

Content-11: Common good practices in safe storage and transport of chemicals

Orientation

What can this unit help you with?

You may use this unit if you

- Have to assess the storage conditions and practices in the factory;
- Have to arrange for the safe storage of chemicals, considering their compatibility;
- Are asked to arrange for the safe transport of chemicals and waste within and outside the factory.

Intended results of the unit

- Students are capable of ensuring good practices in chemical storage;
- Students have an understanding of the safe storage practices for incompatible chemicals.
- Students can assess the storage conditions and suggest improvements for safer storage;
- Students can assess the internal and external transport practices of chemicals and waste and suggest improvements.

Input

Chemicals can have various known and unknown effects on humans, animals and the environment. Unsafe handling of hazardous chemicals can pose extreme threats to our existence.

That's why we need to be mindful about the safe handling of chemicals through every stage of storage and transportation within and outside the factory. Improperly stored and transported chemicals can be highly dangerous and can potentially cause a serious accident in storage or transport. That's why chemical storage and transportation facilities must meet certain minimum standards to ensure safe and efficient handling of chemicals to maintain the workers' health and minimise the risk of safety, health and environment. So, we need to follow some good practices that help us to avoid the fierce aspects of unsafe handling of chemicals and enable us to achieve a safer workplace which is holistic and at the same time efficient.

In our following learning cards, we will get to know the ideal storage conditions and practices in the factory, arrange for the safe storage of chemicals considering their compatibility and arrange for the safe transport of chemicals and waste within and outside the factory.



Figure 1: Safe storage and transport of chemicals. Photo source: Reed Consultancy Bangladesh. Collage courtesy: Kazi Farhan Hossain Purba.

Common causes of incidents during storage of chemicals

Before diving deep, we will know and relate to the most common causes of incidents during storage of chemicals to comprehend and figure out the necessities of ideal storage conditions and common good practices in safe storage of chemicals. The common causes of incidents are:

- Lack of awareness of the properties of dangerous substances;
- Inappropriate storage conditions with respect to the hazards of the substances;
- Inadequate design, installation or maintenance of buildings and equipment;
- Operator error, due to lack of training and other human factors;
- Exposure to heat from a nearby fire or other heat sources;
- Poor control of ignition sources, including smoking and smoking materials, hot work, electrical equipment etc.

All the incidents' causes can be rooted in the lack of following good practices and ideal storage conditions. As we know their importance, now we will have an urgency to look deeply into the good storage practices and incorporate them into our storage activities.

Safe storage of chemicals

For the safe storage of chemicals, we need to pay attention to these following areas: Structure, layout and size of the chemical store, finding the right storage space for each chemical, safe storage and handling practices and emergency provisions. We will explore these areas one by one.

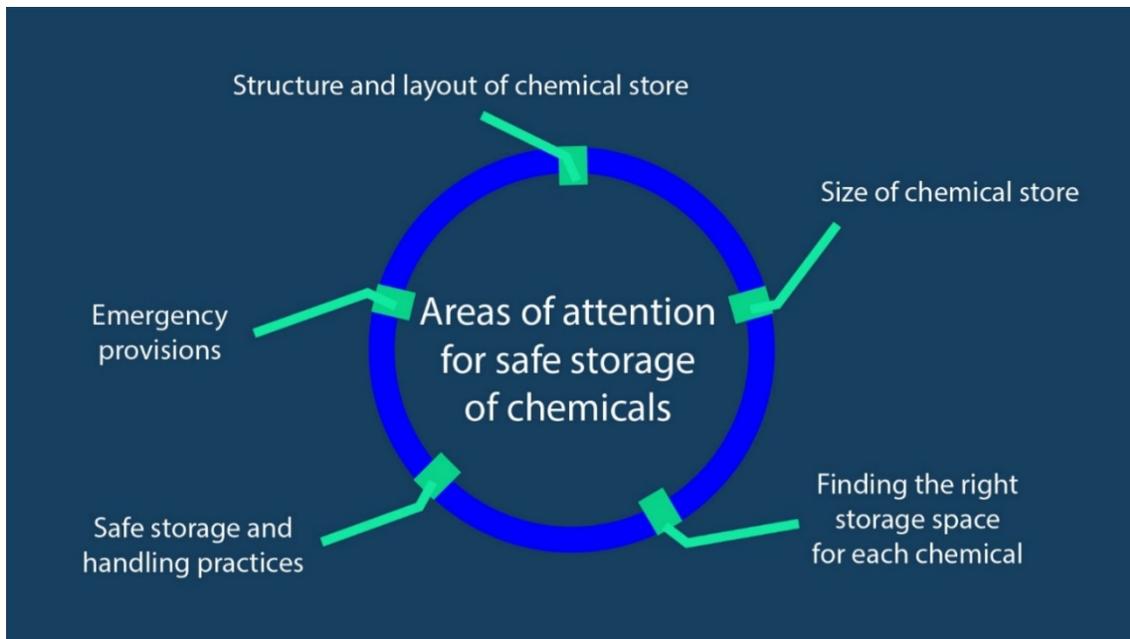


Figure 2: Areas of attention for safe storage of chemicals. Picture courtesy: Kazi Farhan Hossain Purba.

Structure, Layout and Size of Chemical Store

Adequate storage facilities are a pre-requisite for safe storage. The local regulations for specific requirements regarding the storage location, structure, fire resistance and protection facilities should be checked and followed. We need to consider the following points:

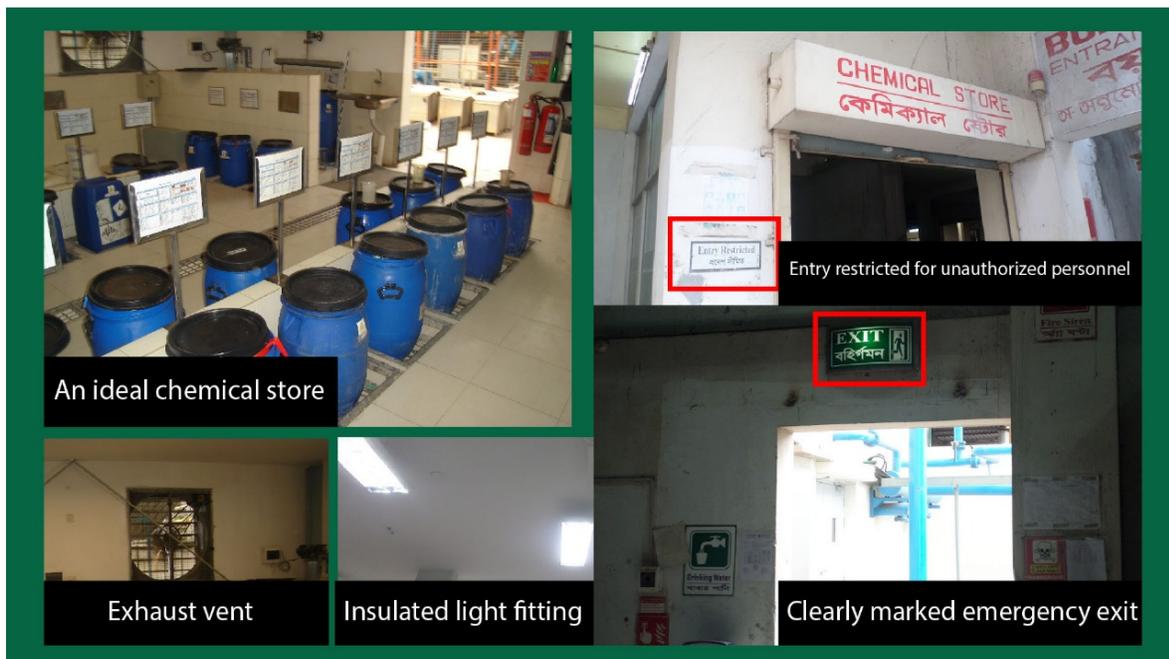


Figure 3: Safe chemical storage - Structure, layout and size of chemical store. Photo source: Reed Consultancy Bangladesh. Collated courtesy: Kazi Farhan Hossain Purba.

- Generally, it is recommended that the chemical store is physically separated from production areas, occupied building and other storage areas like raw material, semi-finished, finished products, workshops or areas with potential sources of ignition like generator, boiler, electrical transformers and control panels.
- The floor of the chemical store is flat to allow easy handling of chemical containers with trolleys, forklifts, etc. and non-permeable to prevent contamination of soil and groundwater from chemical spills.
- The store has at least separate unobstructed and clearly marked emergency exits. However, at all times, unauthorised personnel must be prevented from entering the chemical store.
- Electrical installations like switches, panels, light fittings, cables, etc. inside the chemical store, are insulated, and they should be “explosion-proof”.
- Exhaust vents at floor and ceiling level help maintain temperature and humidity at recommended levels and allow possible air contaminants like heavy and light vapours, dust, etc. to get away from the storage area.

Finding the Right Storage Space for Each Chemical

For placing the chemicals in the chemical store, we need to group chemicals according to their type and compatibility. We also need to consider that maximum permissible or recommended quantities for certain classes of chemicals are maintained.

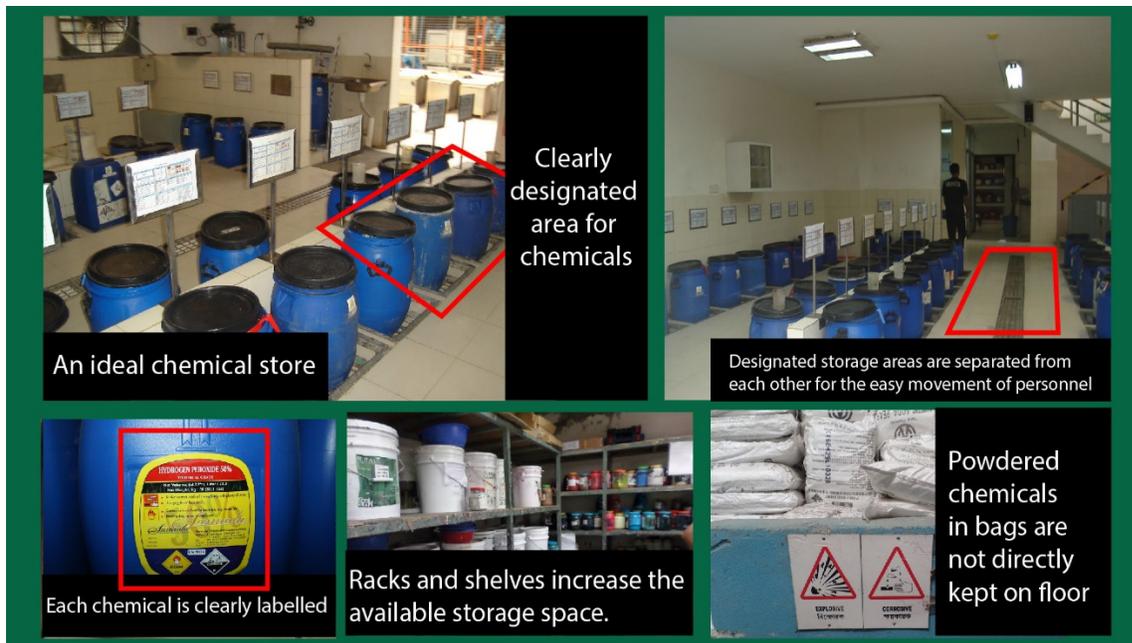


Figure 4: Finding the right storage space for each chemical. Photo source: Reed Consultancy Bangladesh. Collage credit: Kazi Farhan Hossain Purba.

We need to remember the following points:

- Different areas are clearly designated for the storage of the different chemicals;
- The designated storage areas are separated from each other to allow for easy movement of personnel and movement devices (e.g., trolley, forklift). The movement areas are clearly marked;
- We should avoid the storage of powdered chemicals which are kept in bags directly on the floor, to protect against ground humidity;
- Racks and shelves increase the available storage space. We must not have an excess quantity that exceeds the recommended structural capacity of the shelves and rack system;
- For clear identification of the chemicals, we need to ensure that each chemical container is clearly labelled ([Globally Harmonized System \(GHS\) labelling](#)). In addition, each designated chemical storage area is labelled that indicates at least the type of chemical family and hazards classification.
- Storage cabinets, if in use, are of approved quality, lockable and clearly labelled with the hazard class of the chemicals.

Checking Compatibility and Storage Classes of Chemicals

According to [Laboratory Safety for Chemistry Students](#), by Robert H. Hill and David C. Finster:

“Incompatible chemicals are combinations of substances, usually in concentrated form, that react with each other to produce very exothermic reactions that can be violent and explosive and/or can release toxic substances, usually as gases.”

So, contact between incompatible chemicals can result in a serious accident. Therefore, such contact has to be prevented through segregation, either by storing in separate areas or by structural separation like divider walls, separate storage area.

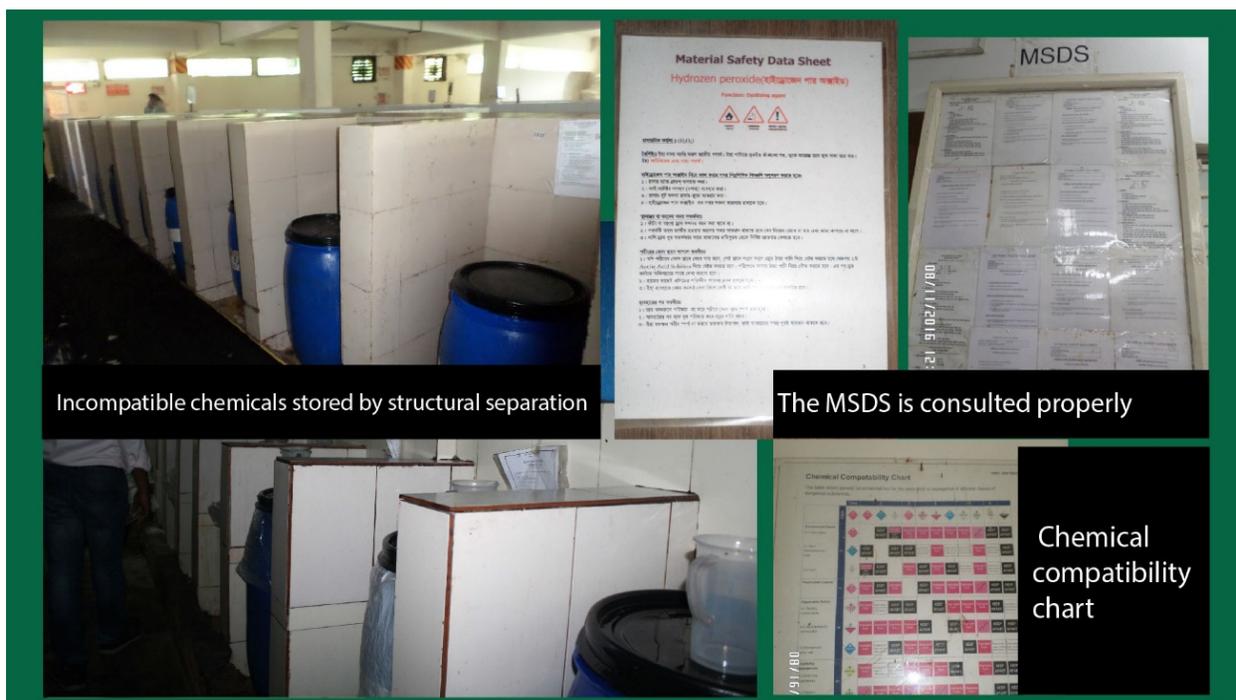


Figure 5: Checking compatibility and storage classes of chemicals. Photo source: Reed Consultancy Bangladesh. Collage credit: Kazi Farhan Hossain Purba.

To handle incompatible chemicals properly, before actually placing the chemicals in the chemical store, we need to:

- Consult chemical inventory on all chemicals to be kept in the store.
- Consult the GHS SDS (Globally Harmonized System Safety Data Sheet) section 7 about handling and storage or technical guidance sheets regarding the storage recommendations. This section contains specific guidelines for storage (e.g. temperature, humidity) and information regarding compatibility and incompatibility with other chemicals.
- Prepare a chemical storage plan.

Following Safe Storage and Handling Practices

For placing the chemicals in the chemical store, we need to group chemicals according to their type and compatibility considering some safe storage and handling practices.

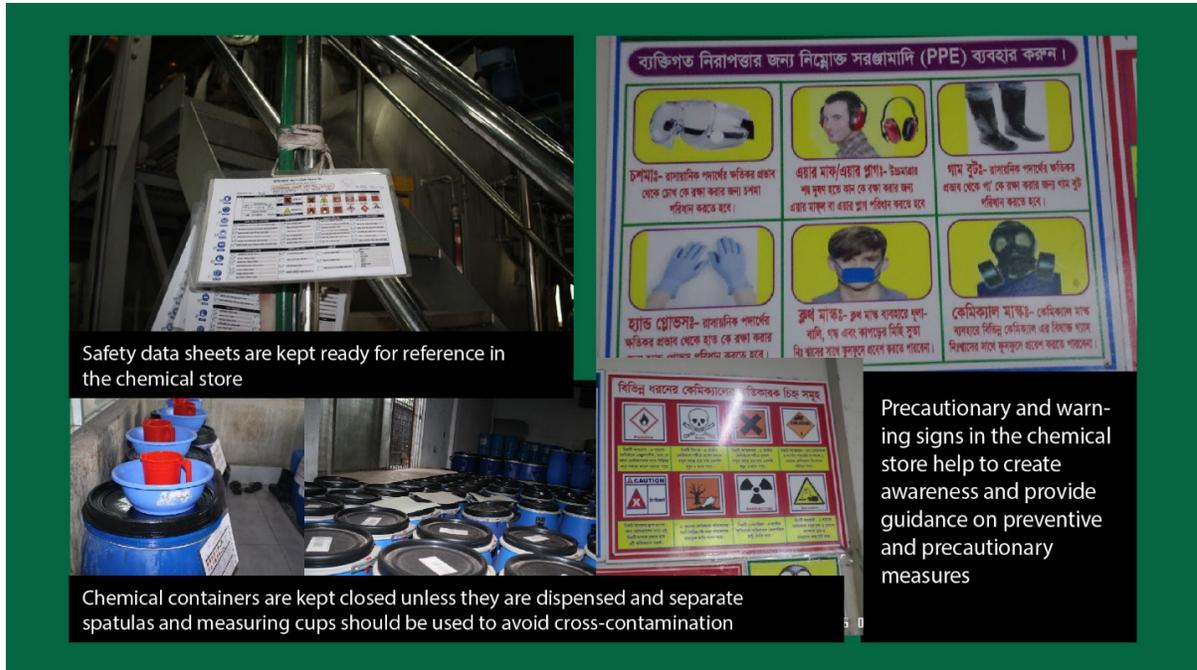


Figure 6: Following safe storage and handling practices with instructions in local language. Photo source: Reed Consultancy Bangladesh. Collage credit: Kazi Farhan Hossain Purba.

We need to remember the following points:

- No chemical containers are stored outside the designated areas or in designated passageways;
- The reference information of all chemicals stored (e.g., a set of safety data sheets) are kept for ready reference in the chemical store. In case of emergency, these provide valuable and often life-saving information to emergency personnel, like doctors and fire-fighters;
- Precautionary and warning signs in the chemical store help create awareness and guide preventive (e.g. no smoking, not eating, no open flames) and precautionary measures. (e.g. type of PPE-Personal Protective Equipment to be worn.)
- The chemical containers are kept closed unless we are dispensing a chemical;
- Separate spatulas and measuring cups should be used to avoid cross-contamination of the process chemicals.

Ensuring Emergency Provisions in the Chemical Store

Emergency provisions in the chemical store are vital because we always need to remember that safety should be our priority. As there can be dangerous chemicals in the chemical store and such areas are prone to accidents, we need to remember and ensure the following measures:

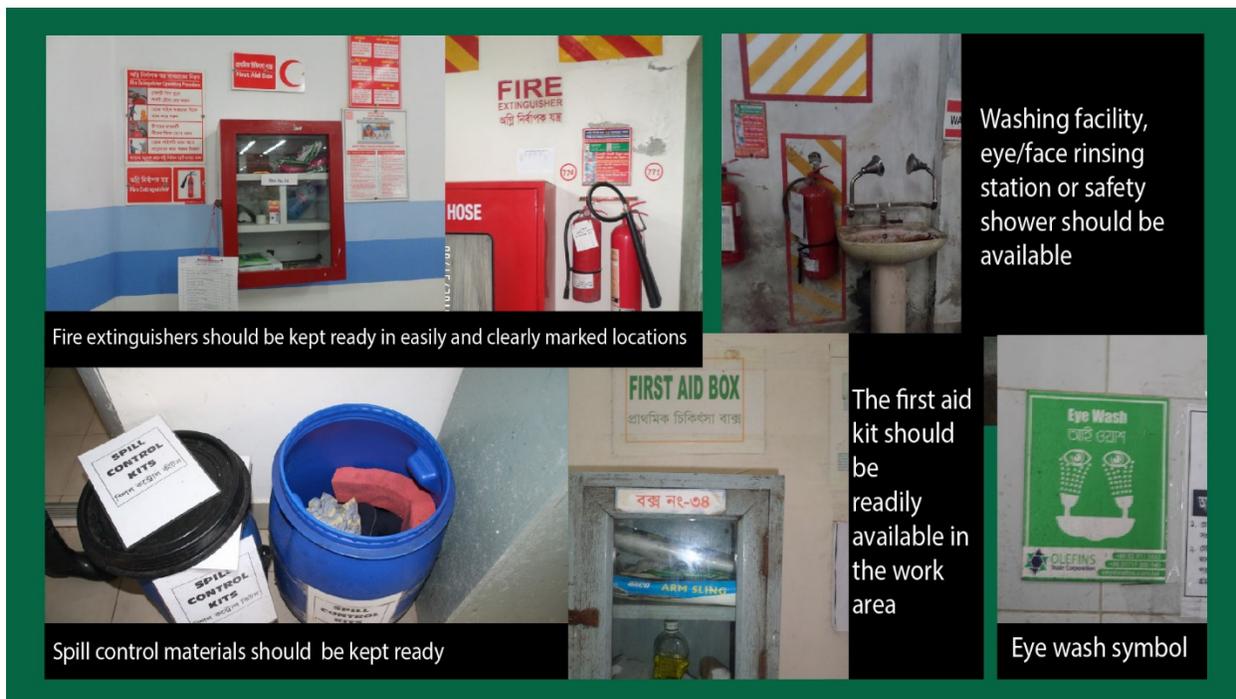


Figure 7: Ensuring emergency provisions in the chemical store. Photo source: Reed Consultancy Bangladesh. Collage credit: Kazi Farhan Hossain Purba.

- Fire extinguisher, suitable for storing chemicals checked with the safety data sheets, is kept ready in easily and clearly marked locations.
- A washing facility, eye/face rinsing station or safety shower are available in or near the chemical store for personal hygiene after handling chemicals and emergencies.
- The first aid kit is readily available in the work area. We need to check with the safety data sheet what additional items should be placed in the first aid box.
- Spill control materials like absorbent material, waste receptacles and emergency personal protective equipment are kept ready.
- In earthquake-prone areas, shelves should have raised edges or rim guards (minimum height 5 cm) to prevent containers from falling off the shelves.

Safe Chemical Transport

Having discussed the safe storage of chemicals, especially the compatibility issues, the significance of safe chemical transport is easily understandable. For the establishment of procedures and practices on the safe transport of chemicals and waste, we need to take a look at the following areas:

1. Transport of chemicals and chemical waste to/from the company;
2. Receiving and unloading of chemicals;
3. Internal transport and conveyance of chemicals and waste like transport to a warehouse, from a warehouse to production areas, within production areas, etc.

Ensuring Safe External Transport of Chemicals and Waste

External transportation means transporting chemicals to/from a company. For the safe external transportation of chemicals, in connection with the purchasing policy and practices, we need to verify the personnel and means of transport of the chemicals being delivered to the enterprise.

In case the chemicals are being delivered by the chemical supplier, we need to ensure that the purchase order includes a clause demanding that the supplier meets the national regulations outlining the requirements for the safe transport of dangerous/hazardous goods.

Here are some aspects to consider for safe external transport:

- Making and labelling of packages during transportation;
- Vehicle requirements, such as transport documents, transport, emergency provisions, qualification of drivers (e.g., special license, training) ;
- Loading requirements about quantity, mixing with other loads considering the compatibility issues.

Ensuring Safe Internal Transport of Chemicals and Waste

Internal transport of chemicals means transport to warehouse, from warehouse to production areas, within production areas, etc.

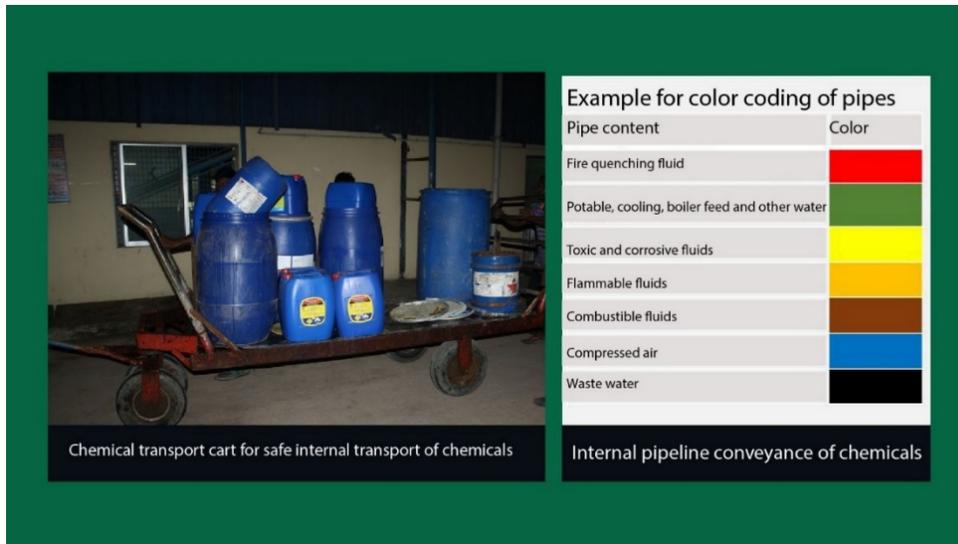


Figure 8: Internal transport of chemicals and waste, Photo source: Reed Consultancy Bangladesh. The example of colour coding of pipes is adapted from Resource Efficient Management of Chemicals (REMC) Company Handbook GIZ. Collage credit: Kazi Farhan Hossain Purba.

To arrange safe internal transport and conveyance of chemicals and waste, we need to be aware of certain points so that everything goes smoothly and no mishaps happen. During the loading of containers and cylinders, we must ensure that valves and connections are not damaged. We have to take adequate precautions to prevent overloading heavy manual loads from falling off the vehicle and ensure smooth and wide enough passageways to avoid excessive shocks or local stress on containers. Carts, trolleys, and other simple transport devices should be provided for internal transportation as we can avoid accidents and spillage that can easily occur during manual carrying. We have to equip forklifts with a fire extinguisher and an electrically conductive strip for earthing static electricity.

For internal pipeline conveyance of chemicals, we could fix an established colour-coding system for everybody in the factory to identify the contents in the respective pipe. Failure to correctly identify a pipework system's service can often cause plant upsets and safety incidents. So, the colour-coding system, like the above picture, recognised by all the responsible people in the factory, can decrease casualties.

Conclusion

By following the good practices of chemical storage and transport, we can cut down and prevent many unwanted circumstances and keep our stored chemicals' integrity for a longer

period which will bring greater well-being to the people and the planet, at the same time, increase our profit.

Didactical elements

Quizzes and self-tests:

True-false

1	The floor of the chemical store is permeable to prevent contamination of soil and ground-water from chemical spills.	
	<ul style="list-style-type: none">▪ Correct▪ False	False
2	Floor markings help in better storage organisation and easier movement.	
	<ul style="list-style-type: none">▪ Correct▪ False	Correct
3	Well ventilated storage areas are needed to reduce the accumulation of dust or vapours and control temperature and humidity.	
	<ul style="list-style-type: none">▪ Correct▪ False	Correct
4	The chemical containers are kept closed unless we are dispensing a chemical.	
	<ul style="list-style-type: none">▪ Correct▪ False	Correct
5	External transport of chemicals means transport to warehouse, from warehouse to production areas, within production areas, etc.	
	<ul style="list-style-type: none">▪ Correct▪ False	False
6	Trolleys, forklifts and pipeline conveyors are used in external chemical transport.	
	<ul style="list-style-type: none">▪ Correct▪ False	False

Open Questions:

1	Why do you think it is necessary to adopt common good practices in chemical storage?	
	<i>Open text</i>	<p>Good chemical storage practices cover all the activities related to awareness building among the workers about the properties of the dangerous substances, their safe storage, storage conditions and the ways to prevent and handle unwanted circumstances. Without good practices, improper storage of the incompatible and dangerous substances, inappropriate storage conditions with respect to the hazards of the substances can cause massive accidents. That's why it is very important to adopt common good practices in chemical storage.</p>
2	Why do you think it is necessary to label each chemical container clearly?	
	<i>Open text</i>	<p>For clear identification of the chemicals, we need to make sure that each chemical container is clearly labelled. Also, each designated chemical storage area is labelled, indicating at least the type of chemical family and hazards classification. Thus we can avoid accidental contact between incompatible chemicals which can otherwise result in fire, explosion and/or formation of highly toxic mixtures. We can identify each chemical and prevent the incompatible ones from contact through segregation by proper labeling, either by storing in separate areas or by structural separation like divider walls, separate storage area.</p>
3	Why should we establish a standard colour coding system for pipeline chemical conveyance in the factory?	

	<i>Open text</i>	By establishing a standard colour coding system for pipeline conveyance, we can clearly identify what the respective pipe may contain. Failure to correctly identify the service of a pipework system can and often is the cause of plant upsets and safety incidents. So by maintaining a standard convention of colour-coding, we can avoid a lot of unwanted accidents.
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Choose multiple:

1	What can be the qualifications of a driver responsible for external chemical transport? (Choose multiple)	
	<ul style="list-style-type: none"> ▪ A degree in chemistry. ▪ Special license for chemical transport ▪ Special training for chemical transport ▪ Expertise in chemical storage and waste management 	<p>Answer:</p> <ul style="list-style-type: none"> ▪ Special license for chemical transport ▪ Special training for chemical transport

Sorting tasks:

Sort the words to the correct sentences:

No	raised	unless
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1. ___chemical containers are stored outside the designated areas or in designated passageways.
2. The chemical containers are kept closed ___we are dispensing a chemical.
3. In earthquake-prone areas, shelves should have ___ edges or rim guards

Answers:

1. No
2. Unless
3. raised

Exercise-2: Imagine the situation below and take action for the mentioned company:

Nilgiri, a tier two textile factory, has a busy external and internal chemical transportation system. The factory faces casualties frequently for the indifference to handle chemicals properly during internal chemical transportation. The factory also has no concern about allowing the unloading of the imported chemicals coming from different suppliers that have no convention of labelling the packages properly, which are often mixed with other incompatible chemical loads. The workers in the factory always feel that the system could be improved to subdue the number of accidents at their factory premises. But for the interest of keeping costs down through cutting corners on safety and avoiding regulation, the factory is not currently focusing on the safe transport of chemicals. For the company, you have to do the following tasks:

- Demonstrate the factory why they need good practices in a chemical transportation system.
- Find out the possible root causes responsible for the casualties happening in the factory.
- Prepare an action plan for safe internal and external transport of chemicals for the factory.

Hotspots

In which photo you can see designated storage areas are separated from each other to allow easy movement of personnel and movement devices?

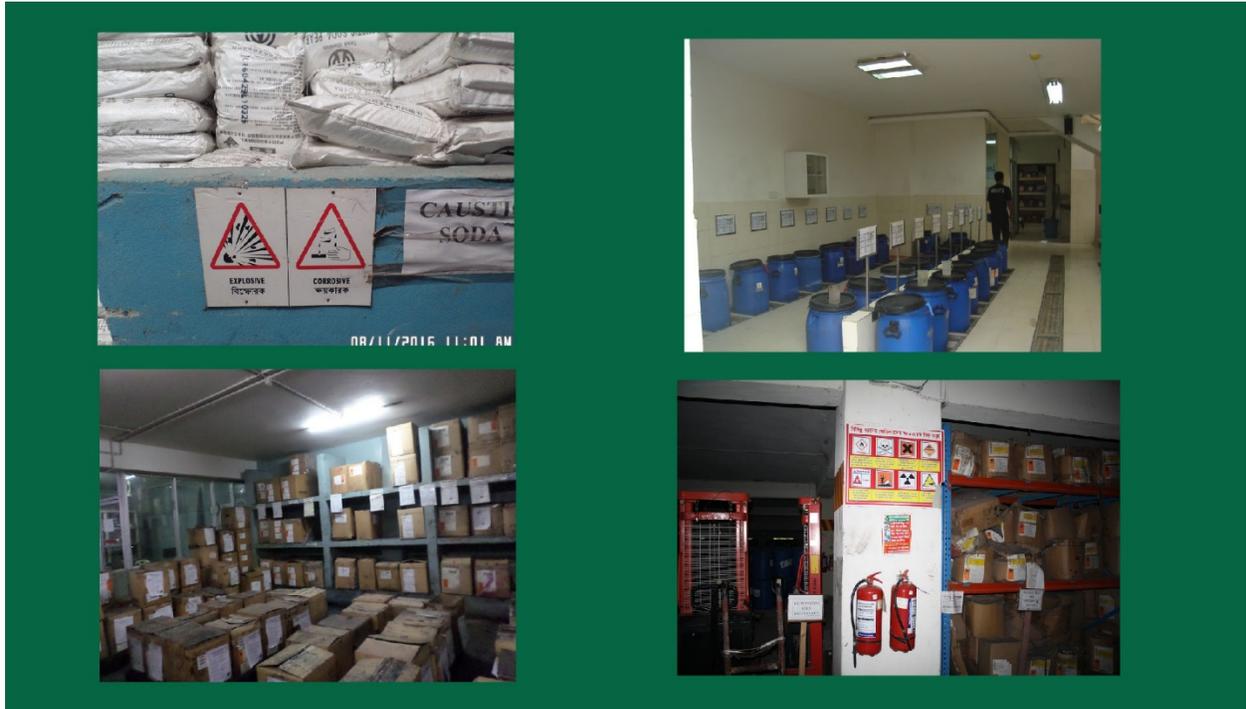


Photo source: Reed Consultancy Bangladesh. Collage credit: Kazi Farhan Hossain Purba.

Answer:



References/additional literature/links

1. Resource Efficient Management of Chemicals (REMC), Promotion of Social and Environmental Standards in the Textile Industry, GIZ Dhaka. Available in <https://www.sia-tool-box.net/solution/resource-efficient-management-chemicals-textile-and-leather-sector-companies>
2. More information on the storage of packaged dangerous goods can be found here: <https://www.hse.gov.uk/pubns/priced/hsg71.pdf> . It reflects good practice for the design of new storage facilities -and where reasonably practicable, to existing sites- and applies to transit or distribution warehouses, open-air storage compounds, and facilities associated with a chemical production site or end user.
3. More information on the guideline for good practices for the storage of chemicals can be found here: https://www.asecos.com/dokumente/Guidelines-for-Good-Practice_Storage-of-Chemicals.pdf. This is a short PDF that provides information on risks related to the storage of chemicals and gives advice on appropriate precautions.
4. To know more about the Globally Harmonized System (GHS) of classification and labelling of chemicals, you can visit this link: <https://www.osha.gov/dsg/hazcom/ghs-guideoct05.pdf>
5. More information about incompatible chemicals can be found here: <https://www.acs.org/content/acs/en/chemical-safety/basics/incompatible-chemicals.html>
6. To know more about the carriage of dangerous goods, you can visit this link: <https://www.hse.gov.uk/cdg/introduction.htm>

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If you wish you can give us feedback on the learning unit here. This is of course, optional.

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How did the technical elements of the unit work for you? Did you have any difficulties?

Didactical Elements

How did the didactical structure of the learning unit work for you? Do you have any comments or suggestions to make it better?

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