23rd International Conference on Renewable Energies and Power Quality (ICREPQ'25)
Tenerife (Spain), 25th to 27th June 2025
ISBN-13: 978-84-09-66511-2

Smart devices based on nanostructures according to adapt turbojets to work with renewable energy

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Abstract. It is proposed in the following article the analysis of the correlation between nanostructure devices with the engagement of turbojets, as well as to know how this improvement can get effect over the usability of new kind of fuel for the turbojet. It means that it will be shared and explained in this research: *What consequences happen inside a turbojet when it is evaluated its performance by a new kind of fuel based on hydro-diesel?* Most of the expected results are given by not controlled variables, such as vibrations considered like big disturbances for the turbojet operation. Therefore, the nanostructures devices that were focused as part of transducers helped to get short response time, besides higher robustness in the control system to achieve optimal results for the turbojet operation with a new kind of fuel: *a green fuel*.

Consequently, this work can help to find new advances of applications for turbojets, such as in airplanes or activities that are needed by the industry. In other words, this research looks for an understanding between the compromise of new advances in technologies, based on nanostructures for smart sensors to enhance the control response in the turbojet's applications, when it is worked with new kind of fuels, because of it is looking for caring the environment conditions.

Key words. Turbojet, nanostructures, smart sensors, mathematical modelling.

1. Introduction

The proposed article keeps the applications of smart devices, which are composed by sensors and actuator's based on nanostructures over some connections of a general turbojet, because of looking for the optimization and enhancement of some physical variables that are part of the normal working tasks for this turbo machine. It means, one quiet important application is depending on the fuel, which will give energy for the movement effect and the energy transformation from the fuel consumes, the mechanical energy proportionated from the turbomachinery, as for example, the turbojet needs gasoline, or gas, as well as gas can be hydrogen (renewable energy). However, while by one side, it is cared the planet because of renewable energy uses of the turbojet, but in spite of by the other side, to choose hydrogen as the main energy charger of the described turbo machinery, it must be warranted that the turbo reactor is correctly protected for this new kind of fuel, owing to many systems depends on this turbomachinery for development of tasks.

Hence, if the main energy charger is changed by hydrogen, then it is quite possible that users will prepare not formal adaptations of this turbojet to receive a new kind of energy charger, in other words this is very dangerous due to hydrogen atoms need specific conditions to transmit energy for the turbojet applications. for this reason, there are stored different devices (based on nanostructures) around strategic places of a general turbojet, according to care for the consuming fuel, also the measurement of the temperature over the combustion camera, furthermore the vibrations effects.

So, these devices are correlating the short response time for the sensors and actuators (based on nanostructures too), moreover their robustness, even though some components of the turbo reactor are covered (protected) by nanostructors thin films, because of avoiding hydrogen evacuations through not expected areas, it means that it can get intelligent response because of the sensors and actuators can achieve some milliseconds due to getting optimal responses or optimal performance. Which, as it was distributed previously and as well as it is detailed on the following article, so the sensors and actuators based on nanostructures provide enough time that microcontrollers can get a decision by the user of the turbojet in order to proportionate specific responses that are given by desired fuel consume, desired temperature and vibrations.

Therefore, in this work it is analysed the usability of green energy, it means hydrogen could be adopted to be used by turbojet, but as it can help to care environment conditions of our planet it must work with specific devices according to warrant its functionality and adaptations to get Optimal Performance always. Every microcontroller of the smart sensor has an execution of advanced algorithms based on indicated mathematical modelling to process the input physical variable and finally the turbojet have some kind of autonomy or smart autonomy to care environment conditions, to keep up to my response and this could be used by researchers and engineers that look for adaptations in this new kind of machinery: the turbojet adapted to use hydrogen as as new kind of fuel correlated with this smart sensors based on nanostructures.

2. Theoretical Analysis.

In this chapter of the article, it is analysed the dynamic of the proposal turbojet, as well as the thermodynamic effect because of getting a mathematical model, which could correlate the theoretical behaviour of this turbomachine with an experimental model. In fact, it is analysed by techniques (such as modulating functions) some kind of identification system, because of providing a mathematical analysis that could explain through equations the main problematic of the system. It means, the mathematical model provided in this chapter with all the possible solutions of the proposal differential equation could summarize the effect of sensors and actuators based on nanostructures to enhance the performance of the proposal system, when it is using green energy as an energy charger during its operation.

Therefore, the following figure 1 depicts a turbojet function scheme, in which “I” represents a jet, “II” represents its turbojet, as well as the functionality is given by the representing blocks “A, B, C, D”, moreover, the arrow in light blue colour (IV) represents the entrance of the energy charger (air) that is crossing through the turbojet. The blue colour block (A) represents the intake for the air inlet, the green colour block (B) represents the compression task, the brown colour block (C) represents the combustion effect during the turbojet operation, in which is added fuel fluid according to increase the energy in its carrier, the red colour block (D) depicts the exhaust that is composed also by a turbine. Furthermore, the long block (clear beige colour) can cross every function block “A, B, C, D” representing the rotating movement caused by the main rotor of the turbojet, the red colour arrow (V) depicts the obtained thrust, for this reason the red colour arrow functionality depicts its thrust.

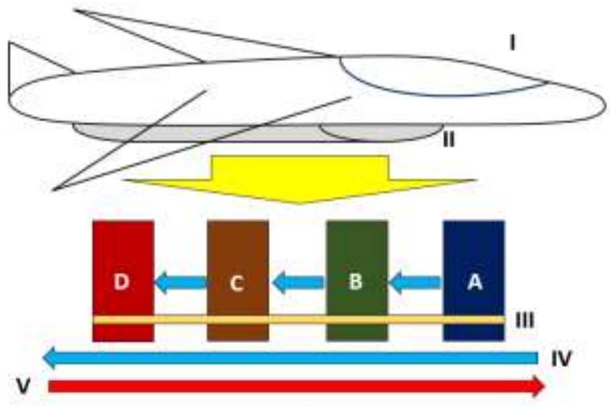

Fig 1. Turbojet functions scheme

Many turbomachinery, such as turbojets can achieve good performance by using new kind of fuel, specially while these can avoid environment contamination, such as for example, fuel based on hydrogen, or mixing of green energy charger for turbojets. However, it needs new structures components, connectors devices because of preventing accidents, by other side, hydrogen atom from gas stage cannot be controllable, in consequence if the hardware is not appropriated, so the possibility to get accidents is high.

Hence, it is proposed to improve the design of turbojets by new kind of materials like nanostructures covering devices as sensors actuators and controllers which could work between function operations of the turbojet functionality (represented on figure 1). It could be between the stage B and C of the figure 1, then it can be controlled the fuel fluids stored over the energy charger to find the combustion effect that could get impulses or thrust of the main system, moreover while it is measured the main physical variables for the operation and performance of the turbojet (airflow, pressure, temperature and vibration), the microcontroller of the associated sensors can execute intricated mathematical models to improve the turbojet performance.

The following equation to describe the translational movement is generalized by Newton’s second law [3], [4], [5], [6].

$$a_0 \frac{d^2y(t)}{dt^2} + a_1 \frac{dy(t)}{dt} + a_2 y(t) = b_1 u(t) \qquad (1)$$

As well as the internal rotational movement is given by the equation (2) [3], [4], [5], [6].

$$c_0 \frac{d^2\theta(t)}{dt^2} + c_1 \frac{d\theta(t)}{dt} + c_2 \theta(t) = f_1 K(t) \qquad (2)$$

It can be possible to find the correlation between the both previous equation (1) and (2), according to get the theoretical thrust, which also can be correlated with the theoretical force, proposed by the equation 3 that proportionate information regarding the mechanical work “W_t” (energy) as dependence on the enthalpy difference between 2 different actions points [3], [4], [5], [6].

$$W_t = ht_1 \; - \; ht_2 \qquad (3)$$

In fact, the equation (4) gives information of the theoretical thrust “U(t)” depending on the input flow mass, exit flow mass, speed (for the flow) in the input and output section points [3], [4], [5], [6].

$$W_t = \frac{dm_f}{dt} V_f \; - \; \frac{dm_i}{dt} V_i \qquad (4)$$

The equation (5) helps to identify the physical parameters of the mechanical model during the translational and rotational effect [3], [4], [5], [6].

$$\frac{d^n y(t)}{dt^n}+\sum_{j=1}^{n-j} a_j \frac{d^{n-j} y(t)}{dt^{n-j}}-\sum_{j=1}^{n-j} b_j \frac{d^{n-j} u(t)}{dt^{n-j}} = e \quad (5)$$

The equation (6) is based on Modulating Functions due to work over experimental data obtained by the measurement of the main physical variables, according to study the turbojet performance [3], [4], [5], [6].

$$\int_0^T y(t)\frac{d^2\phi(t)}{dt^2}dt - a_1\int_0^T y(t)\frac{d\phi(t)}{dt}dt + a_2\int_0^T y(t)\,\phi(t)dt - b_2\int_0^T u(t)\phi(t)dt = e \quad (6)$$

In fact, with the identified parameters of the turbojet, depending the fuel effect on its dynamic, it can be possible to obtain a control system by implicit variables, such as for example to find the speed control through the correlation between the thrust over the turbojet as consequence of the fuel consume that at same time is consequence of the fuel mass flow. Hence, if the range of work tends to be linear, so it can be chosen a simple PID controller [3], [4], [5], [6].

3. Experimental analysis

The mathematical model designed was previously studied and analysed according to design the simulation algorithm, also the algorithm executed by microcontrollers as part of the sensor to work in the internal functions of the turbojet. Hence, it must be correlated the experimental results with the expected or simulated responses of the physical variables that are part integrated of the designed mathematical model, besides to explain it in paragraphs above, any kind of mathematical results could not be achieved if it could not be used samples based on nanostructures for the sensing tasks [1], [2].

Hence, the figure 2 shows a schematic functionality of the smart sensor designed to measure the main physical variables of turbojet, the measuring is given by wireless and infrared as the main electromagnetic wave to get wireless measurements. In fact, the proposed analysis can also provide to the user an optimal interpretation of the functionality of the system. Thus, as it is represented in the figure 2, the sensors based on nanostructures is composed by the sample "NSp", which transform and store solar energy to electrical energy by rechargeable batteries. Besides, the samples "Nr1" and "Nr2" have the task to receive the reflected, refracted and diffracted the electromagnetic signal sent by the transmitter "Ne" due to get the measured physical variables [1], [2].

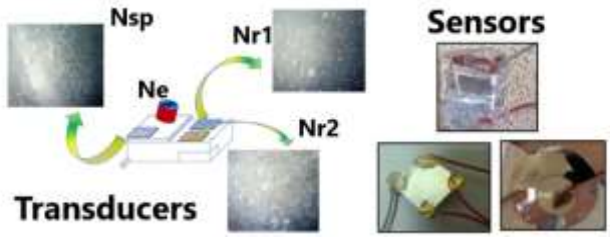

Fig 2. Sensors/transducers for the proposed turbojet

For the experiments, it was evaluated the enhancement of our turbojet described in this work, which is based on 2 kind of fuels: diesel and hydro-diesel (it is considered as green fuel due to its cares in the environment conditions). It is necessary to remember that more description, or technical details of the turbojet are not explained in this article, because of it is looking for a proposal patent regarding the technical details of the turbojet enhanced by nano-structures.

However, in general, in this article is shared knowledge for the quite important Congress (ICREPQ), it is tried to share the consequence of new kind of fuel (hydro-diesel) known as green fuel, owing to, it is looking for adaptations effects in turbojets according to get positive impact in the environment conditions that is based on the usability of smart devices: sensors and actuators prepared by nanostructures. Thus, it is showed in the figure 3 the static curves of the turbojet in front the evaluated fuels, which depend on "Fuel mass flow" and "Thrust". The red colour curve is result of the diesel fuel, moreover the blue colour curve is result of the hydro-diesel fuel, from which it was possible to identify that hydro-diesel can get better response than diesel fuel in the turbojet operation, due to achieving a more extender linear operation, in addition, for fixed value of fuel mass flow the turbojet thrust is bigger from hydro-diesel than diesel only [7], [8].

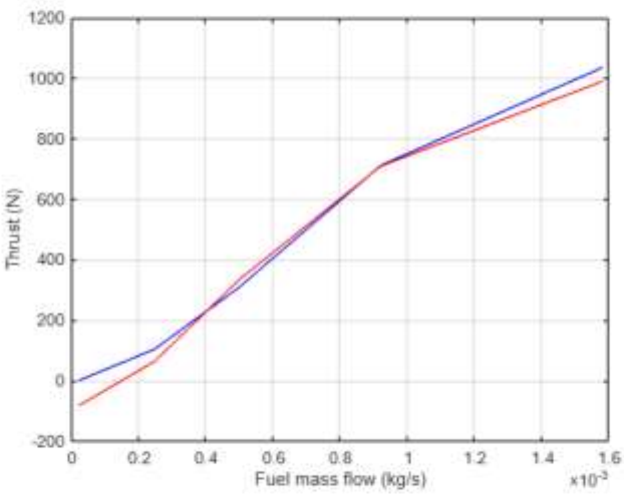

Fig 3. Static curves for the 2 different fuels

The following figure 4 shows the controlled response of the turbojet thrust, depending on the control variable fuel mass flow. The red colour curve is the thrust over the turbojet when the fuel is diesel and the blue colour curve is also the thrust over the turbojet when the consumed fuel is hydro diesel [7], [8].

Thus, it was possible to get a good control variable on the turbojet thrust when it was chosen hydro diesel, which also depended on faster and robust sensors adapted to the performance of turbojets: the smart sensors based on nanostructures that work under operations around 10 mS, moreover the green fuel "hydro diesel" got a good control performance over the dynamic effect on the turbojet due to the good control result on its thrust [7], [8].

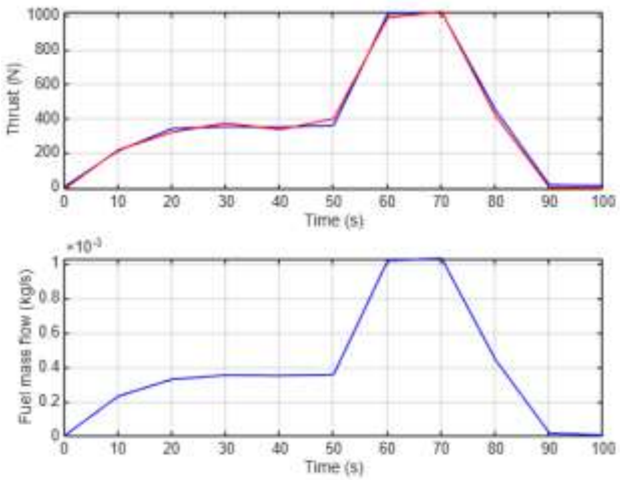

Fig 4. Thrust response depending of fuel mass flow.

4. Conclusions

It can be possible to get as a conclusion from this article that the usability of nanostructures in turbojets helps to enhance its optimization process, in which the nano-structors are part of their main components: sensors and actuators, moreover, sometimes covering some components of the turbojets. Consequently, it is possible to get short response time and high robustness, independent on the restricted working parameters, which are given by the user, therefore the enhancement of the optimal operation of turbojets can be achieved by the incorporations of nanostructures in their main control system devices.

Thus, the main conclusion of this proposed article is depending of the nano-structors effects for the control process in turbojets. In fact, with this enhancement, it is possible to analyse what kind of new fuel can be used to work with turbomachinery, it is quite studied that green energy must be the road to find equilibrium in the energy conversion for turbojets operation. Nevertheless, most of the turbomachinery, like that is studied in this work, are not prepared to work totally with green fuel, such as for example gas mixture to reduce carbon effects, like hydro-diesel, furthermore when the hardware of the turbojets are enough improved to keep high temperature, usually operated by hydrocarbons, so it could be possible also to use hydrogen, by other side it must be understand that turbojets need to be quite adopted to use this new kind of fuel that is also the complementary importance to work with nano-structors in the control process, and in the new kind of covering materials to keep an optimal energy transmissions in turbojets as it was proposed in this article.

It is also possible to propose, like a conclusion in this work that it must be understand the mixing fuel to be used for the combustion effect in the turbojet, such as it is tested in this research. However, it must be an emulsion effect according to know how to insert the fuel in the turbojet because of the mixing of hydro-diesel cannot be uniform and it could meet some kind of emulsion to keep it by molecular result, or perhaps other mechanisms to insert separately the components of hydro-diesel in the combustion camera of the turbojet, while it is achieved a good performance in the caring the environment conditions, because of green fuel. Then, it has necessity of advanced control and smart sensors to get optimal response control like it was studied in this work the optimal control in the fuel flow has implicit variable to optimize fuel consume by advanced sensors on depending of green fuel for turbojets enhancements.

Acknowledgement

It is expressed a warm than}kful to Mrs. Aleksandra Ulianova de Calderón because of her dedication given for the development of the proposed article through her time during the problematic analysis solutions, as well as her critical analysis admirable regarding the necessity of optimal environment cares.

It is expressed warm thankful to Mr. Miguel A. Badillo B., Mr. Michael G. Ramirez M., Mr. César F. Pinglo A., Mr. Bryan C. Bastidas R., and Mr. Brandon A. Polo V., due to their support in the feedback analysis of the article, as well as the development of some prototypes for the experiments.

It is expressed special thankful for the companies "MERQUITEX S.A.C". and "PROYINOX S.A.C." owing to their support for the development prototypes, which were quite important to validate the theoretical models also discussed in this proposed research.
It is expressed special thankful for the companies "OPEN 3D, LABORATORIO DE MANUFACTURA DIGITAL" and "GICA INGENIEROS E. I. R. L." because of their support for the development prototypes, which was based in the support to prepare the experimental setup.

It is expressed special grateful for the Laboratory of Design of the PUCP: Applied Mechanics, Oleo-hydraulics and Pneumatics, because of proportioning part of the place to evaluate part of the experimental analysis described in the presented research.

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