Temperature Mapping at a Pharmaceutical Product Warehouse

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Abstract

To sustain pharmaceuticals products with high quality until they arrive to the patients, it is necessary to store them under specified temperature conditions. Warehouses that store this kind of products use temperature sensors that collects data seven days a week, 24 hours a day. This must be performed by a requirement of the United States Food and Drug Administration (FDA). The temperature mapping is a tool which involves temperature loggers that are placed strategically to monitor a controlled enviroment. If a temperature value is not under the established range, it is considered a temperature excursion. In this study, a temperature mapping was executed to determine if there is a temperature excursion in a pharmaceutical product warehouse. After this study, the collected data by the temperature mapping will be used to validate the established sensors. This report will be presented to suppliers and federal agencies.

Introduction

Temperature mapping can be defined as the process of mapping the changes in temperature that occurs within a single temperature-controlled system [2]. The temperature mapping is used to determine the points of substantial temperature fluctuation. Then, these fluctuations are analyzed to find the causes.

Temperature excursion is defined by the World Health Organization (WHO) Model Guidance as an "event in which a Time Temperature Sensitive Pharmaceutical Product (TTSPP) is exposed to temperatures outside the range(s) prescribed for storage and/or transport. Temperature ranges for storage and transport may be the same or different' they are determined by the product manufacturer, based on stability data" [1, 3].

The Prescription Drug Marketing Act (PDMA) of 1987 is a federal law signed by the President of the United States, Ronald Reagan, on April 22, 1988. This act allows the United States federal government to ban the reimportation of drugs produced in the country, place restrictions on the distribution of drug samples, and ban certain resales of drugs by hospitals and other health care entities [4]. The PDMA was enacted to:

- Ensure that drugs delivered to the customers are safe and effective;
- Avoid the unacceptable risk of consuming drugs that are counterfeit, adulterated, misbranded, sub potent or expired.

Background

The quality of the pharmaceutical products depend, mainly, upon the environment controls during storage and handle [5]. Every pharmaceutical product must be handled and stored under specific storage conditions; labelled on the product information data sheet or product pack. The essential environmental parameter that can impact the quality of pharmaceutical product is temperature. If the temperature is not controlled, an excursion can occur with an adverse impact on product quality.

The temperature mapping is essential to maintain the integrity and quality of temperature sensitive product. This process allows products, merchandise, and items to meet the government and company requirements. With this process, the company can determine the actual temperature in a tridimensional space and guarantee that is within the acceptable range of the products stored.

Problem

A pharmaceutical product warehouse wants to implement a temperature mapping in all the storage areas to comply with the United States Food and Drugs Administration regulation. This regulation, known as the PDMA, states that every pharmaceutical product must be stored in conditions where efficiency and safetyness are not compromised. A temperature mapping was realized, taking into consideration their new storage area, to validate the six sensors used to monitor the temperature at every moment. The warehouse has 3,775,680 cubic feet used for products under the controlled room conditions (air conditioners units maintains the temperature between 68°F to 77°F). Before this temperature mapping, there was not one performed because they only applied this method to their freezers (units in where the temperature is controlled thermostatically between -4°F to +14°F).

Methodology

The following steps explain the process used to conduct the temperature mapping study at the warehouse.

Step 1- Temperature Mapping Sensors Selection

The sensors used for the temperature mapping were TempTale®Ultra; selected because they have enough memory for the study's duration and time interval. Those sensors were calibrated within the once a year. The calibration used complies with the temperature range of this study.

Step 2- Temperature Mapping Team

A cross-functional team was created with members of the quality department, engineering department, operations, and the management of the company.

Step 3-Acceptance Criteria

The acceptance criteria was determined by the manufacturers of the products. They recommend specific temperatures conditions to sustain the quality of the products. These conditions needs to be kept at every moment until they reach the patients. In this study, the acceptance criteria was given by the controlled room temperature conditions 68°F to 77°F (20°C to 25°C).

Step 4- Sensors Locations

As per the company's Standard Operating Procedure and, because of the magnitude of the warehouse (3,775,680 cubic feet), 28 TempTale®Ultra sensors were required to perform the temperature mapping. They were placed at high, medium, and low distance, taking in consideration the warehouse's racks used to store the products.

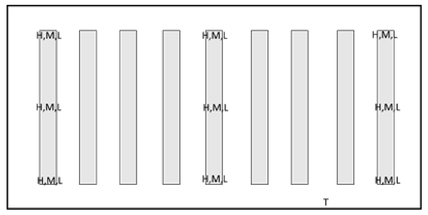

Figure 1
Locations of the sensors

In the figure above, the sensors were located at H (which means high), M (which means medium), and L (which means low) distance from the storage area. There were three sensors in each corner, three sensors between the corners, and three sensors in the middle. Also, one sensor was placed near a thermostat (represented on the Figure 1 as T). The thermostat are those temperature sensors used by the company to control the air flow released by the air conditioners units. This is with the intention to form an "X".

Step 5- Program the Sensors

The program used to configure the TempTale®Ultra sensors (sensors used to perform the temperature mapping) was Sensitech. With Sensitech, the sensors were configured to start at March 23, 2019 at 8:00 am and ended at Monday, March 25, 2019 when the stop button was pushed. For this study, due to the company's Standard Operating Procedures, only 24 hours of the collected data was considered for the temperature mapping. The first 30 minutes of data were not used for the study because is the time that the sensors takes to stabilize. Also, the TempTale®Ultra were configured to record the temperature in Fahrenheit.

Step 6- Put the Sensors in Place

Criteria to place the sensors:

- The layout of the area. For example: whether is a square or includes alcoves.
- Product's packages, so they do not block the air flow so that the sensors can read the real temperature.
- The location of the products. The sensors must be placed on or near the locations where the products are stored or planned to be stored.
- A place where the sensors not be smashed and/or damaged.

Step 7- Conduct the Mapping

The temperature measurement was run for 24 hours at 15 minutes intervals. No personnel or movement of material has been allowed on the study area. Once the time passed, the sensors were collected. The serial numbers and locations were double-checked against the installation notes.

Step 8- Download the Collected Data

The downloaded data was collected using the Sensitech program. Each value was analyzed to identify temperature excursions.

Results and Discussion

The size of the warehouse was 3.7 million cubic feet. As per company SOP and taking in consideration the warehouse dimensions, the quantity of TempTale®Ultra needed to perform the temperature mapping were of 28. Those 28 sensors were installed around and in the middle of the warehouse.

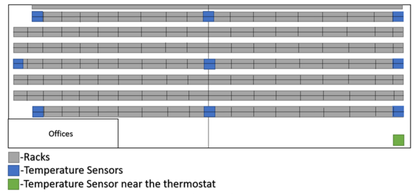

Figure 2
Warehouse architectural plan that shows in where the 28 temperature sensors where installed

The Figure 2 shows were each sensor were installed. Is was detected that temperature excursions occurs during the temperature mapping time.

Figure 3
TempTale®Ultra sensors in where the temperature excursions were found

Sensors B3S16, B3S17, B3S18, B3S19, B3S20, and B3S21 were identify with the temperature excursions, as showed on Figure 3.

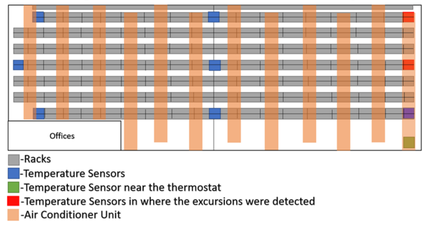

Figure 4
Warehouse architectural plan that shows the air conditioners units' distribution

Because the exact location in the warehouse was documented during their installation, it was easy to identify in where the temperature excursions occurs. As shows in the Figure 4, it was discovered that all six sensors in where the temperature excursions were identified were installed on the same location in the warehouse.

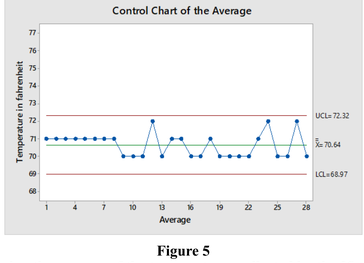

Figure 5
Control chart using the average of the temperatures collected by the 28 temperature mapping sensors

Regardless of the temperature excursions, it can be said that the process is out of control. Figure 5 shows a control chart of the average measured by the temperature mapping. The process is out of control because the first eight averages are on the same side of the centerline. This effect is consequence of the absent of oscillation on the air conditioner units.

After the Temperature Mapping

The Figure 6 shows the 9 TempTale®Ultra that were set to start measure the temperature between 8:30pm on Saturday, April 6, 2019 to 8:30pm on Sunday, April 7, 2019. Each of those sensors were used to prove if the changes in the control parameters were effective. All temperature excursions were verified and corrected.

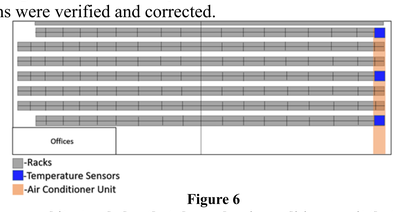

Figure 6
Warehouse architectural plan that shows the air conditioner unit that is above the temperature sensors

After the mapping, this report will be used to demonstrate that the company complies with the regulations of the suppliers and the FDA.

Conclusion

Due to company requirements per Standard Operating Procedures (SOP), the warehouse in where the temperature mapping is performed should be clear of personnel and movement of materials. This requirement difficulted the study due to the necessity of the business to operate on that Saturday. For the next temperature mapping, the perfect time to start it is between Saturday at 8:00 because no work is performed during that time. Another recommendation is to perform the temperature mapping during working hours with movement of material and personnel. This study can be also performed two times a year. This is to take in consideration the different temperatures changes that happens because of the season and the climate changes. With two temperature mapping performed during the year, the parameters in which the air conditioners must be placed will be more accurate.

Future Work

A new temperature mapping will be performed on the entire warehouse to ensure that the changed parameters avoid temperature excursions. Once finished this temperature mapping, another one will be performed on a second warehouse of the company.

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