

## Best Practices for Storing Corrosives

This article will focus on best practices for storing corrosive materials. But let's start by discussing what we mean by corrosives. Corrosive substances are chemicals that cause a reaction that lead to the damage of a solid structure. When we think of corrosive materials we generally think of acids and bases. In fact, the EPA classification for a corrosive chemical is based on two environmental criteria – it must have a pH less than or equal to 2 (corresponding to a 0.01M solution of a strong acid) or greater than or equal to 12.5 or alternatively it must have the ability to corrode steel at a certain rate. OSHA similarly defines what a corrosive is, but within its classification it also includes substances that can cause destruction of skin tissue (usually be denaturing the proteins in cells causing cell death). So, in addition to your strong acids and bases, concentrated weak acids and other substances are considered corrosives.

Corrosive chemicals often have several hazards associated with them. Generally corrosives are toxic and may also be flammable. Concentrated aqueous acids and some non-aqueous liquid acids are significantly oxidizing: nitric, perchloric and chromic, for example. Acids can also be water reactive such as oxalyl chloride, sulfuric acid and chlorosulfonic acid. Some water reactives have a pressure build-up hazard. When assessing your chemical storage all of the hazards associated with a chemical need to be considered in order to choose the safest location for it.

### Where to Store Corrosives

Corrosives need their own space, but where is the best place to store them? What can and can't be stored together? First let's start with where to store them. Here are some general considerations:

- Cabinets and shelves should be sturdy and low to the floor and should be constructed of material that is impervious (i.e. non-reactive) with the corrosive. They should also be ventilated or located near the ventilation system.
- You should next consider secondary containment or spill trays (such as a plastic bin). They can be used in situations where special storage considerations are needed (e.g. glacial acetic acid should be stored in a flammables cabinet but should also be kept in secondary containment in case of a spill). The secondary containment should be big enough to contain the spill of the largest container stored in it.
- The third consideration is the ventilation of vapors that may escape a container. Although a cap on an acid or base is tightly sealed, over time vapors can slip from the cap of a closed container. The result of this process can be seen in the form of crystals that form on the caps of chemical bottles.

The cabinet under the sink are used for storing cleaning liquids and supplies. **NEVER** store chemicals under the sink, especially corrosives. The vapors of volatile acids and bases will cause corrosion of the

plumbing fixtures under the sink. Also, some chemicals, including many corrosives, are water reactive and in the event of a water leak there can be unanticipated and unfortunate consequences.

### How to Store your Corrosives

It is well known that acids and bases are not compatible and that they will react if they come in contact. This could happen if a bottle of acid and a bottle of base were to both fall off of a shelf and break in the same place. This reaction would cause heat and splatter or a toxic cloud generation and in some cases, a fire. For this reason, acids and bases should be separated by a sufficient distance. But incompatibilities are not limited to acid and base reactions, as we will see below.

#### Step 1: Start with the Bases

Look through your chemicals identifying and separating your acids from your bases. All strong bases, such as sodium hydroxide, potassium hydroxide, lithium hydroxide or ammonium hydroxide should be stored in a dedicated corrosive chemicals cabinet that is coated with caustic-resistant material. Many amines, while considered corrosive are weak bases and are flammable and should be stored in a flammables cabinet, though it may need to be ventilated to reduce odor.

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*It was pointed out that acids and bases are not compatible and can generate significant heat when mixed. Estimated peak temperatures for some acid-base combinations (if mixed in a container as opposed to on the floor) are provided in the table below to illustrate this effect.*

Heat Generated by Acid/Base Combinations:				
	15M NH <sub>3</sub>	6M OH <sup>(-)</sup>	18M OH <sup>(-)</sup>	Et <sub>3</sub> N:
12 HCL	89°C	53°C	96°C	80°C
Formic Acid	127°C	65°C	142°C	220°C
Sulfuric Acid	263°C	128°C	298°C	368°C
Acetyl Chloride	219°C	111°C	246°C	455°C

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#### Step 2: Separate Out Your Organic Acids:

Within acidic chemicals there is more separation to be done. First, consider your organic acids and acid chlorides. Concentrated organic acids – such as formic, acetic, propionic and butyric acids – are corrosive with the first three considered flammable. These are best stored in a flammables cabinet. [Important note: This does not apply to halogenated chemicals like trifluoroacetic or trichloroacetic acids which are non-flammable.]

Similarly acid chlorides (such as acetic chloride) tend to be flammable and have the added hazard of being reactive with water – and potentially violently so – while releasing HCL vapors. Again, a flammable liquids storage cabinet is appropriate but these need to be separated from amines. There are other corrosives, such as dichlordimethylsilane, that also fall into the category of being both flammable and water reactive and should be stored in the flammables cabinet. Check your Safety Data Sheets carefully.

### Step 3: Sort the Remaining Acids

With your remaining acids you should separate these into four categories:

**Water Reactive – Oxidizing** (These are rare but an example is Bromine Pentafluoride)

**Water Reactive – Reducing** (such as Phosphorus (III) chloride)

**Aqueous – Oxidizing** (such as Nitric and Perchloric acid)

**Aqueous – Reducing** (Hydrobromic, Trichloroacetic, Formic)

While each of these can be stored in the same cabinet they should be placed into separate secondary bins. The table below will help you sort some of the common acids into the appropriate categories and provides added storage notes. The table also indicates if the acid is volatile. Acid vapors will eventually lead to the corrosion of metal fixtures, storage cabinets and shelves. When storing volatile chemicals you should be aware of this reaction and ensure the area is well ventilated.

### Common strong acids and their vital characteristics:

Acid	Aq/W	Ox/Red	*Volatile	Added Note
Sulfuric >95%	W	---	---	Best stored in a secondary container. Reacts with aqueous acids.
Nitric 67% aqu	Aq	Ox	yes	Reactive when in contact with combustibles and flammables.
Perchloric 60-70%	Aq	Ox	---	Can be explosive if mixed with organic acids. Perchloric Acid will corrode wooden shelves leading to the formation of explosive cellulose perchlorates.
Hydrofluoric 50%	Aq	---	yes	Reacts with glass. Toxic!
Hydrobromic 48%	Aq	Red	yes	
Trichloroacetic	Aq	Organic	---	As 100% w/v, 6 Molar
Hydrochloric 36%	Aq	---	yes	Generates chlorine from reaction with H <sub>2</sub> O <sub>2</sub>
Phosphoric 85%	---	---	---	Not a strong acid; compatible with most acids.
CF <sub>3</sub> SO <sub>3</sub> H	W	---	yes	Similar properties as sulfuric acid
Trifluoroacetic	---	Organic	yes	Reaction only with strong oxidizers
Formic ~90%	Aq	Red	yes	decomposes to CO + H <sub>2</sub> O
Phosphorus (III) chloride	W	Red	yes	Can produce phosphine with water reaction
Dichlordimethylsilane	W	Organic	yes	pressurizes with HCl gas if moisture gets in.

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