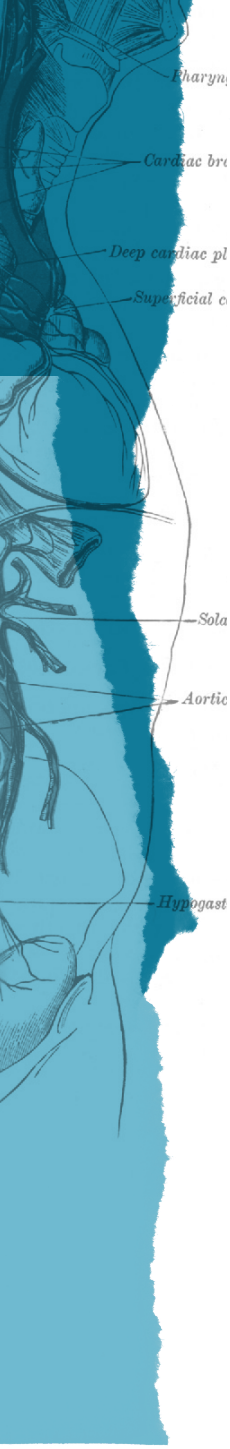

Fecha de recepción: julio 31 de 2021
Fecha de aceptación: mayo 24 2022

ARTÍCULO DE REFLEXIÓN

https://dx.doi.org/10.14482/sun.39.01.378.001

Calculating the risk of fire in community pharmacies. Gustav-Purt method

Cálculo del riesgo de incendio en farmacias comunitarias. Método de Gustav Purt

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Single author article. I declare that I have no conflict of interest nor have I received any type of funding to carry out this work.

Vol. 39 (1) - 2023
ISSN 0120-5552
eISSN 2011-7531

ABSTRACT

Introduction: Fire is a chemical reaction of combustion, based on the strongly exothermic "oxidation-reduction" phenomena that produce a big detachment of light and heat.Its effects are, generally, harmful, producing personal injuries due to smoke, toxic gasses, and extremely hot temperatures; and damaged materials and buildings.

Fire is produced when the three following factors simultaneously coexist in time and space: Fuel; a comburent agent, usually the oxygen in the air; and heat, which contributes the necessary energy to actuate the reaction. Besides, it is necessary, for the production of the flame, the existence of a chain reaction.

Method: The Gustav-Purt Method, which aim is to calculate the potential risk in a determinate building and of the means to fight fires should be implemented.

Results: After the calculation of the distinct factors, the conclusion that the risk of fire in a pharmacy is high is reached.

Discussion: Therefore, strict inspection by sanitary authorities to avert the danger of the fire is necessary.

Keywords: Fuel; Fire; Heat; Smoke; Pharmacy.

RESUMEN

Introducción: El fuego es una reacción química de combustión, basado en los fenómenos de oxidación-reducción fuertemente exotérmica que se manifiesta por desprender gran cantidad de luz y calor. Sus efectos son generalmente perjudiciales, produciendo daños personales por el humo, gases tóxicos y temperaturas extremas, causando grandes daños a instalaciones y bienes.

El fuego se produce cuándo existen simultáneamente en el tiempo y en un mismo lugar los tres factores siguientes: Combustible, Agente Comburente, normalmente el oxígeno del aire y Calor, que contribuye con la energía necesaria para activar la reacción. Además, es necesario, para la producción de la llama, la existencia de reacciones de cadena.

Método: El método de Gustav Purt, tiene por objetivo calcular el riesgo potencial existente en un edificio determinado y qué medios de lucha contra incendios son necesarios implementar.

Resultados: Tras el cálculo de los distintos factores, se llega a la conclusión que el riesgo de incendio en una farmacia es elevado.

Discusión: Por consiguiente, es necesario la estricta inspección de las autoridades sanitarias de la Administración para evitar el peligro del fuego.

Palabras clave: Combustible; Fuego; Calor; Humo; Farmacia.

Every technician working in prevention has to know the basic principles of the detection and prevention of fires, the constructive passive measures of the buildings, the conditions of evacuation of the job centers, and general behavior in case of an accident. All this constitutes a social duty of first magnitude, more important in an open sanitary establishment to the public, such as the community pharmacy.

Fire originates by the incidence of a source of heat that goes in contact with fuel and initiates the emanation of gasses, which inflame when the temperature is achieved. With this inflammation, a contribution of calories to the environment is originated, adding them to the already existent heat from the first source (1).

To understand the process of fire, it is necessary to define "energy of activation", that is, the minimum necessary energy that initiates the reaction. It depends on the type of fuel and its condition (pressure, temperature, etc.). The energy of activation is provided by the "ignition sources", these can be electrical (warming by resistance, warming by induction, static loads, etc.), mechanical (heat of compression), thermal (sparks of combustion, hot surfaces), and chemical (heat of solutions, heat of decomposition). All, or almost all, of these can be found in a community pharmacy.

Combustion, represented by a triangle, with each side corresponding to fuel, comburent agent (oxygen), and energy of activation (heat). If any of these elements is not present, the combustion does not happen (2).

Some metals do not need oxygen for his oxidation, as is the case for sodium and potassium (they can be present in the laboratories of master formulas of community pharmacies), that can lead to oxidation when going into contact with water, without the mediation of atmospheric air.

This has brought, as a consequence, with the configuration of a tetrahedron of fire, as a new element is introduced: the chain reaction (3).

A chain reaction is the set of correlated events in the time that define a fire. They follow these stages: ignition, propagation, and consequences.

1. Ignition: It is produced when a fuel, in determinate conditions, goes into contact with air and receives the energy of activation supplied by a focus of ignition.

2. Propagation: it is the evolution of the fire in space and time.

3. Consequences: they are the harms caused by fire and its propagation. The fatal consequences for people are generally caused by the impossibility of evacuation and the desorientation of them by faulty vision, due to the smokes and gasses; leading to poisoning, asphyxia, and burns (4).

Technicians of Prevention against Fire in Community Pharmacies.

Once analyzed, the different factors that take part in a fire (fuel, comburent agent, energy of activation, and chain reaction), and the need for them to happen simultaneously to produce the fire, leads us to act, in the first place, in the phase of design of a community pharmacy, to avert fires and their consequences.

They have to foresee installations of extraction and suitable ventilation in the laboratory where carry out master formulas. Also, the location of services like electrical installation and stoves, and their corresponding protection elements must be studied.

Measures on fuel.

- Storage and conservation, the heat power of stored products, and assigning a maximum volume have to be takein into account, like, for example, the accumulation of big quantities of ethanol in a pharmacy.
- Signage of security.
- Substitution, if possible, of a fuel by another that has a higher flashpoint.
- Ventilation of these zones.
- Refrigeration of the zones with fuel, to decrease the temperature to less than the flashpoint.
- Getting rid of flammable waste and utilization of hermetic containers.
- Cleaning, in a throughout manner, those zones where flammable mixes can generate.

Measures on the comburent agent.

- Reduction of the proportion of oxygen, by means of the utilization of inert gasses like carbon dioxide or nitrogen.
- Using tight containers.

Measures on the energy of activation.

- Preventive maintenance of the installations and electrical devices.
- Refrigeration or ventilation of venues exposed to environmental thermal loads.

Measures on the chain reaction.

- Addition of antioxidants in plastics.

It is understood as protection against fire, the set of measures meant to mitigate the negative effects produced by it. These measures can be summed up in two concrete actions:

- Detection and alarm.
- Extinguishment.

Means of detection and alarm.

Detection is the discovery of the existence of a fire inevitably after it has initiated.

The detection of the focus of fire is fundamental to avert the propagation of the fire. Generally, fires arise accompanied by the following manifestations: gasses, smokes, flames, and heat. The systems of fire detection are based on these.

The fast detection of a fire has to go with a correct location of it, if this is not achieved, the detection system would be ineffective.

Automatic detectors.

They are sensitive devices to variations of environment, that automatically register, compare, and measure the phenomena or the variations that announce the apparition of a fire (smokes, gasses, heat, flames, etc.). They transmite this signal to a head office.

These detectors can be;

- Gases or ionic detectors.
- Visible smoke detectors.
- Fixed temperature detectors.
- Flame detectors.

In ancient pharmacy offices, any of these detectors can be found, however, in new opening pharmacies, and, also, in pharmacies with a big surface for the attention of the public, the detectors are a necessary investment in the design of the pharmacy.

Detectors of combustion gasses are more frequently used in pharmacies, stores, and big surfaces, to detect the visible and invisible smokes produced in a fire. They are based on the absorption of the light by the smokes.

Detectors of temperature:

They can be of two types:

- The thermostatic detectors signal the apparition of a fire when it exceeds a fixed temperature that was selected in advance.
- The thermovelocimetric detectors signal the apparition of a fire, when the growth of temperature by unit of time exceeds a determinate value, usually 10ºC/minute. The detection installation and alarm is completed with the manual buttons of alarm, which are activated by hand in case of fire.

Means of extinction of fires.

- Elimination of fuel.
- Suffocation, consists in acting on the comburent agent.
- Cooling, deleting the energy of activation.

Extinguishing agents.

Main agents are: water, foam, carbonaceous anhydride, powders, and halons.

Water: It is the most used extinguishing substance. It acts like a cooling and stifling material, because, when it evaporates, it produces steam that covers the fire, hampering the contribution of oxygen. Joined to his advantages of economy, abundance, availability, and safety, it presents the inconveniencet that it disperses the fire, produces considerable harm, and can not be used where there is electrical risk.

Foams. They are bubbles of air or gas, generally aqueous, floating in the surface of the liquids because of his low density, preventing the fuel from continuing its contact with the air. It presents the problems of not being able to be used in electrical fires and of being very corrosive.

Carbonaceous Anhydride.

It is a gas that liquefies by compression and cooling, stored in suitable containers, and once it is expelled from the container, it expands, producing a species of snow known as carbonaceous snow, which acts like a stifler. In front of the advantages of not being toxic, application in electrical fires, not producing deteriorations, it presents the problem of not being applicable to fires with embers.

Powders. In front of the advantage to be applicable to electrical fires and not being toxic, they present the problem of not being able to be used in machines or delicate installations, and they pose a danger of reflation when ceasing application.

Halons. They are halogenated hydrocarbons. They are very good inhibitors and good stiflers, non corrosives and non conductors, but they are toxic to the environment, can not be applied to fires with embers, and their cost is high. Nowadays, because of the certainty that they cause irreparable harm to the ozone layer, it has already gone out of use (5).

Systems of Extinguishment.

In pharmacies, handheld fire extinguishers are used. They are enclosed containers with an extinguishing substance inside that can be projected and directed on a fire by the action of inner pressure. It is previously obtained by compression. Of interest:

- They have to be kept fully charged, in operating conditions, and in suitable places.
- They have to be kept in easily visible places. Generally, in hallways, in areas free of obstacles.
- The extinguishers will be identified by the agent extinguisher contained therein, and the class of fire against which it has to be applied.
- His location will be vertical, to a height of 1,2 m from the ground to the base of the extinguisher.
- It has to be periodically inspected to verify his state of load.
- To choose the extinguisher the nature of the fuel or class of fire has to be taken into account, also environmental conditions, toxicity of the agent, etc.

Alarm

This is the set of lights that facilitate the visibility in case of emergency or evacuation of the edifice by a fire. Only they have to use their own sources of energy.

It has to work at least during an hour, providing a minimum illumination of 5 lux. The base of the installation has to be autonomous, sufficiently protected, with canalisations, and using a conductive material, resistant to fire (6).

The Gustav-Purt Method.

INTRODUCTION

The evaluation of the objective risks is one of the pillars of the technicians of prevention. The method of evaluation of the risk of fire presented in this section is one of the most used among the specialists in the subject for the evaluation of average risks.

This method of evaluation was presented by Dr. Gustav Purt in the sixth International Seminar of Automatic Detection of Fires.

It contains, essentially, preventive measures that have the following purpose:

- First, achieving a very small probability of a fire.
- Second, in case of fire, it must not be able to extend quickly and freely, meaning it must only cause the least possible damage (7).

The destroying action of fire develops in two distinct fields:

Buildings and their contents.

The risk for a building is in the possibility that it may produce an important harm: the destruction of real estate. It depends, essentially, of the opposite action of two factors:

- The intensity and length of the fire.
- The resistance of the construction.

The risk of the content is constituted by the harm to the workers and material in the interior.

The two risks are related, so, the destruction of the building achieves, generally, the destruction of its content, whereas, inversely, the thermal load released by its content represents, very frequently, the main danger for the building (8).

METHOD

Pharmacies are health establishments where there is order and cleanliness, however, it is also a potentially dangerous place due to the high number of flammable products, among them, the most abundant is ethyl alcohol.

Pharmacy owners are in charge of maintaining the safety of clients and employees, therefore, they must be in charge of safety. If they do not comply with elementary prevention rules, the Sanitary Inspection must force them to have, for example, security cabinets that resist fire, for at least 90 minutes, until firefighters arrive.

An outbreak of fire occurred in a pharmacy on duty in the city of Valencia (Spain) on June 30, 2021.

After the outbreak of fire in the pharmacy, fortunately resolved by the workers themselves, all occupational risk prevention systems were reviewed, proceeding to the purchase of two safety cabinets and increasing ventilation throughout the pharmacy.

Calculation of the Inherent Risk (IR).

This paper will proceed only with the calculation of the risk for the content, because it is homogeneous for all the pharmacies. The calculation of the risk to the building, to my understanding, is not necessary in a work like this, because it is influenced by the year of construction of the building, material, among other factors.

In case of fire in a pharmacy, a clear danger for the workers, as well as for the clients, exists. Regarding the latter, they could be pensioners. It is necessary to say that the main people are used to be polymedicated patients, and, therefore, they frequently visit the pharmacy, and the length of their visits might be quite long.

Except for people with some disability, a healthy person in a pharmacy, in case of fire, would easily reach the public streets, since clients can not go to the interior of the pharmacy, having to remain, imperatively, in the part of attention to the public, that is to say, the closest to the door.

There is danger for the products (in this case, medicine and sanitary products), because they present a big sanitary value. In a pharmacy, there are objects of high value, and the medicine therein are important to cure illnesses, they are not irreplaceable, but they deteriorate in contact with the extinguishing agents.

The smoke increases, even more, the danger for the workers of the pharmacy. The smoke affects vision and breathing, this gives place to dizziness and faintings.

The studio of these three factors of influence gives us the following formula:

IR= H. D. F

H = Danger for people coefficient.

D = Danger for vulnerability to destruction coefficient

F = Influence of smoke coefficient.

Calculation of the Different Factors. Results

H = Danger for people coefficient.

The following table shows the numerical values attributed.

Table1. Values of the coefficient h of danger for the people.

SCALE	DEGREE OF DANGER	H
1	There is no danger for people	1
2	There is danger for people, but they are not disabled	2
3	People in danger because they are disabled	3

In the case of a pharmacy, in my opinion, this factor corresponds to a value H of 2 (in case of people with functional diversity the value would be 3), yes, there is danger for the people, but they can be saved.

D = Factor of danger for vulnerability to destruction.

The table indicates the classification.

Table 2. Values of the coefficient d corresponding to the vulnerability to the destruction.

SCALE	DEGREE OF DANGER	D
1	The content of the building does not represent an important value	1
2	The content of the building represents an important value	2
3	The disappearance of the content is definitive	3

In the case of a pharmacy, to my understanding, D corresponds to a value of 2, the content is supposed to have a considerable value.

F = Corresponding factor to the action of smoke.

Table 3. Values of the coefficient f for the smoke.

SCALE	DATA	F
1	Without danger of smoke	1
2	More of the 20% of the materials release smokes	2
3	More of the 50% of the materials release smokes	3

The value that corresponds to F in a pharmacy is 3, more than 50% of the weight of the material fuels are materials that release a lot of smoke, and, besides, they are toxic.

In a pharmacy, applying the anterior formula would generate an index of risk of the content of

I.R. = 2x2x3 =12;

In case that the users of the office of pharmacy are disabled people, or with reduced mobility, the calculation would be

I.R. = 3x2x3 = 18. A risk above 10 is considered high (9).

CONCLUSION

After these simple calculations, it is concluded that community pharmacies are places that present a high risk of fire, therefore, the authorities inspectors of the sanitary administration are urged to verify that pharmacies are fulfilling all the norms of security to protect clients and workers of the pharmacies. Mainly, the location, in ventilated places, of safety cabinets for flammable chemical products at temperatures of 180º C for 90 minutes.

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