UNIVERSIDAD TÉCNICA DEL NORTE

FACULTAD DE INGENIERÍA EN CIENCIAS APLICADAS

CARRERA DE INGENIERÍA MECATRÓNICA

TRABAJO DE GRADO PREVIO A LA OBTENCIÓN DEL TÍTULO DE INGENIERO EN MECATRÓNICA

TEMA:

BUILDING A CHEESE RIPENING ROOM FOR SMALL INDUSTRY.

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IBARRA – ECUADOR
2015

BUILDING A CHEESE RIPENING ROOM FOR SMALL INDUSTRY.

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Summary. This project consists of a cold room provided all necessary health conditions, humidity and temperature, through low-cost control also modularly constructed with materials of domestic manufacture. This type of cold storage for its low cost can be implemented in small companies in the country. The main work was the implementation of a cooling system and efficient humidification without the presence of forced air that guarantees a temperature of 12 ° C to 15 ° C and humidity of 75% RH to 85% RH. with this he could get a better quality product by reducing the time to maturity of 5-3 weeks.

1. INTRODUCTION

- The micro-dairy "Las Mercedes" makes the ripening process manually and quarter-brick. This process had many difficulties because moisture is kept by sandbags which were wet manually every certain period of time and the temperature was stabilized by increasing the thickness of the walls and placing them in nearby places moors, and the city of Cayambe, a person should also monitor the maturation of cheese must verify these parameters and try to control them in any way to avoid problems such as:

- Swelling
- Putrefaction
- Palate defects
- body and texture defects

Example of putrefaction cheese for mishandling parameters of humidity and temperature in the ripening process

Fig.1 Putrefacción del queso
Autor: Martín, (2012)

2. PROCESS DESCRIPTION

The chamber dimensions 2 m wide and two 2 m long and two 2.4 m high is composed of a cooling system, which consists of thermal insulation, evaporation system, condensing unit, and a humidification system and spray control system.

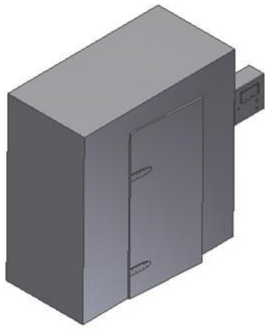

Fig.2 Ripening room
Source: Author

2.1. Cooling system

The exchange of heat through walls and ceilings floors varies a camera structure, material from which this built, has its own insulation coefficient and thickness, in addition to the area exposed to differences in temperature of the refrigerated space (inside the chamber) with temperature. To determine the ability of the team is necessary to know the following factors: load heat transfer, air infiltration, the intake charge and the additional burdens that this exposed the room.

2.1.1. Calculation of thermal load

For the calculation of the thermal load is considered a temperature within the chamber 10°C, an external temperature of 25 ° C, thermal conductivity (k) to the walls and ceiling and floor polyurethane concrete 0.263 and 12 (BTU • in / ft2 • hr • ° F) respectively, using this formula was obtained the following charges:

$$Q=U \times A \times \Delta T$$

Walls and roof load (Q1), load floor (Q2), air infiltration (Q3), Load per product (Q4), supplementary charges (Q5), because people load (Q6) follows for the load Total is exposed to the room:

$Q_t = Q_1 + Q_2 + Q_3 + Q_4 + Q_5 + Q_6$

$Q_t = 548.38 + 3299.6 + 253.7 + 481.24 + 34.1 + 720$

$Q_t = 5337.02$ BTU/h

2.1.2. Selecting Condensing unit

The selection of the condensing unit is based on the total heat load which is obtained above 5337.02 BTU / h, allowing to find the condensing unit HP ½ equivalent cooling capacity of 5500 BTU / h at a temperature of 7.2 ° C.

Fig. 3 Condensig unit
Sourse: (Tecumseh, 2013)

2.1.3. Evaporator selection.

For this device an evaporator static type TermoCoil model used EBS-050-E with a heat capacity of 6050 BTU / h with DT temperature difference of evaporation and temperature 10, of dimensions 0.83 x 0.33 x 0.08 m, with to ensure ease of control of humidity and temperature.

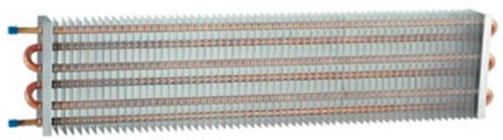

Fig.4 Evaporador estático
Fuente: (Dufrio, 2014)

2.1.4. Positioning for evaporator.

In the chamber there will be a heat exchanger through which cold body radiation is the evaporator which absorbs heat from the hot bodies which in this case is cheese.

For positioning the law of inverse square that tells us that the radiative heat transfer decreases as the square of the distance it is used (William C. & William M., 2000).

$$\frac{T_1}{T_2} = \frac{d_2^2}{d_1^2}$$

Where you have:
T_1= Temperature to distance 1
T_2= Temperature to distance 2
d_1= distance1
d_2= distance 2

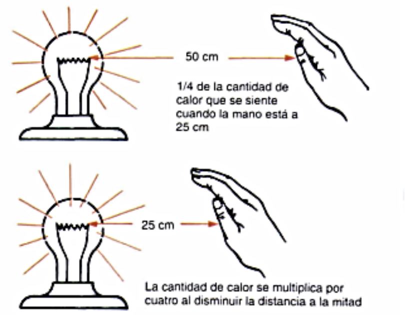

Fig.4 Inverse square law
Souce: (William C. & William M., 2000)

Based on this law and the manufacturer's specifications proceeded to put the evaporator in the central part of the chamber there is a good temperature distribution, and there is no problem of condensation drips on the product.

2.1.5. Temperature and humidity test

In order to ensure the temperature and humidity required for cheese ripening, for 9 days taking these data into the ripening for this was performed chamber it was divided into sectors which facilitated the analysis of the results and positioning sensor as there was no software that allows simulation of this phenomenon.

Tabla 1. Data collection sectors

	Right sector	Media sector	Left sector
Low Section	A1,B1,C1	A2,B2,C2	A3,B3,C3
Media Section	A4,B4,C4	A5,B5,C5	A6,B6,C6
Top section	A7,B7,C7	A8,B8,C8	A9,B9,C9

With data collected from different sectors of the ripening average temperature, humidity and the respective standard deviation of the different sectors A, B, C was obtained corresponding to the chamber walls, then an average was obtained generally the temperature and humidity of the sections of the rear wall, right sidewall, left side, with the average temperature and humidity of the chamber walls wall top, middle and bottom temperature was obtained to identify whether each of the sections meet the requirement of humidity and temperature for ripening finally got the camera has an average temperature of 13.01 ° C with a variation of ± 0.88 ° C, the average humidity is 77.43% with a variation of ± 4.04% which ensures parameters cheese ripening are 12 ° C to 15 ° C temperature and 70% at 90% relative humidity.

Tabla 2. Temperature and humidity levels

	Ripening Room	
	Humedad (%)	Temperatura(°C)
	Superior	
Promedio	75,55	12,88
DS	3,95	0,85
	Medio	
Promedio	75,75	12,87
DS	4,15	0,84
	Inferior	
Promedio	80,98	13,27
DS	4,01	0,97

2.1.6. Control System

The Full Gauge MT-530 controller was chosen because it meets the requirements as well as control of temperature to humidity, it is also not necessary to implement a visual and audible alarm as this incorporates it into its hardware, this controller also has three outputs type relay which allows an additional connection in addition to the necessary additionally recorded maximum and minimum temperature and humidity both allowing the user to control these parameters in addition to its easy connection via RS 485.

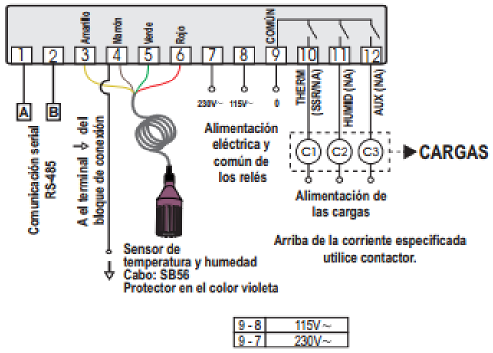

Fig.5 Diagrama de conexiones controlador
Fuente: Full Gauge, 2015

2.1.7. Conservation chamber temperatura

To calculate an initial temperature of 12 ° C was obtained when the cooling system and a temperature of 14 ° C after 45 minutes, these data were obtained during the tests of temperature and humidity, with the door closed during turns off all testing this equation representing the temperature variation at any moment of time it was achieved.

$$T = 25 - 13 \left(\frac{11}{13}\right)^{\frac{t}{45}}$$

With what was obtained for the camera before it reaches room temperature it takes 722.81 minutes ie 12 hours.

3. CONCLUSIONS

• By implementing this camera, the cheese ripening process is optimized, reducing time from four to two weeks.

• The analysis of the defects in the process of cheese ripening helped edit all parameters of temperature and humidity that affect, to get a quality product.

• Due to internal driver software calibration parameters it was made more accurately, shorter and versatility of application helped reduce manufacturing costs of the room.

• The investment of the project is easily recoverable due to reduced time and increased production of cheese so it was analyzed that the project be paid in about 5 months.

• When a static evaporator has taken into account the position thereof according to the heat radiation so that there is a uniform temperature within the chamber.

4. RECOMMENDATIONS

• You must use personal protective equipment such as rubber boots, overalls and gloves properly disinfected during manufacture and cheese ripening to prevent product contamination and possible pollution losses.

• Staff under no circumstances should you open the control box when the computer is running.

• When the alarm is activated the camera means that there is too much variation in temperature or humidity so they should immediately inform the technical staff.

• It should be disinfected after each harvest cheese with disinfectant Ecoxi 100 food grade so that there is the possible formation of pockets of fungi inside the camera that may affect the process of cheese ripening.

• It is recommended that a technical maintenance of the camera every 6 months to ensure their proper functioning.

5. BIBLIOGRAPHY

Copeland Corporation. (2008). *Manual de Refrigeración.* Sidney, Gran Bretaña: Pittsburgh.

Danfoss. (2014). *Termostatos.* Recuperado el 16 de julio de 2015, de http://www.danfoss.com/Spain/Products/Categories/Group/RA/Thermostatic-Expansion-Valves/Thermostatic-Expansion-Valves-Exchangeable-Orifice/7e55a30d-3b82-4450-8ee0-073b94f88cd7.html

Dufrio. (2014). *Sistemas inteligentes de refrigeración*. Recuperado el 05 de agosto de 2015, de www.dufrio.com.br

Dupont. (2014). *La nueva generación de refrigerantes para refrigeración fija*. Recuperado el 20 de julio de 2015, de http://www2.dupont.com/Opteon_Stationary/es_ES/index.html

Full Gauge. (2010). *Full Gauge Controls*. Recuperado el 05 de octubre de 2015, de http://www.fullgauge.com/

Giraldo, D., & Tabares, I. (1997). *Teoría de control.* México D. F.: Pretince Ispanoamericana.

Kern, D. Q. (1999). *Procesos de Transferencia de Calor.* Mexico: Prince Continental.

Martín, P. (12 de diciembre de 2012). *Defecto en los quesos*. Recuperado el 05 de agosto de 2015, de http://quesodeoveja.org/otros-defectos-en-los-quesos/

McCabe, W. L. (1998). *Operaciones Unitarias en Energia Quimica.* Recuperado el 01 de julio de 2015, de http://www.academia.edu/8348642/Operaciones_Unitarias_en_Ingenier%C3%ADa_Qu%C3%ADmica

Meyer , M. (2010). *Elaboracion de Productos Lacteos.* Argentina : Editorial trillas.

Ogata, K. (1998). *Ingenieria de Control Moderna.* Mexico : PRENTICE-HALL.

RIMA Internacional. (2002). *Ailante, reflectante, barreras radiantes y capas de control de radiación.* Olathe, EEUU: RIMA-I.

Solant Aislantes. (enero de 2015). *Aislación térmica*. Recuperado el 12 de agosto de 2015, de isolant.com.ar/lexico.html

Tecumseh. (24 de enero de 2013). *Unidades condensadoras*. Recuperado el 10 de agosto de 2015, de http://www.tecumseh.com/es/South-America/Products/Condensing-Units

Villegas G., A. (2004). *Tecnología Quesera.* Buenos Aires, Argentina: Trillas ediciones S. A.

William C., W., & William M., J. (2000). *Tecnologia de Refrigeracion y aire acondicionado.* México D. F.: Paraninfo.

Kuroki, T. ;Sato, T. ; Nabeshima, T. ; Nishijima, K. (2010). *Comparative study of digital PI control algorithm for Dc-to-dc converters*. Obtenido de IEEE Xplore: http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6147303

6. BIOGRAFÍA DEL AUTOR

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Born in Quito belonging to Ecuador, June 24, 1990. He completed his primary school studies in LaVictoria school. The high school course in the Liceo Aduanero in the specialty of Mathematical Physics. Currently he is a graduate of the Universidad Tecnica del Norte - Imbabura Ibarra in the Engineering Mechatronics in 2015. Interest Area: Mechanical design, process automation, renewable energy.