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STORAGE OF CHEMICAL SUBSTANCES DUE TO INCOMPATIBILITIES, WITH INFORMATION FROM THE OFFICIAL MEXICAN STANDARDS AND THE GLOBAL HARMONIZED SYSTEM

Mirna Rosa Estrada Yáñez
Instituto de Investigaciones en Materiales.
Universidad Nacional Autónoma de México
México

Abstract: The storage of chemical substances is an activity that concerns us all. Doing it incorrectly has led to accidents and claims in the past. An aspect of vital importance for the prevention of these is to take into account chemical incompatibilities. Various lists of chemical substances have been generated that guide chemistry professionals for correct storage, but they are confusing for people from other professions or other specialties. In this work, the hazard communication information from the official Mexican standards (Secretariat of Labor and Social Welfare (STPS) and Secretary of Communications and Transport (SCT)) is used to separate chemical substances into 9 groups and in a simple way Secure your receipt in the first storage level.

INTRODUCTION

When one reviews the Safety Data Sheets (SDS or Safety Data Sheets) (of 16 sections according to the Global Harmonized System (SGA)[1]) for how to properly store reagents, the information is in two sections. Section 7 Handling and Storage provides basic general information such as keeping it in a cool, dry place, away from sources of ignition if they are flammable, keeping the substance under an inert atmosphere if it decomposes with environmental components, kept tightly closed, in a vertical position, etc. In section 10 Stability and Reactivity there is usually a list of incompatible substances for each substance searched for. If there are fifty substances in the warehouse, at the end there is a puzzle to put together. When one searches the WEB, there are lists proposed for the correct storage that must be studied before they can be used. In universities and research centers it is common to have many substances and solvents in each laboratory. Organizing and storing them safely is a real challenge, especially if you are not a professional chemist. How to have a simple tutorial that anyone can follow? First we must take into account that the storage can be divided into two levels. The first will separate the most important dangers in general. The second level requires knowing the specific hazards: both what appears in the SDS of each substance found in a given warehouse (from section 10) and what is known about it in the chemical information.

In the system that we present in this work, there are nine divisions (those with low risk (without incompatibilities) are considered to form a group) for the first storage level. It is illustrated in Figure 1der.

Hazardous chemical reagents, in addition to presenting risks by themselves, are capable of causing dangerous situations when reacting. When doing a synthesis in the lab, if an exothermic reaction is known to occur, cool the reaction flask and slowly drop in the reagent. If we know that toxic or flammable gases are produced, we place suitable traps or we lead it with a hose towards the extraction hood, etc. But when we store them and they come together accidentally, we have no control over the consequences of the reaction: production of explosions, release of heat (exothermic reactions), fire, toxic gases, corrosive gases, flammable gases, or a combination of the previous. When two reactants, when they come into contact, present the aforementioned reaction conditions, we say that they are incompatible for storage.

We took as a basis to illustrate the storage system the rhombus provided by the official Mexican standard NOM-018-STPS-2000[2] on Chemical Hazard Communication. This

1. United Nations. Globally Harmonized System of Classification and Labeling of Chemical Products (GHS). (United Nations, 2021).

2. Secretary of labor and social security. Official Mexican STANDARD NOM-018-STPS-2000 System for the identification and communication of dangers and risks due to dangerous chemical substances in the workplace

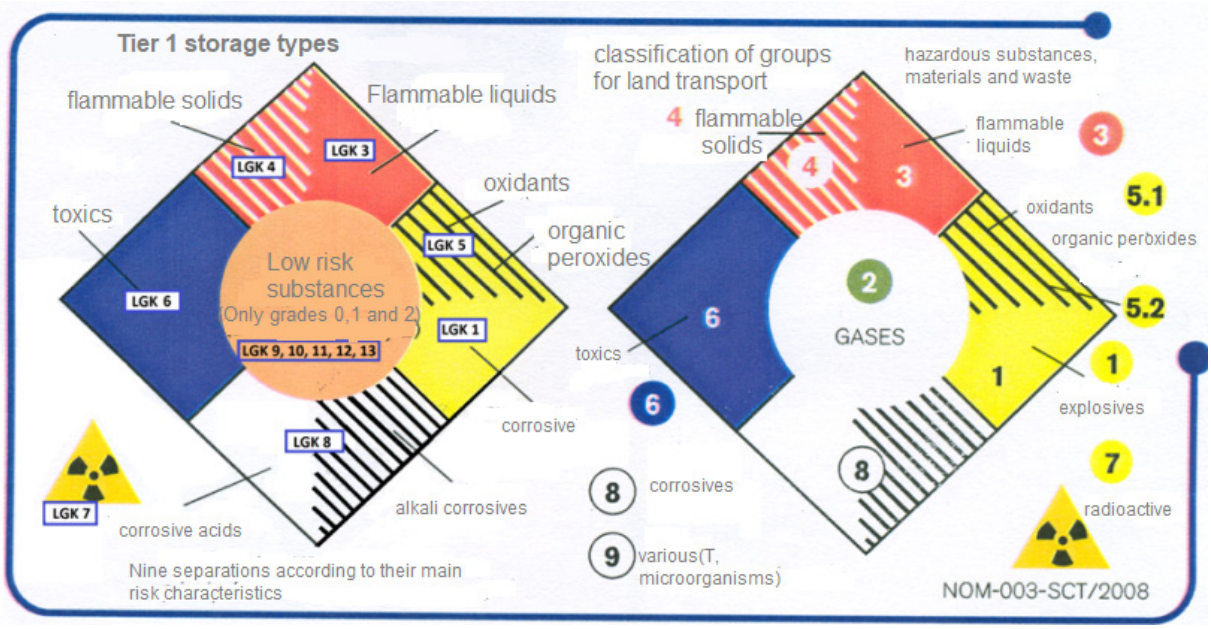

Figure 1, left.) Nine Groups;

Figure 1 right.) Transport groups.

consists of a diamond divided in turn into four diamonds in blue, red, yellow and white, and has associated health risks in blue (acute or chronic toxic or allergenic, etc.), risk of burning in red (flammable or combustible), risk of reactivity in yellow (high exothermic enthalpies), and special risks in white (we will assign corrosivity). According to the standard, numbers 3 and 4 are associated with a "high" risk and numbers 0, 1, and 2 with a "low" risk. Although qualitative, this begins to give us the guideline to distinguish those reagents with which we must be more careful when we store them: those of high risk, with numbers 3 or 4 in any of the inner diamonds. In the standard that is replacing it, aligned with the GHS, instead of numbers 3 or 4 we will see the pictogram(s) of the dangers of the substance to be considered together with the description of the danger phrases that express their magnitude and type of effect). It is illustrated in Figure 2. So far we would have 4 storage groups: poisons, flammable, highly reactive (high enthalpies of reaction), and corrosive. On the other hand, as can be seen in the previous paragraph, one of the possible consequences of the incompatibility is the generation of fire. To generate fire, three components are required: an oxidizer, a fuel and an ignition source.

In Table 1, when observing the oxidizers, we can recognize that they are substances whose reactions are generally exothermic, so they contribute with two factors necessary for the fire, oxygen and the ignition source, all that remains is to add the fuel to be able to generate fire. This is the basis for keeping oxidizers separate from any combustible or flammable material. The pictogram for oxidizer is a circle with fire at the top (or oxygen with its crown of fire). If we look at this symbol we know that it must be avoided at all costs to store it together with fuels and inflammables (flame image). Of course, pyrophoric substances (which burn in contact with air) must also be kept away from other flammable substances (liquids) as they constitute a source of ignition. Strong reducing agents such as alkali metals and

Flammable or combustible 	Oxidants 	Ignition sources
Wood, paper	metal perchlorates	Flaming, Sparkling,
plastic	metal peroxides	heat, hot surfaces
powder	Ammonium nitrate and nitrite	Electrical equipment, heaters
Pyrophoric metals	Hydrogen peroxide	pyrophoric substances
Acetone, alcohol, hexane, ethe	Nitric acid, perchloric acid, bromine	Cigars, incandescent lasers, exothermic reactions
Acetylene, hydrogen	oxygen	electric shock
Ethylene oxide, LP gas	nitrous oxide, ozone	static electricity

Table 1. Components to generate fire with examples of chemical reagents.

metal hydrides are solid substances classified as flammable solids because when they react with water they generate hydrogen, which is a flammable gas. Dividing the flammable diamond into two triangles, we have a space for flammable liquids and another for flammable solids.

The yellow diamond can be associated with both oxidizing agents and organic peroxides. Dividing the yellow rhombus into two triangles, we indicate a place for explosives (flat yellow) and another for oxidants (grayed yellow). It is then clear that in this system the oxidizers (oxygen with its crown of fire) will be kept separate from the explosives (bomb exploding) and also separated from the flammable solids and flammable liquids (flame). The white rhombus can be associated with corrosive materials, dividing this rhombus into two triangles we have one for alkalis (grated white) and another for acids (smooth white). The blue diamond is associated with substances that affect health. For storage and transport, acute toxicity is relevant. The toxic ones (skull with two crossbones) must be separated from the flammable ones because in the event of a fire they would pass into the gaseous phase where they could cause greater damage to the population. It is difficult to completely separate these because normally the damage to health is an additional hazard to the others already mentioned (flammability, corrosive or oxidising). When burned, halogenated solvents cause environmental damage, destroy the ozone layer, are toxic and are stored separately from flammable ones. So halogenated solvents and toxic inorganic solids form another group.

Radioactive material has its own legislation and storage criteria, which is why it is excluded from the rhombus proposed as a mnemonic, but it constitutes a group. The last group is the low risk group. In the norm that came into force in October 2018, they will not carry pictograms, in the outgoing norm (from 2000) they presented only the numbers 0, 1, 2 in all the diamonds.

The 003 standard of the Ministry of Communications and Transport (NOM-003-SCT/2008 Characteristics of the labels of containers and packaging intended for the transport of hazardous substances, materials

and waste) are based on the classification established in the Regulation for Land Transportation of Hazardous Materials and Waste in Mexico, in which hazardous substances, materials and waste are divided into nine classes: 1 corresponds to explosives, 2 to gases, 3 to flammable liquids, 4 to flammable solids, 5 to oxidants and organic peroxides, 6 to acute toxins, 7 to radioactive materials, 8 to corrosive liquids and 9 miscellaneous (some chemical substances not described in the previous classes, high or low temperatures and microorganisms). This classification coincides with 7 of the proposed groups. The great advantage of this is that in section 14, regarding the transport of the SDS of all chemical substances, the class in which the substance is classified to be transported is given. If no class is associated with it, the substance is considered low risk. In Figure 1 left) the second diamond shows the equivalence of this first level separation, thus excluding most of the incompatibilities that are mentioned in the SDS of hazardous chemical reagents.

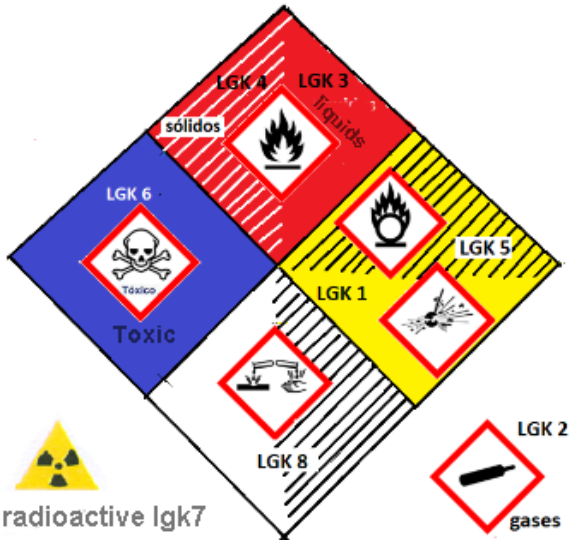

Figure 2. Diamond with GHS pictograms included.

Besides, in the NOM-018-STPS-2015[3], the presentation of the groups largely coincides with this separation (it has more divisions). Table 2 shows 23 classes of hazardous substances of the Global Harmonized System (GHS). We have added the colors of the rhombus in Figure 1left to Table 2.

The numbers corresponding to this standard (first column of the table) indicate the type of material and are included in Figure 1 (left) and indicated as LGK (for its German acronym Lagerklassen der Gefahrstoffe).

Storage Classes(LGK)	Designation
1	Explosive Substances(2nd German Explosives Act: Storage Groups 1.1-1.4)
2A	Compressed, liquefied or dissolved gases under pressure
2B	Gases packaged under pressure (aerosols)
3A	**Flammable liquids (flash point below 55 °C**
3B	**Combustible liquids (Ordinance on flammable liquids, hazard class A III)**
4.1 A	**Flammable solids(2nd German Explosives Act: Storage Groups I-III)**
4.1 B	**Sólidos inflamables(Método A 10 de la CE)**
4.2	**Sustancias inflamables de combustion espontanea**
4.3	**Substances which, in contact with water, emit flammable gases**
5.1 A	Oxidizing agents (TRGS 515 group 1)
5.2 B	Oxidizing agents (TRGS 515 groups 2+3)
5.1 C	Oxidizing agents ((TRGS 515 groups A-C)

3. Secretary of labor and social security. Official Mexican STANDARD NOM-018-STPS-2015, Harmonized system for the identification and communication of hazards and risks due to hazardous chemical substances in the workplace. (2015).

5.2	organic peroxides
6.1A	Flammable toxic compounds
6.1 B	non-flammable toxic compounds
6.2	infectious substances
7	radioactive material
8 A	**flammable corrosive compounds**
8 B	**non-flammable corrosive compounds**
10	Flammable liquids if they do not belong to storage classes LGK 3A or 3B
11	flammable solids
12	Non-flammable liquids in non-flammable containers
13	Non-flammable solids in non-flammable containers

Table 2. German System Storage Groups Illustrated (LGK)[4]

The second level of storage consists of separating incompatibles within the same class and is not part of this work. For substances in a given store, it is required to take into account Section 10 Stability and Reactivity of the SDS of all reagents present in the store. Classes with LGK from 10 to 13 are substances that we have called low risk and could be used to separate dangerous substances in a warehouse.

4. Technical rules for hazardous substances TRGS 510. Storage of hazardous substances in mobile containers. GMBl 2021 p. 178-216 [No. 9-10] (v. 16.2.2021)

REFERENCES

[1]United Nations. Globally Harmonized System of Classification and Labeling of Chemical Products (GHS). (United Nations, 2021).

[2]Secretary of labor and social security. Official Mexican STANDARD NOM-018-STPS-2000 System for the identification and communication of dangers and risks due to dangerous chemical substances in the workplace

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[4]Technical rules for hazardous substances TRGS 510. Storage of hazardous substances in mobile containers.

[5] GMBl 2021 p. 178-216 [No. 9-10] (v. 16.2.2021)