and when.

• **Addressing**. The solution must assign a VPN client address on the intranet and ensure that private addresses are kept private.

• **Data encryption**. Data transported on the public network must be unreadable to unauthorized customers on the network.

• **Password management**. The solution must generate and update encryption keys for the client and server.

• **Multi-protocol support**. The solution must handle common protocols used on the public network.

Deployment

The de facto standard protocol is IPSEC, but there are also PPTP, L2F, L2TP, SSL/TLS, SSH, etc. Each with its advantages and disadvantages in terms of security, ease, maintenance, and types of clients supported.

Currently, there is a growing line of products related to the SSL/TLS protocol, which tries to make the configuration and operation of these solutions more friendly.

Hardware solutions almost always offer higher performance and ease of configuration, but do not have the flexibility of software versions. Within this family, we have products from Fortinet, Sonic WALL, Watch Guard, Nortel, Cisco, Linksys, Nets creen (Juniper Networks), Symantec, Nokia, U.S. Robotics, D-link, Mikrotik, etc.

Software VPN applications are the most configurable and are ideal when interoperability problems arise in previous models. The performance is lower and the configuration more delicate, because it adds the operating system and the security of the computer in general (Eumed, 2017).

User administration

When selecting a VPN technology, it is important to consider administrative issues. Large networks need to store directory information on a per-user basis in a centralized data store or directory service, so that administrators and applications can add, modify, or query this information. Each access or tunnel server could maintain its own internal database of per-user properties, such as names, passwords and dial-up permission attributes. However, because it is administratively prohibitive to maintain multiple user accounts on multiple servers and keep them up to date at the same time, most administrators set up a master account database on the main domain controller or directory server, or on a RADIUS server.

Common uses

The objective of this section is to specify the most common applications given by common users and corporations of a bureaucratic nature, it should be clarified, with completely different purposes (Jacinto, Martínez, & Martínez, 2015).

The first of these is the leap in geographical restrictions. In many cases, there is content whose availability is very restricted because it is only accessible in certain countries. Given this situation, any user with Internet access can use VPN connections that are provided by mobile applications, browser plug-ins, or programs developed for computers whose software facilities to alter the connection network, Windows or Linux-based systems, for example. And through this VPN connection, give the device from which the procedure has performed the IP of a proxy located in the desired country.

Second is data privacy when surfing on a public Wi-Fi network. It is very common to find open networks in places such as airports, cafes, and shopping malls, which, although they fulfill their function and provide access to the network, are not at all secure, since they lend themselves to users intercepting information. This problem is avoided when using a VPN connection since it allows the person to use it to hide private data, such as credit card information, and so on.

Finally, but the most relevant point, given that it is one of the greatest interest to the article, is its use in the area of corporations. While it is true that access to a certain company's database requires a password, this is visible to anyone who uses the same network as the first person in question (Montiel, Jacinto, & Martínez, 2016). This is where the use of VPNs becomes almost essential in the case of multinationals, or companies with franchises that require coordinating people who are a considerable distance away, since it is viable to use the Internet for the transfer of data and information, safely. Because VPN connections allow the encryption of such information, either the password mentioned in the first place or confidential data belonging to the company.

Methodology

This part of the article will explain in detail how we will solve the problem, what software and materials will be used. In this case, the methodology will be tested on a LAN and WAN simulator called Packet Tracer from CISCO and on computers with Windows operating system.

Site-to-site VPN

The following explains the basic tasks for configuring IP-based Virtual Private Networks (VPNs), site-to-site, and IP-based extranets on a Cisco 7200 Series router using generic routing encapsulation (GRE) and IPSec tunneling protocols. Basic security, network address translation (NAT), encryption, Cisco IOS weighted equal queuing (WFQ), and extended access lists for basic traffic filtering are configured (Fig. 3).

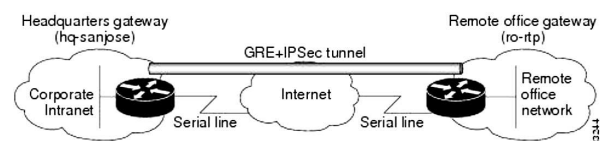*Figure 3.* Site-to-site VPN business scenario.

Fig. 4 shows the physical elements of the scenario. The Internet provides the central interconnecting fabric between the central office and the remote office routers. Both the headquarters and the remote office use a VPN gateway.

The GRE tunnel is configured on the first serial interface in slot 1 of the chassis (serial 1/0) of the central and remote
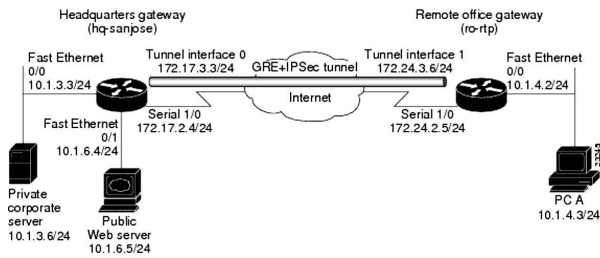
Figure 4. Physical elements of the site-to-site VPN scenario.

office routers. The configuration steps in the following sections are for the headquarters router unless otherwise noted.

Extranet scenario

The extranet scenario presented in Fig. 5 is based on the site-to-site scenario by providing a business partner with access to the same headquarters network. In the Extranet scenario, the site and trading partner are connected through a secure IPSec tunnel and the trading partner only has access to the site's public server to perform various IP-based networking tasks, such as placing and managing product orders.
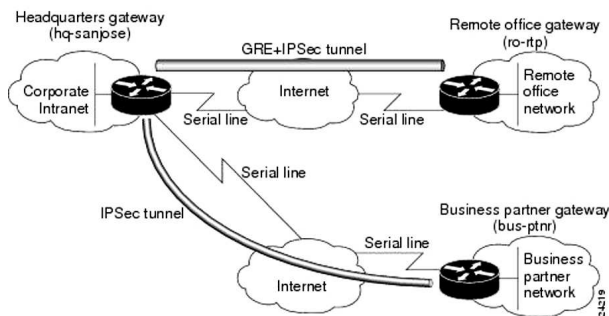

Figure 5. Extranet VPN business scenario.

The configuration steps in the following sections are for the headquarters router unless otherwise noted.

Tunnel configuration

The tunnel provides a way to encapsulate packages within a transport protocol. Tunneling is implemented as a virtual interface to provide a simple interface for configuration. The tunnel interface is not tied to specific *passenger* or *transport* protocols but is an architecture designed to provide the services needed to implement any standard point-to-point encapsulation scheme. Since tunnels are point-to-point links, you must configure a different tunnel for each link.

• **GRE Tunnel**. GRE is capable of handling multiprotocol transport and IP multicast traffic between two sites, which have only IP multicast connectivity. The

importance of using tunnels in a VPN environment is based on the fact that IPSec encryption only works in IP multicast frames.

Network redundancy (resilience) is an important consideration in the decision to use GRE tunnels, IPSec tunnels, or tunnels using IPSec over GRE. GRE can be used in conjunction with IPSec to pass routing updates between sites on an IPSec VPN.

To configure a GRE tunnel between the central office and the remote office routers, you must configure a tunnel, source, and destination interface at the central office and the remote office routers. To do this, complete the following steps starting in global configuration mode.

Paso 1	hq-sanjose(config)# **interfaz tunnel 0** hq-sanjose (config-if) # **dirección IP 172.17.3.3** **255.255.255.0**
Paso 2	hq-sanjose(config-if)# **fuente del túnel 172.17.2.4** **255.255.255.0**
Paso 3	hq-sanjose(config-if)# **destino del túnel** **172.24.2.5 255.255.255.0**
Paso 5	hq-sanjose(config)# **túnel de interfaz 0** hq-sanjose (config-if) # **no shutdown** % LINK-3-UPDOWN: Interface Tunnel0, estado cambiado Para arriba
Paso 6	hq-sanjose(config-if)# **salir** hq-sanjose (config) # ip route 10.1.4.0 255.255.255.0 tunnel 0

• **Set up a different shared key**. Because pre-shared keys were specified as the authentication method for policy 1 in the *Configuring IKE Policies* section (the policy that will also be used on the partner router) complete the following steps on the home router and the partner router:

• **Step 1**: Establish the identity of each Internet Security Association and Key Management Protocol (ISAKMP) peer. Each peer identity must be established in its hostname or by its IP address. By default, a peer identity is set to your IP address. In this scenario, you only need to complete this task on the business partner router.

• **Step 2**: Specify the shared keys in each pair. Note that a given pre-shared key is shared between two pairs. On a given pair, you can specify the same key for sharing with multiple remote pairs; however, a more secure approach is to specify different keys for sharing between different pairs.

• **Create extended access lists using access list numbers**. To create an extended access list that denies and allows certain types of traffic, completes the following steps starting in global configuration mode (table 1).

VPN configuration in Windows 10

This part of the article will explain in detail how we will solve the problem, what software and materials will be used. Whether it's for business or personal use, you can connect to a VPN (a virtual private network) on your Windows 10 PC. A

Table 1

Extended access lists.

	Mando	Propósito
Paso 1	`hq-sanjose(config)# access-list 102 deny tcp any alguna`	Defina la lista de acceso 102 y configure la lista de acceso para denegar todo el tráfico TCP.
Paso 2	`hq-sanjose(config)# access-list 102 deny udp any alguna`	Configure la lista de acceso 102 para denegar todo el tráfico UDP.
Paso 3	`hq-sanjose(config)# access-list 102 permiso ip cualquiera`	Configure la lista de acceso 102 para permitir todo el tráfico IP.

VPN connection can help provide a more secure connection to your company's network and the Internet.

To connect to a VPN, you need a VPN profile on your PC. You can either create a VPN profile on your own or set up a professional account to get a company VPN profile.

• Create a VPN profile. If you do not have a VPN profile on your Windows 10 PC, you will need to create one. If it's for work, look for the VPN settings or a VPN application on the company's intranet site when you're at work, or contact the company's technical support staff. Select the Start button, and then select **Settings > Network and Internet > VPN > Add a VPN connection**.

• Under Add a VPN connection, do the following. Under VPN Provider, choose Windows (integrated). In the Connection box, type a descriptive name (for example, my Personal VPN) for the VPN connection profile. This is the name of the VPN connection that you should look up in the server names or the address box when you want to connect. Enter the VPN server address.

• Under VPN Type, choose the type of VPN connection you want to create. You will need to know what type of VPN connection the company or the VPN service uses, in this case, the Point-to-Point Tunneling Protocol (PPTP) will be used, but the steps for L2TP/IPSec with pre-shared key are very similar, and you should have no problem following them.

• Under Login Information Type, choose the type of login information (or credentials) you will use. This information can be a user name and password, a one-time password, a certificate, or a smart card if you connect to a VPN at work. Enter your username and password in the appropriate boxes (optional).

• Select Save. If you need to edit the VPN connection information or specify additional settings, such as the proxy settings to be used for the VPN connection, choose the VPN connection, then Advanced.

• Connect to a VPN. Once you have a VPN profile, you can log in. At the far right of the taskbar, select the Network icon Select the VPN connection you want to use, and then do one of the following depending on what happens when you select the VPN connection.

• If the Connect button is displayed below the VPN connection, select Connect. If the VPN is opened in Settings, select the VPN connection, and then select Connect. If prompted, enter your user name and password or other login information. When you are connected, the name of the VPN connection will display *Connected* below.

• To quickly check if you're connected to the VPN while performing tasks on your computer, select the Network icon on the far right of the taskbar, and then see if the VPN connection indicates *Connected* below it.

Testing

It is taken into account in the accounts and results taken from the population of the United States because of the facility and complete information that this country is a superpower.

Data filtering

The latest statistics show a steady trend of increasing data leakage around the world (Fig. 6 (Greenberg, 2017)).
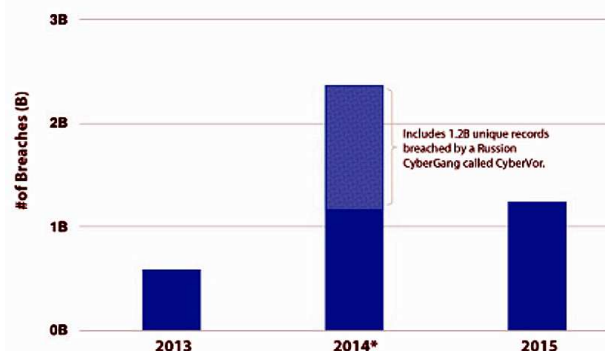

*Figure 6*. Records breached (Greenberg, 2017).

Data privacy and national security

Certain data are analyzed that have reference to the problem, the little privacy that can be had when connecting to the Internet, the attack in San Bernardino, California, United States, on December 2, 2015, was analyzed where it was questioned why the iPhone that was involved with the attack was not unblocked by Apple but the FBI had to intervene, where it makes you question more about how secure the internet network you use is and how easily our information or more importantly, state information can be stolen and that your government is not doing enough on the cyber front to deal with terrorism (Fig. 7).

As new technologies come out, this one benefits us as it harms us if it is in the wrong hands and so we have the need
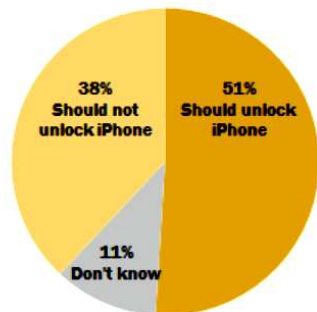
Figure 7. Apple unlock iPhone (Center, 2017).

to protect ourselves more and more from such attacks and in this case at a computer security level, by accessing a separate server for internet use, VPNs become a good option for the security of your data and make it much more difficult for hackers or third parties to record data online.

Frequency of VPN use

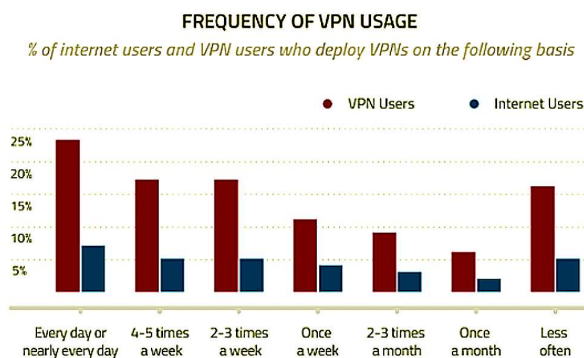According to the data, people use VPNs at least once a week (Fig. 8).

Figure 8. Frequency of VPN usage (Young, 2017).

Main consumers of VPN use

Asia and the Middle East remain the largest consumers of VPNs (Fig. 9).

Anonymous navigation

Anonymous browsing is used to protect our data when surfing the net since it hides the computer's IP to leave no
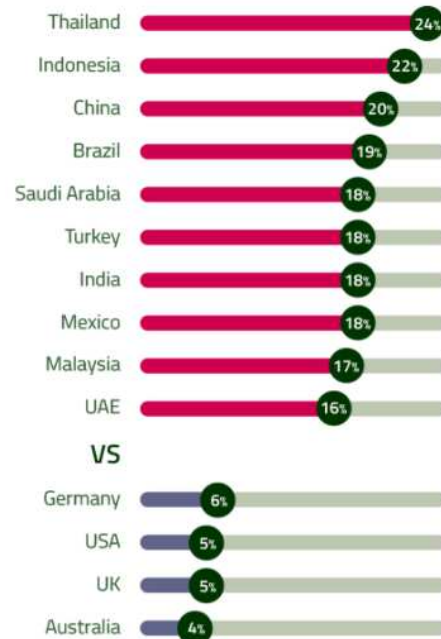

Figure 9. Top 10 markets for accessing content via VPNs (Mander, 2017b).

trace of what is done on the Internet, and for this purpose, VPNs are implemented. Among the countries that most use this method are Saudi Arabia and Vietnam, among others (Mander, 2017a).

Lack of confidence in privacy

NTIA analysis shows that as you use more devices in your home, you are more likely to become a victim of information theft via the Internet (Fig. 10) (Rafi, 2017).

By far the most frequent concern, shared by 63 percent of online households, was identity theft. Other common concerns include credit card or bank fraud, data collection or tracking by online services, loss of control over personal data, data collection or tracking by the government, and personal security threats (Fig. 11) (Rafi, 2017).

Privacy and security concerns change users' online behavior

According to the survey conducted in 2015, for fear of information and identity theft online made 45% of users surveyed refrain from making financial moves, make purchases, and even give controversial opinions in social networks and 30% of users were obtained to do at least 2 of these actions (Fig. 12) (Rafi, 2017).
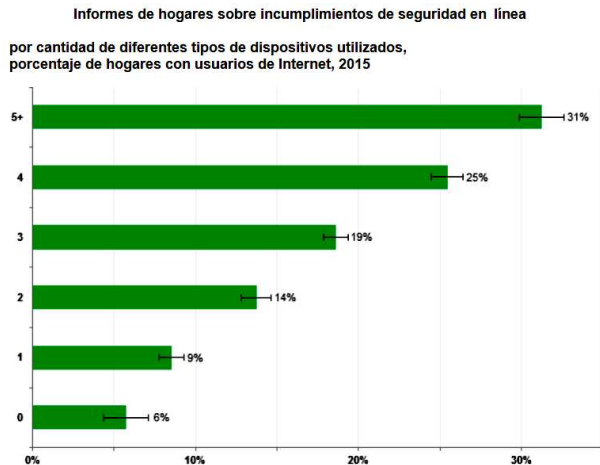
Figure 10. Household reports of online security breaches (Rafi, 2017).

Figure 11. Key online privacy concerns and security risks (Rafi, 2017).
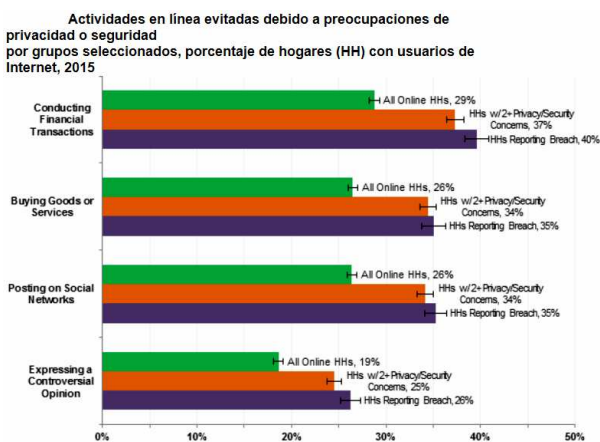

Figure 12. Online activities avoided due to privacy or security concerns (Rafi, 2017).

Be prepared for a cyber attack on companies and organizations

Insecurity matters, private organizations, and companies, a threat to their information is much more sensitive than to

the common population, and it goes beyond how prepared they are for such threats, it is estimated that 62% of companies do not have a plan to these incidents.

Only 37% of respondents, most of them in the heavily regulated financial services industry, have a fully operational incident response plan. Three in ten have no plan at all, and of these, almost half do not believe they need one (Burg, 2017).
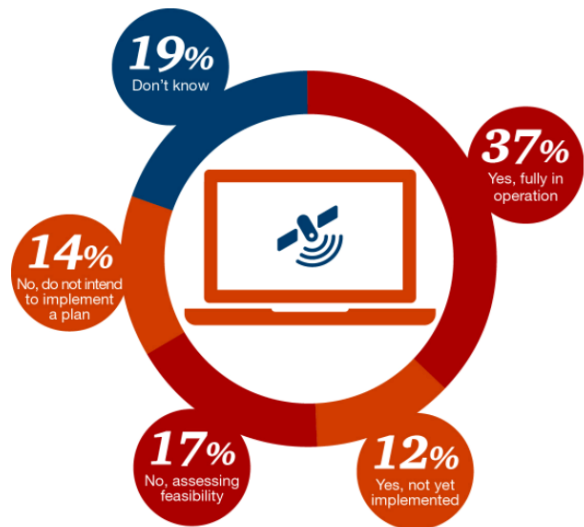
Figure 13. Concept on the use of online security (Burg, 2017).

Conclusion of the analysed data

With these data it is demonstrated the great necessity to implement a safe and reliable method at the time of speaking of computer science security, to anticipate this type of incidents and if it is at the level of the common population, it will be possible to be estimated at the level of companies, since as they have managed to intervene in the computer science security of the nation the gravity of the subject is noticed, and one of the main objectives of the companies is to have a good handling of data of its clients and the information that there handle.

Currently, it has been demonstrated that the use of VPNs is one of the best options for computer security and many providers offer this service, and why not also the use of VPNs at the personal level, and as shown above is not so difficult to install on computers and there are also free VPN service providers that explain step by step their installation.

Conclusions

The use of virtual private networks is currently presented as a good alternative for companies because through tunneling provides confidence and certainty that at all times

communications are reliable, also thanks to the technology provided by the VPNs can obtain considerable economic savings by reducing the costs of data transmission since it is not necessary to use a dedicated line very expensive, on the contrary, allows you to use a public network such as the Internet.

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Instrucciones para los autores

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