

Study of high temperature conditions in Misantla bakery

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Abstract: This document aims to publicize the temperature evaluation carried out in the production area of a bakery in the city of Misantla, said evaluation was carried out to know the temperatures to which the workers in this space are exposed during their working hours, as well as, to determine if the temperatures are within the permissible limits as established in NOM-015-STP-200. The methodology comprised recognition, evaluation, and control of elevated temperature conditions within the bakery. This study is descriptive and is developed as a quantitative investigation. The research population is made up of exposed workers in the bakery. The temperature evaluation was carried out according to the procedure established in point No. 9 of the standard, taking the temperatures with the help of a prototype measuring temperature and relative humidity (prepared at the Higher Technological Institute of Misantla) and a anemometer, obtaining a temperature index of 40.7 ° C, and given this result it has been concluded that the temperature index exceeds the Maximum Permissible Limits of exposure to high temperatures established by the standard, which becomes a threat for the health of Occupationally Exposed Personnel (POE).

Keywords: Thermal insulator, High temperature, Maximum limits allowed, Hot, Occupational Health.

Introduction

Since the beginning of history, man has been exposed to extreme conditions for the development of his work, a condition to control is the temperature, this can be lowered or elevated and is the cause of a great impact not only on the productivity of the worker but also in the health of the same. Currently it is necessary to propose improvements in these environments since, together with global warming, they make the working conditions of workers exposed to high temperatures more worrying. The World Health Organization (WHO) states that the optimal ambient temperature for the body is between 18 and 24° C, when the body is kept at about 36 ° C - 37 ° C (WHO, 1946), however, in Many times this temperature is not optimal in the workplace due to the activities involved in the process. Exposure to heat can cause various health effects, of varying severity, such as skin rashes, edema of the extremities, burns, muscle cramps, dehydration, exhaustion, cardiovascular diseases and some degenerative ones. But, without a doubt, the most serious effect of exposure to situations of intense heat is heat stroke. When the so-called heat stroke occurs, the body temperature exceeds 40.6° C, being fatal between 15% and 25% of the cases (INHT, 2016). This entity is characterized by a dysfunction of the Central Nervous System (CNS), multiorgan failure and a state of hyperthermia (Epstein, 2019).

Among other consequences, when this population is repeatedly subjected to high temperatures, a state of dehydration occurs, presenting a variation in the glomerular filtration rate, which leads to electrolyte alterations and later to kidney failure (Lorenzo, 2016). Recent studies also show repercussions on mental health, including depression and anxiety (Thompson, 2018).

Many jobs require working in hot environments, in which activities are carried out with thermal conditions not favorable for humans, work in closed places or without direct exposure to the sun where heat and humidity are high due to the work process or the conditions climatic conditions in the area and the absence of means to reduce them, among which are: foundries, steel mills, brick manufacturing, ceramic objects manufacturing, vulcanizing processes, cement plants, greenhouses, ovens and bakeries, among others (Urrutia, 2010) , of which it is important to highlight this last work, the bakery, which is where this study is being carried out.

The heat that is generated in furnaces when burning fuel such as natural gas or diesel, which is absorbed in the home or on its surface, causes a rise in temperature above normal. This temperature difference produces the transfer of heat from the hot medium to the environment, thermal insulators reduce heat loss in processes, thus saving time and money. On the other hand, thermal insulators are used to prevent accidents, in addition to guaranteeing the health of workers and their comfort in work spaces with high temperatures (Energía, 2009).

In Mexico, the Ministry of Labor and Social Welfare, through the Official Mexican Standard: NOM-015-STPS-2001, establishes the high or low temperature conditions and the safety and hygiene conditions for places where work is

carried out with high temperatures for this case study. This standard establishes the Maximum Permissible Limits (MPL) of exposure to high thermal conditions, which are the maximum exposure times in addition to specifying the recovery times for workers. NOM-015-STPS-2001 also establishes a series of steps to follow for the recognition, evaluation and control of work centers with high temperatures, in this case study applied to a bakery in the City of Misantla, with The objective of evaluating the temperature conditions of this workplace based on Mexican regulations and with specific objectives such as: Carrying out a diagnosis of the temperatures of the bakery following the methodology of NOM-015-STPS-2001; evaluate if there are conditions that are affecting workers, create an improvement plan and carry out its application; improve the conditions in the workspace with high temperatures using the Thermo Egg mixture as an alternative of thermal insulation material; report the results based on NOM-015-STPS-2001.

For the evaluation method established by the standard, an electronic measuring instrument for high or low temperatures and humidity (prototype) was designed, prepared at the Instituto Tecnológico Superior de Misantla, which complies with the provisions of the standard to perform the measurements. With the information collected, it is possible to establish a sustained diagnosis of the conditions in which the activities in the bakery are carried out and thus efforts can be directed towards the protection of Occupationally Exposed Personnel (OEP).

Materials and Methods

This study is descriptive in nature, it serves to analyze what a phenomenon and its components are like and how it manifests itself. It allows to detail the phenomenon studied basically through the measurement of one or more of its attributes. Thus, this study is developed as a quantitative investigation. The population in this case study is the production area workers in a high-selling bakery in the city of Misantla.

In the city of Misantla, due to its climate and traditions, the bread industry is very common, there are more than 50 bakeries, with different characteristics of demand and variety in their products. Being an activity that takes place in high temperature conditions, it becomes the object of analysis to contribute to the improvement of the process, starting from a diagnosis. This diagnosis is widely described in the norm of the Ministry of Labor and Social Welfare marked with the number 015 in its last update in 2001. Below, in Figure 1, each of the stages of the methodology is detailed.

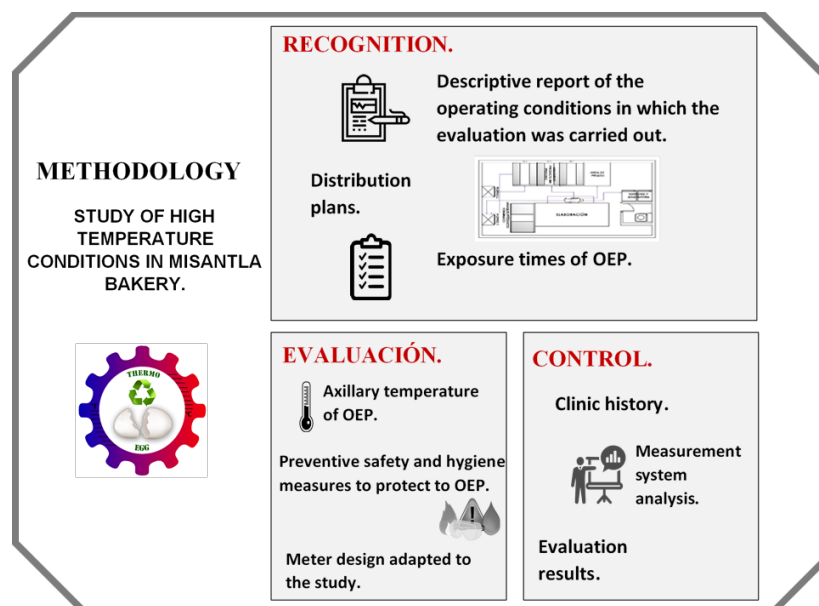


Figure 1. Methodology used for the development of the research.

Recognition

- *Descriptive report*

This bakery has one of the largest bread distribution networks in the city of Misantla, different types of bread are made, among which stand out, piece bread, fine bread, large bread, miniature bread, cookies, toasted bread. and volcanoes. Although each of these types of bread has its specific process, a general process of the activities carried out by the workers in this establishment is described below.

In the first place, there is the receipt and storage of raw materials, although this activity is carried out once or twice a week entails a rigorous workload since the workers carry out the unloading of said material.

For the elaboration of the bread, it begins with the dosage and the weighing of the raw material that the workers carry out with the help of a scale, later, the mixing and kneading of the ingredients is carried out with the help of an industrial mixer and kneader although sometimes This activity is carried out by hand, once the dough is obtained it is left in process for a set time for each type of bread and it is at this time that the oven is turned on to 250 ° C to preheat it, it is necessary to clarify that from this point of the process until the end of the process the oven remains on.

Once the rest time of the dough has elapsed, the table is prepared where the portions for each bread will be prepared, the dough is weighed and cut according to the piece that is made and the molding or formed by hand or with tube begins of the dough to place the pieces on trays for cooking. When the pieces of dough are ready on the tray, they are decorated, shined and cut to each one to give the last detail and thus move on to baking where the dough is left to cook depending on what bread is being made.

Once the cooking time has passed, the worker removes the trays from the oven so that the bread can cool down and thus be able to pack it for distribution.

- *Distribution plan*

Next, in Figure 2 a Layout of the bakery is shown, in which the activity flows carried out by the workers are also indicated. All the tours that are carried out during the production process are repeated several times until the estimated production time is finished, which is approximately 8 hours, since sometimes the workers carry out work days of up to 10 hours.

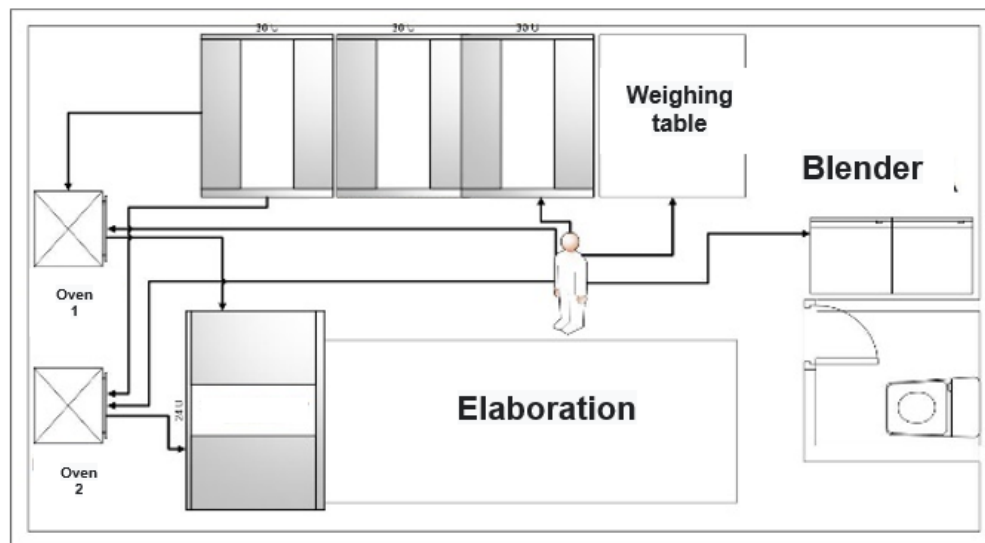


Figure 2. Bakery layout with worker activity streams



Figure 3. Electronic meter for high or low temperatures and relative humidity. (prototype)

- *Exposure time of the three workers*

As mentioned above, the working day of the operators is approximately 8 hours since, sometimes, the workers work almost 10 continuous hours, to meet the demand of their customers. Therefore, the estimated time of exposure to heat of the workers is 6 hours when they work the 8-hour day, this considering that when the bread enters the baking process, the workers take short breaks in which they are engaged in activities with less energy demand.

Evaluation

- *Meter design*

The electronic meter for high or low temperatures and humidity that was developed at the Higher Technological Institute of Misantla, is a prototype that consists of a vertical wooden structure (Figure 3), which has three DHT22 sensors, programmed in Arduino to measure temperature. and relative humidity, the first sensor is located at a height of 0.10 m (ankle region), the second sensor is located at a height of 1.10 m in the abdominal region and the third sensor is located at a height of 1.70 m These measures are based on NOM-015-STPS-2001 if the activity is carried out standing up. With the development of this prototype, the use of a tripod that holds a wet bulb thermometer and a dry bulb thermometer is avoided, thus facilitating measurement.

- *Taking temperature*

With the help of the afore mentioned meter, temperature measurements were made in the work environment only once during the entire working day, to know the temperature of the place where the bakery workers are. As already mentioned in this case study, if you work in a hot environment, it is important to keep this environment acclimatized and to maintain adequate conditions for the workers.

Since heat is generated in the bakery by the ovens and the activities carried out in it, as well as by its distribution, in addition to the ambient temperature measurements, the axillary temperatures of the workers were taken, before starting their working day. work and at the end, because due to these conditions it is impossible for the operator to acclimatise his body and to continue with his activities in a normal way. When the heat generated by the body cannot be emitted into the environment, it accumulates inside the body and its temperature tends to increase, and irreversible damage may occur (Brenda Jacklitsch, 2016).

- *Personal Protective Equipment (PPE)*

The workers of this bakery, like those of almost all bakeries in the city of Misantla, make bread in an artisanal way. Although they have sophisticated ovens, blenders, or some other tool to carry out their work, the way in which the bread is made is the same as that of their ancestors. Therefore, it is normal to find that the workers of the bakeries in the region operate without the use of the appropriate Personal Protective Equipment, where appropriate, they replace some equipment with conventional objects, an example of this being the use of rags to handle trays. instead of wearing leather gloves.

Control

- *Measurement system analysis*

The analysis of the measurement system that was carried out to the instrument designed through a GR&R, the measurement system was evaluated resulting in a percentage of variation and a few distinctive categories, to establish if the instrument is reliable for this type of measurements. since it has the repeatability and reproducibility allowed.

- *Clinic story*

A medical history of the bakery workers was made, where congenital, degenerative diseases and allergies were identified. Specifically, one of the workers needs special care and that he suffers from Diabetes. Medical research reports that heat is closely linked to diabetes and kidney failure (Brenda Jacklitsch, 2016).

Therefore, it is necessary to work on monitoring the health of the workers and proposing the improvement plan for this bakery. The strong part of this investigation is the diagnosis to determine the actual temperature that occupationally exposed personnel (OEP) are receiving.

The procedure carried out for the recognition and evaluation of the temperature conditions of the bakery, were carried out in accordance with the provisions of NOM-015-STPS-2001, which establishes work regimes according to the activities that operators develop in their working hours, which can be consulted in Figure 4. For this case study, the regime established for bakery workers is Moderate.

Régimen de trabajo	Actividad	Ejemplo de Gasto Metabólico aproximado	
		watts	kcal/h
Ligero	Sentarse tranquilamente	116.18	100
	Sentarse, movimiento moderado de los brazos y el tronco (por ejemplo, trabajo de oficina, mecanografía)	130.81 a 162.21	112.5 a 139.5
	Sentado, movimientos moderados de los brazos y el tronco (por ejemplo, tocando el órgano o conduciendo un automóvil)	159.88 a 188.95	137.5 a 162.5
	Parado, trabajo moderado en máquinas o bancos de máquinas, mayormente con las manos	159.88 a 188.95	137.5 a 162.5
	Parado, trabajo liviano en máquinas o banco, a veces caminando un poco	188.95 a 218.02	162.5 a 187.5
	Sentado, movimientos pesados de los brazos y piernas	188.95 a 232.56	162.5 a 200.0
Moderado	Parado, trabajo moderado en máquina o banco a veces caminando un poco	218.02 a 290.69	187.5 a 250.0
	Caminando de un sitio a otro empujando y levantando moderadamente	290.69 a 406.97	250.0 a 350.0
Pesado	Levantando, empujando o tirando cargas pesadas, intermitentemente (por ejemplo, trabajo de pico y pala)	436.04 a 581.39	375.0 a 500.0
	Trabajo pesado constante	581.39 a 697.67	500.0 a 600.0

Figure 4. Definition of the work regime according to the operator's activity

In addition, the standard establishes the Maximum Permissible Limits (LMP) of time to which Occupationally Exposed Personnel (EOP) can be in terms of exposure to high thermal conditions and the minimum recovery time that they must have for eight-hour workdays (see Figure 5).

Temperatura máxima en °C de I _{tgbh}			Porcentaje del tiempo de exposición y de no exposición
Régimen de trabajo			
Ligero	Moderado	Pesado	
30.0	26.7	25.0	100% de exposición
30.6	27.8	25.9	75% de exposición 25% de recuperación en cada hora
31.7	29.4	27.8	50% de exposición 50% de recuperación en cada hora
32.2	31.1	30.0	25% de exposición 75% de recuperación en cada hora

Figure 5. Maximum permissible exposure limits to elevated thermal conditions.

The values obtained were compiled in a format of our own elaboration in accordance with the provisions of NOM-015-STPS-2001 (Figure 6). Once the evaluation was concluded, the temperature of the electronic meter designed for this activity was calculated with the recorded values, using Equation 1.

	MEDICIÓN 1					
	Beginning		Intermediate		Final	
	Relative humidity	Temperature (°C)	Relative humidity	Temperature (°C)	Relative humidity	Temperature (°C)
Measure height 0.10 m	58%	38	54%	40	48%	44
Measure height 1.10 m	59%	37	38%	55	51%	39
Measure height 1.70 m	66%	34	62%	35	59%	36
Axillary temperature (°C)	Beginning			Final		
	37.4			38.7		
Airspeed	1.9 m/s					
Work regime	26.7°					
TGBHP (°C)	40.7					

Figure 6. Recording of values obtained in the measurement.

$$I_{tg\ bh\ promedio} = \left[\frac{I_{tg\ bh\ cabeza} + 2I_{tg\ bh\ abdomen} + I_{tg\ bh\ tobillos}}{4} \right] \quad (1)$$

Results and Discussion

Safety conditions for operators in work centers must be controlled to ensure their well-being and contribute to improving their performance. The main objective was to know what real temperature the operators of a bakery in the city of Misantla are exposed to and what the improvement proposals may be to implement the working conditions in this labor sector.

In the descriptive recognition of operations based on the tasks carried out in the work area, a factor that must be considered is the ambient temperature, only in the summer of 2018 temperatures of 42 degrees Celsius were reached, with an exposure time of more than eight hours a day, being a physical risk to control, developing an improved distribution proposal that helps to solve the safety conditions of the occupationally exposed worker.

According to this methodology, taking ten measurements throughout the working day during a week, the following averaged results were obtained, measurements based on the standard: final body temperature in degrees Celsius is 38.7 starting from an initial 37.4 (they are taken based on the sampling the most significant excluding the highest and lowest). Given these results, actions should be taken, in this sense a temperature of 40.7 ° C was obtained, which exceeds the maximum permissible limits (27.8), by 46.40% according to what the standard establishes and higher by 9% of what medically is the average body temperature considered normal (36.1 ° C to 37.2 ° C).

These measurements were made by a thermal stress meter developed and automated by means of Arduino and validated through an analysis of the GR&R measurement system, with a variation percentage of 2.65%, corresponding to 2.60 of repeatability and 0.05 reproducibility, with 53 as a number used to identify the capability of a measurement system and detect the difference between a measured characteristic.

Therefore, actions must be taken regarding exposure times and rest times for operators to regulate their temperature, and propose an improvement in the oven to reduce the heat that radiates to the outside.

Conclusions

As a small company, the bakery does not have the optimal conditions for its workers to carry out their activities in a comfortable environment, however, they try to do so to the best of their knowledge. This heat-generating source such as the oven and considering that there are no air currents that help to lower the temperature, as well as that it does not have a type of thermal insulation that keeps the heat inside it, since this generates conditions unsafe for everyone.

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