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Design and construction of an industrial ship conditioning system

Ricardo Fabricio Muñoz Farfán[a], **Telly Yarita Macías Zambrano**[b], **Fausto Roberto Andrade Badillo**[c], **Adrián Adalberto Hernández Solís**[d]

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Corresponding Author [a]

Keywords

conditioning;
efficiency energetic;
evaporative;
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thermal comfort;

Abstract

This project is based on the design and construction of an industrial air conditioning system for the improvement of the working thermal comfort of workers that for various reasons there is the trend of the increase in body temperature are these by machines, equipment or the same work activities, which affects the productive performance and possible health risks. During development, the selection of mechanical equipment such as the fan, water pump, ventilation transport ducts is studied with high rates of energy efficiency. In the light of the above, the environmental economic partner alternative is chosen to implement the evaporative conditioning system, conducive to working in open places to lower the temperature by labor and technology installed in the production areas, as well as the extraction of fumes derived from production processes. The importance of the evaporative conditioning system is to derive the appropriate mechanisms to take advantage of the surface heat transfer of a panel and copper and aluminum coil using water, and thus take advantage of its temperature differential reaching 25°C, with an average humidity of 66% and energy consumption of 0.29 KW/h. To obtain results, the experimental field method, random cluster sampling, application of experimental observation sheets for the survey of diagnostic information of the current situation of the medium and equipment was applied.

Contents

[a] Instituto Superior Tecnológico Paulo Emilio Macías, Portoviejo, Ecuador
[b] Instituto Superior Tecnológico Paulo Emilio Macías, Portoviejo, Ecuador
[c] Instituto Superior Tecnológico Paulo Emilio Macías, Portoviejo, Ecuador
[d] Instituto Superior Tecnológico Paulo Emilio Macías, Portoviejo, Ecuador

1 Introduction

Evaporative type conditioning is a natural phenomenon that is present in the environment due to the contact that water has with the surrounding air achieving the exchange of temperature between the two sources, acquiring a reduction of final temperature (Flores, 2011). Thermal comfort is important within the industrial environment and service, as continuous technological advancement makes it essential to understand and operate eco-sustainable equipment or systems providing abiotic resources (Hidalgo & Pérez, 2016; Özdil *et al.,* 2007; Sharma & Ali, 1986; Nicol & Humphreys, 2002; Puteh *et al.,* 2012).

Executive Decree 2393 of the Workers' Safety and Health Regulation in Article 54 tells us that in working environments due to the effect of machines and work in production processes should not exceed the maximum permissible temperature values for the worker who is between 35 and 37ºC, and if this temperature has to increase from incorporating insulators for the reduction of the heat of the machines or implementing air conditioning systems in the enclosures (IESS, 1986). In the summer season, high temperatures are specifically reached, in industrial activity as in social services, around 34oC average heat, the temperature of the enclosure between 20 and 27ºC and humidity between 30 and 70%; smoke and general environmental characteristics characterize hard working hours and tiredness achieving the decrease in the production of workers, these aspects being important to solve to achieve an adequate level of competitive products and also respond to local and international environmental legislation (Company, 2016). On the other hand, it is important to mention that these evaporative systems fulfill the function of aerators and coolers in production areas (Flores *et al.,* 2011), with high-efficiency parameters correlating with energy efficiency regulations by the European Commission (Olivares, 2017; Kuznik *et al.,* 2008; Sun *et al.,* 2004; Martens, 1998), which is essential in many cases for the generation of gases products from manufacturing processes which in turn makes potential sinks dangerous to health.

2 Materials and Methods

This research was carried out in the city of Portoviejo – Manabí – Ecuador, position 341 n, 170ft height, 1 atm atmospheric pressure; in the facilities of the Instituto Superior Tecnológico Paulo Emilio Macías (Farfán *et al.,* 2019), with an experimental design based on several tests of the test at variable reason interval, applied to a conditioning system that is intended to reach temperatures from 35ºC max. 24.5ºC.min.

3 Results and Discussions

To achieve this goal, the materials described in Table 1 were selected below:

Table 1
Materials and equipment for the development of the industrial and commercial conditioning system

Description	Amount
Panel – Serpentine (copper /aluminium)	1
Iron galv.1220x2440x0.90mm	5
1/2 Hp 220V Induced Fan	1
Water Pump 37.3 W, 127 V. AQUA 45W	1
1/8 rivets	1
Ventoletas 1/8 X L	32

Contactor assistants	2
9-amp 220v contactors	2
Temperature and humidity sensor	1
Arduino UNO Controller	1
Selector	1
Pilot Lights	3
Lcd	1
Control cabinet and force box	1
Cable #12	10mts x 3 lines
1/4x 90" elbow	2
Clamps of 1/2	2
Insulating tape.	1
1/4x 2.5 plastigam tube	4
Silicone	2
Cutting disc 4 1/2"x 1/16".	2

Description of the evaporative conditioning system

Industrial conditioning systems have a heat transfer center type coil panel, flowing inside the water and on the outside is a water pump that bathes from the top to the bottom of the panel, accumulating in a reserve pool to meet the closed cycle; on the other hand, for the aforementioned recirculation, it will be done using a low-consumption submersible water pump (ACR Latin America, 2019; Hanus *et al.,* 1987; Sun, 1997; Kinsara *et al.,* 1996).

The fan is located at the bottom of the heart center which can operate in ventilation and cooler mode. For air transport, a piping system was used, with thermal insulation of glass wool around it to reduce heat loss per wall and have a good energy efficiency coefficient. (Commercial steel of Ecuador S.A., 2019). The temperature and relative humidity monitoring system is made by an Arduino Uno controller through sensors equipped in the center of the main duct and its display on an LCD screen that is located in the control and force enclosure. Then, in Table (Arduino Corporation, 2019). In table 2 is show the instrumentation used for data-taking is cited.

Table 2
Instrumentation specifications

Description	Technical characteristics
Temperature and humidity meter, dew point	Proskit MT-4616 PEAK METER MS6508
Wet-bulb	Rank: -20 to 60 degrees C 4 degrees Fahrenheit/140.5 degrees Fahrenheit RH: 0 to 100%, accuracy 2%
Liquid and Solid Temperature Meter	TA288 Stainless steel probe Range: 50oC and 300oC
Wind speed meter Anemometer	Specifications Air speed 0 - 30m/s, 0 - 90km/h, 0 - 5860ft/min, 0 - 65mph Resolution: 0.1m/s, 0.3km/h, 19ft/min, 0.2mphPrecision speed: +/- 5%
Sonómetro digital Tipo II ANSI S1.4 IEC 651	Acoustic pressure range: 30-130 dbA Frequency range: 31.5 Hz – 8.5 Khz Accuracy range: + - 1.5%

Figure 1 shows the Mechanical Scheme of the Evaporative Conditioning System

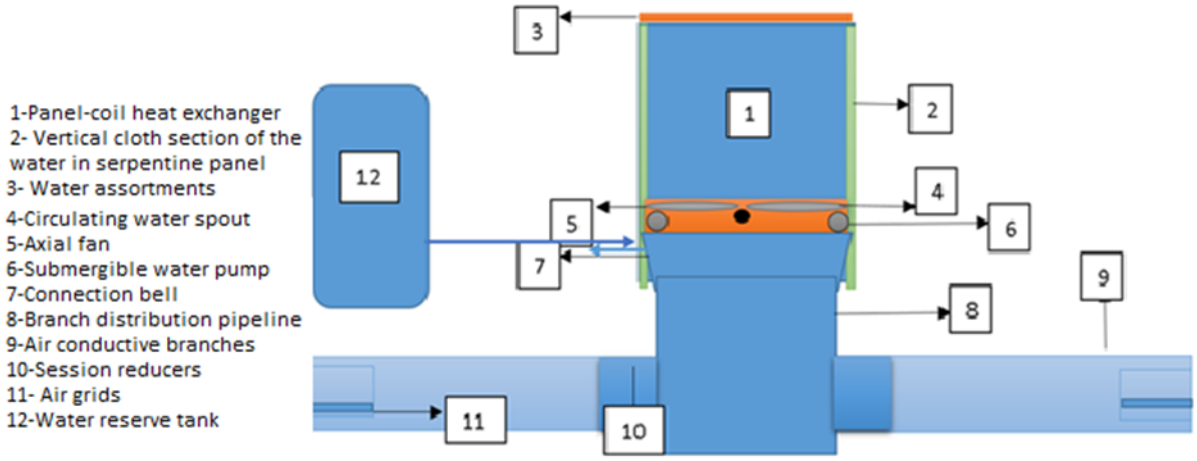

Figure 1. Mechanical scheme of the evaporative conditioning system

Figure 2 shows images of the control panel and in (B) the item of ventilation and pumping.

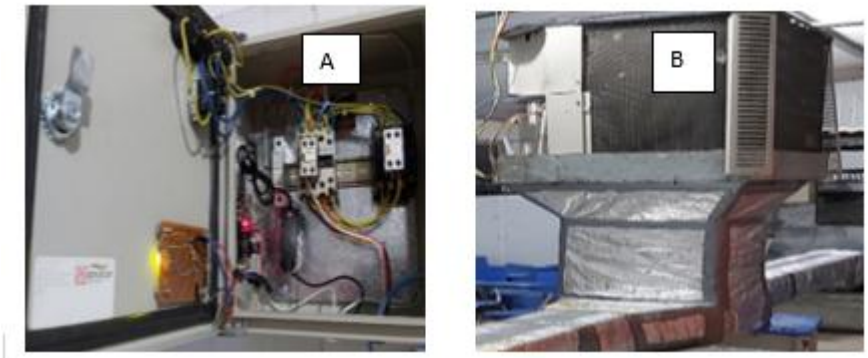

Figure 2. Cabinet of control and Power

In Figure 3, the mechanical equipment of the system is observed, in (Av) LCD Viewer

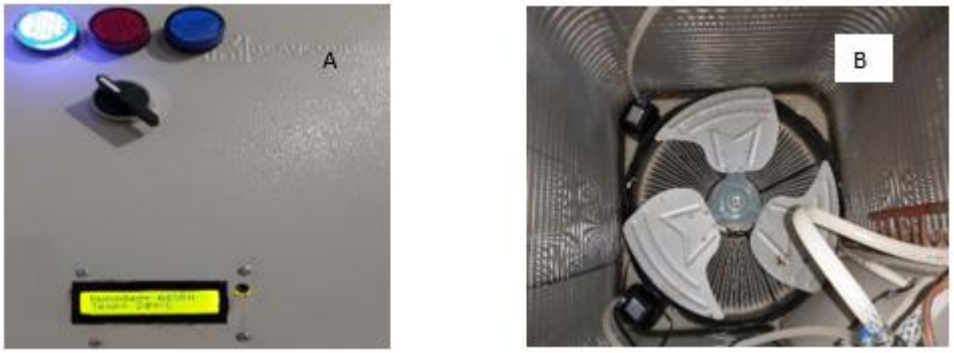

Figure 3. Mechanical system equipment

The technical operating data of the conditioning system were obtained from the experimentation phase. In figure 4, the ambient temperature values are displayed.

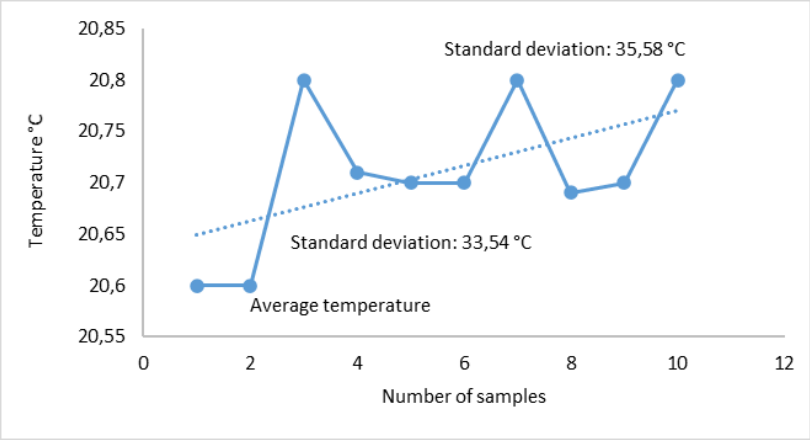

Figure 4. Ambient temperature

Figure 5. details the relative ambient humidity.

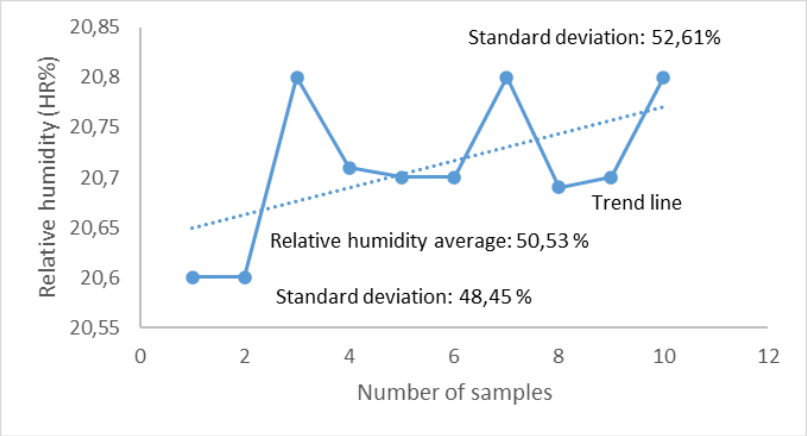

Figure 5. Relative ambient humidity

Figure 6. Shows the results obtained in the measurements of Temperature Environmental Spray Point.

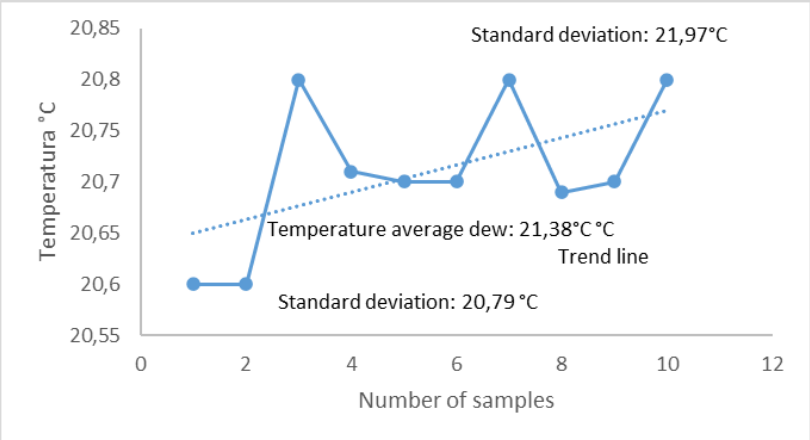

Figure 6. Temperature Environmental Spray Point

Figure 7. Shows the temperature of the ambient wet bulb

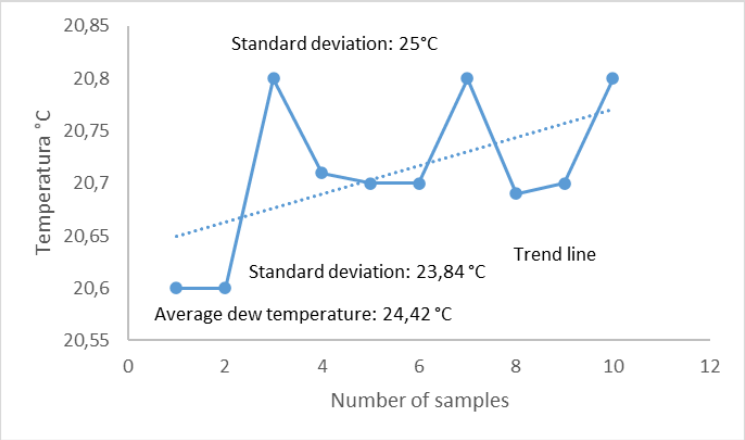

Figure 7. Ambient Wet Bulb Temperature

Figure 8. Shows the air temperature of the system.

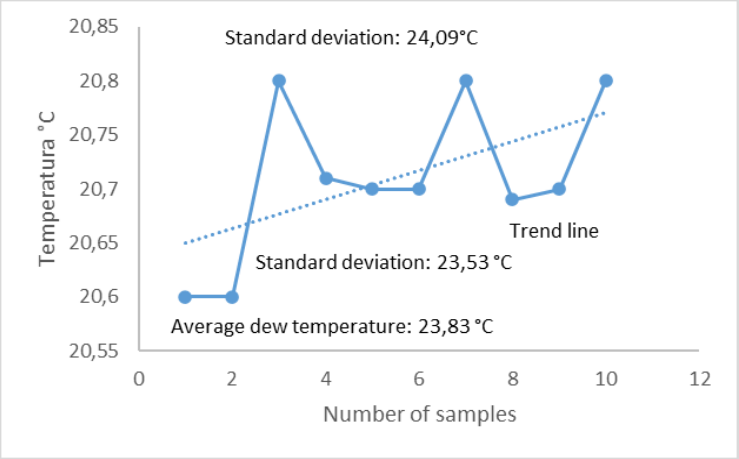

Figure 8. System air temperature

Figure 9. Shows the relative humidity of the System.

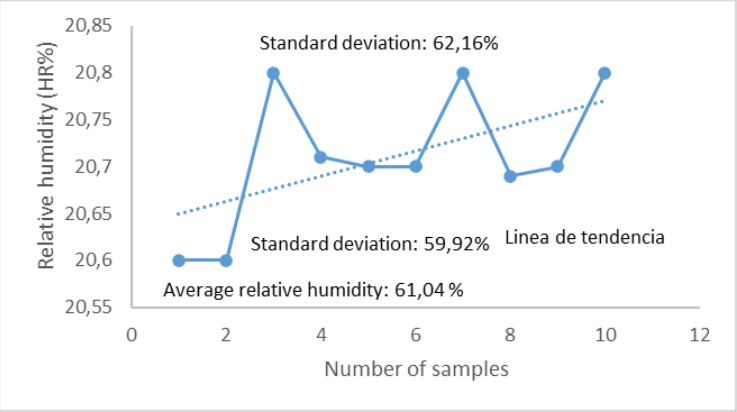

Figure 9. Relative humidity of the system

Figure 10. Shows the System spray Temperature.

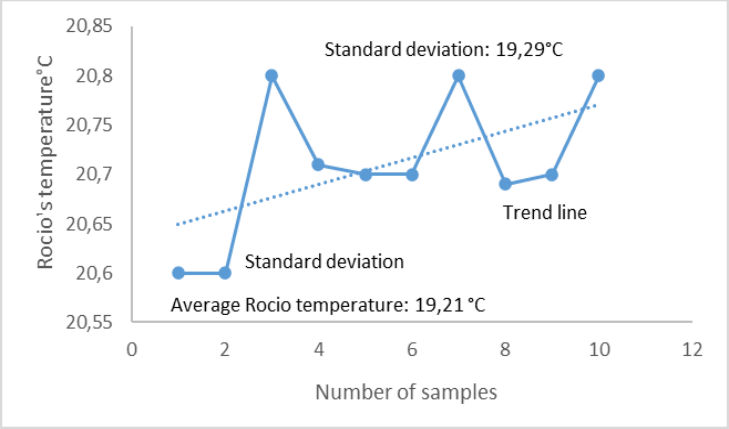

Figure 10. System spray Temperature

Figure 11. Shows the Wet System Bulb Temperature.

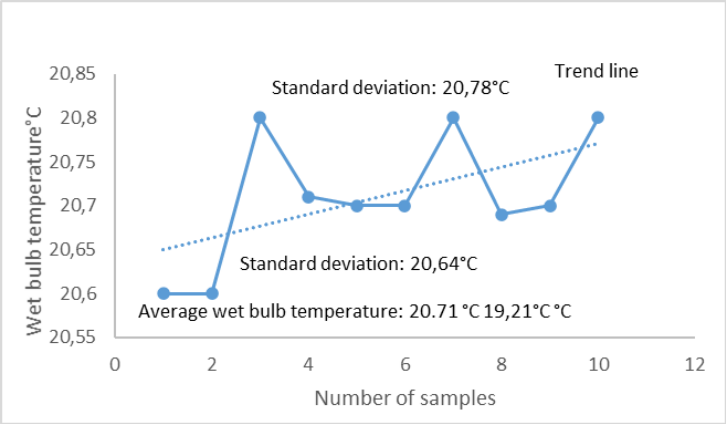

Figure 11. Wet System Bulb Temperature

Table 3 describes the energy efficiency parameters of the conditioning equipment.

Table 3
Energy Efficiency Parameters

Unit	Consumption at (KWh)		Consumption (KW/h)	Annual Consumption (KW year)	Industrial Cost ($) - (KW)
Axial fan	0.22	0.22			0.072
Water Pump	0.036X2	0.072			
Total Consumption		0.29	6.96	2540.4	

Table 4 describes the proposed technical specifications of the equipment.

Table 4
Technical specifications of the equipment

Design conditions:	
Country:	Ecuador
Altitude:	100 meters above sea level
Average outdoor temperature:	32.5º C
HR:	50.5%
Interior design temperature:	27º C
Enclosure area:	20m^2
Temperature	24 a 25°C
Relative Humidity of the system	60%
Wet Bulb Temperature	20.71 °C
Temperature Dew Point	19.21 °C
Energy consumption	0.29 KW h
Conditioning capacity	20 m^2
Cooling power	2.1 Kw
Voltage	110/220 V single-phase
Acoustic pressure level	80 dBA
Water consumption	3 L/h

4 Conclusion

Environmentally friendly system (eco-friendly) Low energy consumption system with 0.44 KWh. Low decibel of operation reducing hearing pollution Low-cost maintenance and operation system. Friendly to hearing pollution. (8 hours of noise exposure).

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Biography of Authors

Ricardo Fabricio,
Mechanical Engineer, Master of the Postgraduate Program in Industrial Eco-efficiency of the Higher Polytechnic School of the Litoral, Professor of the Instituto Superior Tecnológico Paulo Emilio Macías.
Email: itspem.rmunoz@gmail.com

Telly Yarita,
Industrial Engineer, Projects Specialization, Master in Agricultural Engineering. Professor-Researcher at the Instituto Superior Tecnológico Paulo Emilio Macías. External evaluator of research papers. Investment and social projects advisor FUNDACMA.
Email: itspem.tmacias@gmail.com

Fausto Roberto,
Civil Engineer, Professor-Researcher of the Instituto Superior Tecnológico Paulo Emilio Macías.
Email: itspem.fandrade@gmail.com

Adrián Alberto,
Civil Engineer, Professor-Researcher of the Instituto Superior Tecnológico Paulo Emilio Macías.
Email: itspem.ahernandez@gmail.com