Learning Objective

• List various cleaners and their modes of action.

All-Purpose Cleaners

All-purpose cleansers (Figure \(\PageIndex{1}\)) contain mixtures of anionic and nonionic surfactants, polymeric phosphates or other sequestering agents, solvents, hydrotropic substances, polymeric compounds, corrosion inhibitors, skin-protective agents, and sometimes perfumes and colorants.[7] Aversive agents, such as denatonium, are occasionally added to cleaning products to discourage animals and small children from consuming them.

Figure \(\PageIndex{1}\)

Fabuloso multipurpose cleaner and generic surface cleaners.


Some cleaners contain water-soluble organic solvents like glycol ethers and fatty alcohols, which ease the removal of oil, fat and paint. Disinfectant additives include quaternary ammonium compounds, phenol derivatives, terpene alcohols (pine oil), aldehydes, and aldehyde-amine condensation products.

All-purpose cleaners are usually concentrated solutions of surfactants and water softeners, which enhance the behavior of surfactant in hard water. Typical surfactants are alkylbenzenesulfonates, an anionic detergent, and modified fatty alcohols. A typical water softener is sodium triphosphate.

All-purpose cleansers are effective with most common kinds of dirt. Their dilute solutions are neutral or weakly alkaline, and are safe for use on most surfaces.

**Acidic cleaning agents** are mainly used for removal of inorganic deposits like scaling. The active ingredients are normally strong mineral acids and chelants. Often, surfactants and corrosion inhibitors are added to the acid.

Hydrochloric acid is a common mineral acid typically used for concrete. Vinegar can also be used to clean hard surfaces and remove calcium deposits that also helps to maintain our environment bacteria free. Sulphuric acid is used in acidic drain cleaners to unblock clogged pipes by dissolving greases, proteins, and even carbohydrate-containing substances.
such as toilet tissue.

**Alkaline cleaning agents** contain strong bases like sodium hydroxide or potassium hydroxide. Bleach (pH 12) and ammonia (pH 11) are common alkaline cleaning agents. Often, dispersants, to prevent redeposition of dissolved dirt, and chelants, to attack rust, are added to the alkaline agent.

Alkaline cleaners can dissolve fats (including grease), oils, and protein-based substances.

**Neutral washing agents** are pH-neutral and based on non-ionic surfactants that disperse different types

**Degreasers** are cleaning agents specially made for removal of grease. These may be solvent-based or solvent-containing and metamorphic.

### Special Purpose Cleaners

Traditional **oven cleaners** contain sodium hydroxide (lye), solvents, and other ingredients, and work best when used in a slightly-warm (not hot) oven. If used in a self-cleaning oven, the lye will cause permanent damage to the oven.

New-style oven cleaners are based on ingredients other than lye. These products must be used in a cold oven. Most new-style oven cleaners can be used in self-cleaning ovens.

Oven cleaners are some of the most toxic household cleaning products available on the market. Correct use of an oven cleaner may be reasonably safe, but incorrect use can have harmful effects.

One popular oven cleaner brand in the US is “Easy-Off”, sold by Reckitt Benckiser. Popular choices in the UK include “Zep Oven Brite” and “Mr Muscle Oven Cleaner”.

**Toilet bowl cleaning agents** are aimed at removal of calcium carbonate deposits, which are attacked by acids. Powdered cleaners contain acids that come in the form of solid salts, such as sodium hydrogen sulfate. Liquid toilet bowl cleaners contain other acids, typically dilute hydrochloric, phosphoric, or formic acids. These convert the calcium carbonate into salts that are soluble in water or are easily rinsed away.

**Chemical drain cleaners** can be in solid or liquid form that are readily available through hardware stores, though some (primarily acidic ones) are intended for use by licensed plumbers. Alkaline drain cleaners are available in either solid or liquid state while the acidic ones are usually in liquid form.

- Alkaline drain openers primarily contain sodium hydroxide (lye) and some may contain potassium hydroxide. They
may appear in liquid or solid form. Solid formulations of corrosive alkaline drain cleaners are composed of a caustic substance (often sodium hydroxide or potassium hydroxide), aluminum particles, and 'additives.' These additives often include wetting agents such as alkyl aryl sulfonates, but the exact nature of these additives are not known for commercial drain cleaners, as they are regarded as the trade secrets that make each drain cleaner unique to its brand.

The aluminum granules that are included in the solid caustic drain cleaner is an aluminum oxide that breaks down and re-oxidizes to release hydrogen gas. The components of this reaction are shown below. Because the release of hydrogen gas is overall an exothermic reaction, the extra heat released helps to break down the greases, oils, etc. that form the clog.

1. Breakdown of Aluminum Oxide: $\text{Al}_2\text{O}_3 + 2\text{NaOH} + 3\text{H}_2\text{O} \rightarrow 2\text{Na}[\text{Al(OH)}_4]$

2. Oxidation of Aluminum metal: $2\text{Al} + 2\text{NaOH} + 6\text{H}_2\text{O} \rightarrow 2\text{Na}[\text{Al(OH)}_4] + 3\text{H}_2$

The actual breakdown of a clog occurs by reaction with the hydroxide ions (-OH) generated by the cleaner. Clogs are often composed of natural substances such as hair, fats, oils, etc. and breakdown occurs via a saponification reaction of a base and triglycerol. Essentially, the hydroxide ions from the dissolution of lye in water attack the carbonyl carbons of the fat, which eventually kicks off the hydrophobic tails of the triglyceride (e.g. glyceryl trioleate) to isolate glycerol and a fatty acid salt.

Alkaline drain openers can dissolve hair (containing proteins) and fats inside pipes via alkaline hydrolysis of amide and ester functionalities respectively:

$$\text{RCONH}_2(\text{amide or proteins}) + \text{OH}^- \rightarrow \text{NH}_3 + \text{RCOO}^-$$

$$\text{RCO}_2\text{R'}(\text{ester or fats}) + \text{OH}^- \rightarrow \text{R'OH} + \text{RCOO}^-$$

- **Acidic drain openers** (in very high concentrations) hydrolyze proteins and fats via acid hydrolysis, similar to their alkaline versions mentioned above:

$$\text{RCONH}_2(\text{amide or proteins}) + \text{H}_3\text{O}^+ \rightarrow \text{NH}_4^+ + \text{RCOOH}$$

$$\text{RCO}_2\text{R'}(\text{ester or fats}) + \text{H}_2\text{O} + \text{H}_2\text{SO}_4 \rightarrow \text{RCO}_2\text{H} + \text{R'OH}$$

Apart from grease and hair, an acidic drain cleaner containing sulfuric acid can be also used to dissolve tissue paper inside water pipes.
Concentrated sulfuric acid dehydrates substances containing carbohydrates, like tissue paper which consists of cellulose:

\[(\text{C}_6\text{H}_{10}\text{O}_5)_n + \text{H}_2\text{SO}_4 \rightarrow 6n \text{ C} + 5n \text{ H}_2\text{O}\]

- **Enzymatic drain cleaners** contain either bacteria or concentrated enzymes that degrade the organic residue that builds up on sewer pipes to help prevent slow-running drains. Most enzymatic drain cleaners are intended for general maintenance to maintain proper flow and are not intended to clear fully clogged drain pipes.[citation needed]

Advantages of enzymatic drain cleaners include relative safety for use in a wide range of plumbing fixtures, low environmental impact, low cost and ease of use.

Disadvantages of most enzymatic drain cleaners include longer cleaning times compared to most other drain cleaners. Because enzymatic cleaners rely on liquid flowing through the pipe to disperse, they are also generally not intended to open completely clogged drains.

Safety considerations for enzymatic drain cleaners include a requirement to avoid contact with eyes and prolonged contact with skin.

**Metal cleaners** are used for cleaning stainless steel sinks, faucets, metal trim, silverware, etc. These products contain abrasives (e.g., siliceous chalk, diatomaceous earth, alumina) with a particle size < 20 μm. Fatty alcohol or alkylphenol polyglycol ethers with 7-12 ethylene oxide (EO) units are used as surfactants.[7]

For ferrous metals, the cleaners contain chelating agents, abrasives, and surfactants. These agents include citric and phosphoric acids, which are nonaggressive. Surfactants are usually modified fatty alcohols. Silver cleaning is a specialty since silver is noble but tends to tarnish via formation of black silver sulfide, which is removable via silver-specific complexants such as thiourea.

Stainless steel, nickel, and chromium cleaners contain lactic, citric, or phosphoric acid. A solvent (mineral spirits) may be added.

Nonferrous metal cleaners contain ammonia, ammonium soaps (ammonium oleate, stearate) and chelating agents (ammonium citrate, oxalate).

**Scouring agents** are mixtures of the usual cleaning chemicals (surfactants, water softeners) as well as abrasive powders. The abrasive powder must be of a uniform particle size.

Particles are usually smaller than 0.05 mm. Pumice, calcium carbonate (limestone, chalk, dolomite), kaolinite, quartz, soapstone or talc are often used as abrasives, i.e. polishing agents.

Special bleaching powders contain compounds that release sodium hypochlorite, the classical household bleaching agent. These precursor agents include trichloroisocyanuric acid and mixtures of sodium hypochlorite (“chlorinated orthophosphate”).

Examples of notable products include: Ajax, Bar Keepers Friend, Bon Ami, Comet, Vim, Zud, and others.
Glass cleaners. Light duty hard surface cleaners are not intended to handle heavy dirt and grease. Because these products are expected to clean without rinsing and result in a streak-free shine, they contain no salts. Typical window cleaning items consist of alcohols, either ethanol or isopropanol, and surfactants for dissolving grease. Other components include small amounts of ammonia as well as dyes and perfumes.

These are composed of organic, water-miscible solvent such as isopropyl alcohol and an alkaline detergent. Some glass cleaners also contain a fine, mild abrasive. Most glass cleaners are available as sprays or liquid. They are sprayed directly onto windows, mirrors and other glass surfaces or applied on with a soft cloth and rubbed off using a soft, lint-free duster. A glass cloth ideal for the purpose and soft water to which some methylated spirit or vinegar is added which is an inexpensive glass cleaner.

Silverware can be freed of silver sulfide tarnish with thiourea, and either hydrochloric or sulfuric acid.

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**Green Cleaners**

Green cleaning refers to using cleaning methods and products with environmentally friendly ingredients and procedures which are designed to preserve human health and environmental quality.[1] Green cleaning techniques and products avoid the use of products which contain toxic chemicals, some of which emit volatile organic compounds causing respiratory, dermatological and other conditions.[2] Green cleaning can also describe the way residential and industrial cleaning products are manufactured, packaged and distributed. If the manufacturing process is environmentally friendly and the products are biodegradable, then the term "green" or "eco-friendly" may apply.

Common household ingredients that are safe to use on its own or in combination for a variety of cleaning applications include baking soda, soap, alcohol, cornstarch, lemon juice, white vinegar, citrus solvent, washing soda (SAL soda or sodium carbonate), oxygen bleach, vegetable oil, and hydrogen peroxide. The links below provide information on safe ingredients for homemade substitutions and homemade cleaning products.

[https://learn.eartheasy.com/guides/non-toxic-home-cleaning/#homecleaning](https://learn.eartheasy.com/guides/non-toxic-home-cleaning/#homecleaning)

Hazards of Using and Mixing Cleaners

Danger arises from chemical drain cleaners' potential to injure eyes, lungs, and skin; and damage to clothing and household materials such as wood, paint, aluminum, and fiberglass. Chemical drain cleaners should be used only according to the manufacturer's instructions, as other use may cause injury.[7] Strongly corrosive and acid drain cleaners are among the most hazardous household products available to the public. Chemical drain cleaners can cause strong reactions—sometimes explosively—with other chemicals that may have been used previously, which can result in serious injury to anyone in the vicinity.[8] In one such incident, a five-year-old boy was left scarred for life after an acidic drain cleaner leaked through his bedroom ceiling as he slept.[9]

Strong Alkali Drain cleaners are equally capable of causing rapid, severe burns, as seen in the cases of a woman doused with concentrated lye in an attack. A small girl was also permanently disfigured by a common lye drain opener.[10][11] Moreover, because the acidic or basic drain cleaners themselves are washed down the drain, this contributes to pollution in the water supply. The heat generation can also soften plastic PVC pipes, and the pressure
buildup by gas generation can cause older pipes to burst. Commercial chemical based solutions can cause corrosion and other damage to your pipes and sewer lines[12]

Oftentimes, individuals may unknowingly mix two different types of drain cleaners, which can even lead to deadly results. For example, consider the mixing of an acidic and basic drain cleaner:

Sulfuric Acid + Sodium Hydroxide $\rightarrow$ sodium sulfate (a salt) + water

\[ \text{H}_2\text{SO}_4 + 2 \text{NaOH} \rightarrow \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O} \]

The neutralization reaction of the acid and base may seem harmless, but in reality this reaction is extremely exothermic and can cause pipes to violently explode. Consider another example of mixing, this time between an acid drain cleaner and bleach:

Hydrochloric acid + bleach $\rightarrow$ water + table salt + chlorine gas

\[ 2\text{HCl} + \text{NaClO} \rightarrow \text{H}_2\text{O} + \text{NaCl} + \text{Cl}_2 \]

This reaction generates chlorine gas, which is toxic to the lungs.

**Summary**

- All-purpose cleansers are effective with most common kinds of dirt and are formulated to contain mixtures of surfactants, sequestering agents, solvents, hydrotropic substances, polymeric compounds, corrosion inhibitors, skin-protective agents, and sometimes perfumes and colorants.

- Special purpose cleaners are formulated with specific chemicals to effectively remove dirt, grime or stain from a particular surface (e.g. glass cleaner, metal cleaner, etc.) or appliance (e.g. oven cleaner).

- Green cleaners are gaining popularity among environmentalists who are interested in using cleaners that are made of biodegradable and eco-friendly ingredients.

**Sources**

Wikipedia


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