JANGRO

Guide to **pH Scale and Cleaning Agents**

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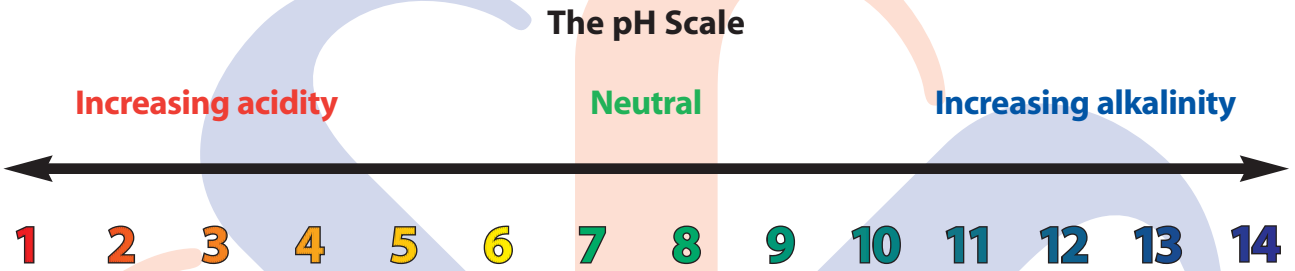
pH Scale

Introduction

The pH Scale is a means of measuring the degree of acidity or alkalinity of a cleaning agent or solution, in simple, easy-to-understand, numeric terms. The scale itself has a range of 0-14, with 0 being the most acidic and 14 being the most alkaline. The mid-point on the scale is 7 and is classed as neutral and this corresponds with the pH measurement for distilled water.



The colours indicated on the chart are illustrative of the colours that would be indicated following a litmus test.

Acidic Products

When a pH value of a product or solution decreases below 7, its acidity will start to increase. Most acid based cleaning materials will have a typical pH value of between 0.5 and 5 on the scale. Concentrated pure acids will have a pH value of approximately 0.1, though these would never be used as cleaning as cleaning agents.

Acidic products are most commonly used to remove limescale deposits from hard surfaces as they will dissolve salts that are not soluble in water.

Alkaline Products

As you can see from the chart, if the pH value rises above 7, the product or solution will become more alkaline. Alkaline products are particularly effective in removing greasy and fatty deposits from hard surfaces. They will typically have a pH value of between 11 and 12.5.

Stronger alkaline products such as emulsion floor polish strippers will have a value of around 13. Caustic soda, which is extremely corrosive, will have a pH value of 14.

Neutral Products

As we have pointed out earlier, the pH of distilled water is 7 which is taken as being the purest neutral solution. However, in reality, any product or solution with a pH value of between 6 and 9 is generally considered to be neutral.

Neutral products are commonly used for general cleaning procedures and include washing-up liquid and carpet cleaning solution.

How is the pH Value Tested?

The approximate pH value of any liquid product or solution can be tested using Universal Indicator Paper, a type of litmus paper you may remember from science lessons in your schooldays.

After being dipped into a solution the colour of the paper will change. The colour of the paper can then be compared with a colour chart, the colour corresponding to the relevant value on the scale. The colours are illustrated in the chart at the head of this section.

Cleaning Agents

Introduction

In this section we will be looking at how cleaning agents work and examining the range of different categories of cleaning agents, each of which performs a specific role in the overall cleaning regime.

It is fair to say that there is a seemingly endless array of cleaning agents available on the market. The Jangro catalogue alone contains over 130 separate products that can be applied to a vast range of cleaning tasks. Apart from water, which is considered to be a cleaning agent on its own, most cleaning products fall into one of the following categories:

- Detergents
- Abrasives
- Degreasers
- Acid Cleaners
- Organic Solvents
- Bio-Enzyme Cleaners
- Oxygen Cleaners

We will look at each of these a little later in the section. Before we do so we will take a look at the origins of detergents.

Synthetic Detergents

If you look up detergent in the dictionary, it is defined in it's simplest term as a 'cleaning agent'. During the last two to three decades, however, the word detergent has tended to imply synthetic detergent rather than the older soap based products. In fact, commercial formulations consist of a number of components and we shall use the term surface active agent, or its abbreviation surfactant, to describe the special active ingredients that give detergents their usual properties.

Advantages of Synthetic Detergents

You may well ask why soap, which served well for so many years, was eventually displaced. Soaps are cheap and they are manufactured from a renewable source, whereas many of the synthetic detergents are made from petrochemicals. Soaps are also biodegradable; that is, they are more readily broken down by bacteria, and thus they do not pollute water sources. However, due to their gelling properties, soaps do have a greater tendency to cause blockages in sewerage systems than synthetic detergents. For instance, the drainage outlet from a bath will contain fatty and greasy deposits due to the amount of soap-based products disposed of, whereas a sink outlet, which drains synthetic detergents, will be relatively clear.

The most important reason for the displacement of soap is the fact that, when a carboxylic acid soap is used in hard water, precipitation occurs. The calcium and magnesium salts, which give hardness to the water, form insoluble salts with the fatty acid in soap and a curd-like precipitate occurs and settles on what ever is being washed. By using a large excess of soap, it is possible to redisperse the precipitate, but it is extremely sticky and difficult to move. This problem with soap can be demonstrated by a simple experiment in which a concentrated solution of hard-water salts is added to a 0.1% solution of soap and also to a 0.1% solution of synthetic surfactant. The soap precipitates, but the synthetic surfactant remains clear because it's salts are water-soluble.

There are other disadvantages with soap; it deteriorates on storage, and it lacks cleaning power when compared with more modern synthetic detergents, which can be designed to perform specialised cleaning tasks. Finally, and very importantly, soap does not rinse easily and tends to leave a residue behind on the surface being cleaned. These residues, particularly in fabrics, can cause bad odours and a deterioration in the fabric.

Why Are They Different?

What's the difference between a synthetic detergent and soap? In general terms, the difference can be likened to the difference between cotton and nylon. On the one hand, soap and cotton are produced from natural products by a relatively small modification. On the other hand, synthetic surfactants and nylon are produced entirely within a chemical factory.

The development of the first detergents came about in an effort to overcome the reaction of soaps with hard water. This provides a good illustration of one of the standard chemical approaches to developing a suitable detergent. If a useful substance has some undesirable property, an attempt is made to prepare an analogue, a near chemical relation, which will prove more satisfactory. We will look at the various substances added to detergents to increase their effectiveness later in the section.

How do Cleaning Agents Work?

To understand how cleaning agents work, we must first grasp the basic principles of soil removal. We have touched on the some of the scientific aspects of cleaning earlier in the Guide; it is important that we understand how this science is applied to the principles of soil removal.

Water, on its own is a poor cleaning agent, as it has some significant limitations. Generally, most cleaning functions rely on a combination of water with another cleaning agent, which will overcome some of these difficulties.

In order for soil to be removed from a surface, a cleaning agent or solution must have all of the following properties:

Wetting Properties

In order for a cleaning agent to be effective, it has to gain access to the soil adhering to a surface and either dissolve it or lift it from the surface. Applying water to soil will tend to be ineffective as it will form globules which will not penetrate the surface. The formulation of globules is caused by high surface tension. In order for the surface to be penetrated, this surface tension needs to be reduced.

Soil Suspension

Once soil is removed from a surface, it is held in the cleaning solution. The suspended soil particles must not be allowed to be re-deposited onto the newly cleaned surface. The process of re-depositing soil is called "flocculation".

Emulsification of Grease

When the soil particle surface has been penetrated, the cleaning agent will "emulsify" the grease contained within it. This process allows the soil to be partially dissolved and removed from the surface.

Water Hardness

Water hardness differs depending on which area of the country you live. While soft water is more conducive to cleaning, hard water makes things a little more difficult. All water contains different levels of calcium and magnesium salts that will inhibit the ability to clean effectively in the following ways:

1. When "hard" water, that is water with high concentrations of these salts, is combined with soap, the salts form an insoluble scum that reduces its ability to clean and makes rinsing difficult.

2. Calcium combines with fats in the soil and forms a soapy substance that adheres to the surface being cleaned.
3. The calcium and magnesium salts tend to cause flocculation.

The properties outlined above will lead to the dissolution of soil particles and allow for effective cleaning. In order to dislodge soil effectively, cleaning solutions can be applied at high pressure. The pressure and temperature of the water as well as the cleaning agent to be used will depend on the nature and type of soiling on the surface to be cleaned.

Detergents

The term detergent can be used to describe any cleaning agent. However, with the range of products available, we tend to use the term to describe those cleaning agents that contain large amounts of chemicals known as "surfactants". Other chemicals can be added to detergents to increase their effectiveness in given situations.

Essential Properties

Ideally, an effective detergent will possess all of the following properties:

- An ability to reduce the surface tension of water.
- An ability to emulsify soil and lift it from the surface being cleaned.
- An ability to suspend soil particles in a solution.
- To be soluble and remain effective in cold water.
- To be soluble and remain effective in hard water.
- To be harmless to the user when used correctly.
- To not cause damage to the surface being cleaned.
- To be easily rinsed from a surface and leave no streaks or deposit.
- To be economical.

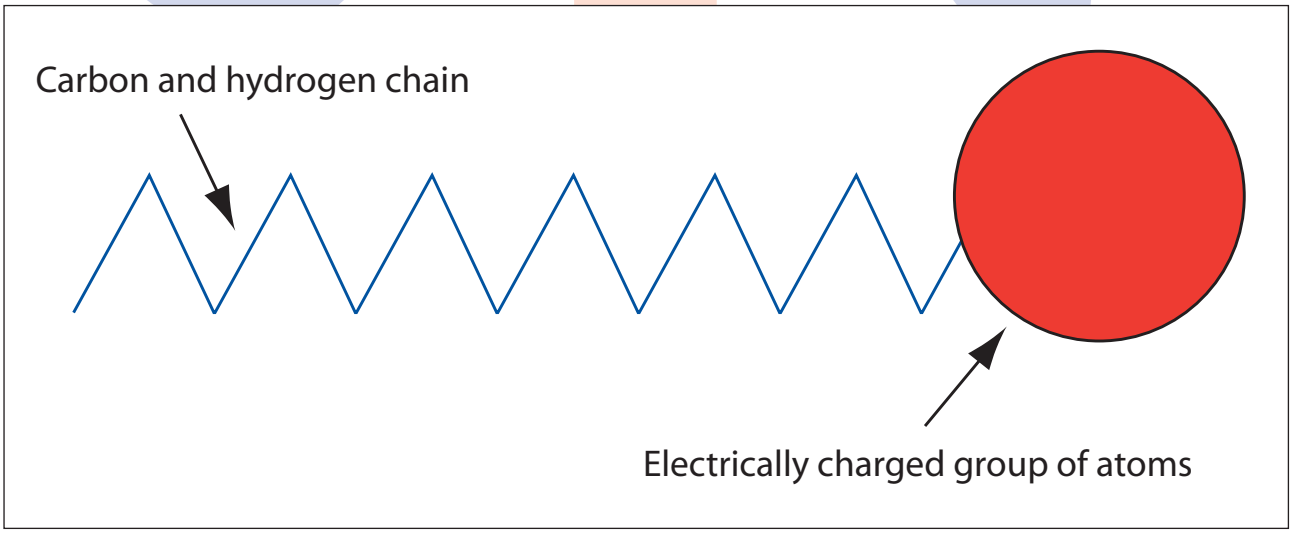
Let us look more closely at some of the chemicals used in detergents and the functions they perform, starting with the most important chemical contained in detergents, Surfactants.

Surface-Active Agents (Surfactants)

These are the basic ingredients of all detergents and are relatively complex molecules that perform a number of tasks.

The Make-Up of Surfactant Molecules

Before we go any further, it is important that you understand how surfactants work. First of all, we can think of them as having two ends; one end forms a chain of carbon and hydrogen atoms (this may include a ring of atoms); the other end contains a group of atoms which carry an electrical charge.



The carbon and hydrogen chain is water repellent or "hydrophobic", to give it its technical term. These chains will seek out any material within a solution that is not water and attach itself to it (it can even stick out of the surface of the water).

The group of atoms at the head of the molecule carrying the electrical charge acts in the opposite way. It prefers to be surrounded by water and the technical term for this is "hydrophilic".

There are four main types of surfactants, these are:

ANIONICS
NON-IONICS
CATIONICS
AMPHOTERICS

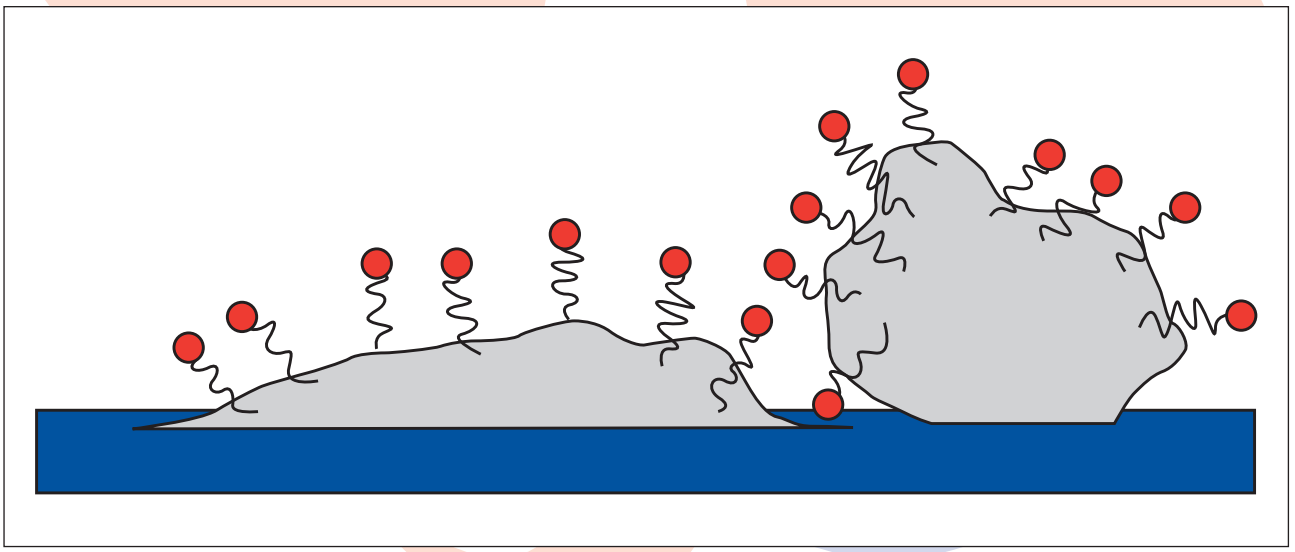
They are categorised depending on the type of electrical charge they carry. In simple terms they carry the following charges:

Anionic - these carry a negative electrical charge (-)
Non-Ionic - these carry a small negative charge (-)
Cationic - which are positively charged (+) and are not very effective
Amphoteric - which can be either positively or negatively charged depending on the pH of the solution.

Even though surfactant molecules have different levels of electrical charge, it will not affect the way in which they work. However, if the types are mixed, this will lead to them being rendered ineffective.

How Surfactants Work

The following sequence of diagrams show how surfactants work. Follow them closely to get a better understanding of how the cleaning process happens.



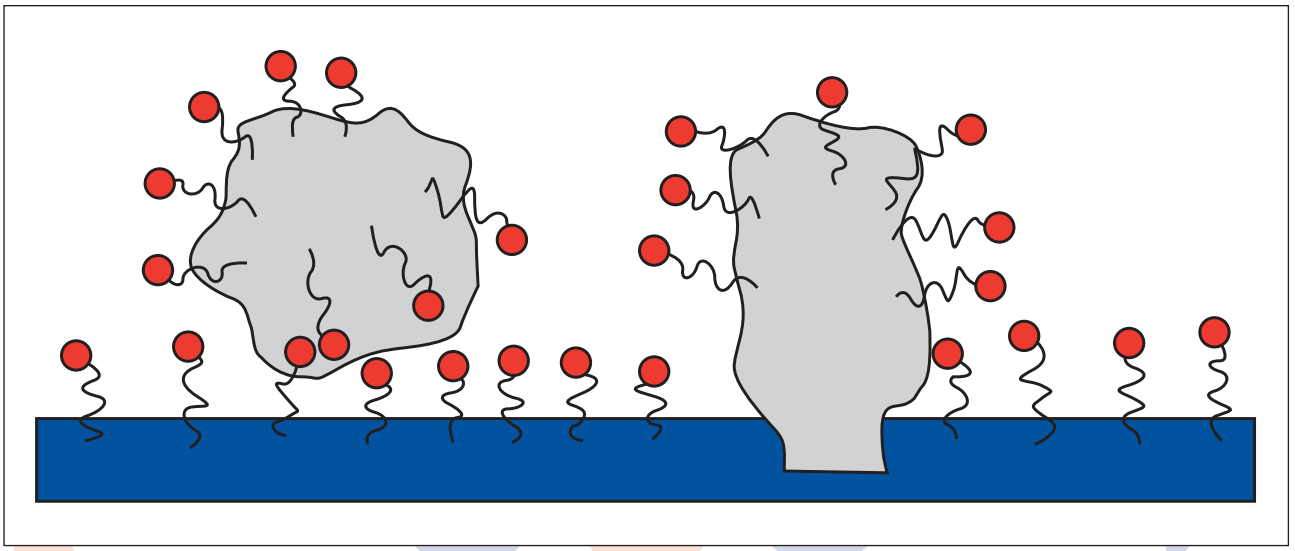
Wetting the Surface and Penetrating Dirt

When the cleaning solution is applied to a surface, the cleaning molecules crowd around anything that does not contain water. Their hydrophobic ends point inwards away from the body of the water and penetrate the surface of any soil particles

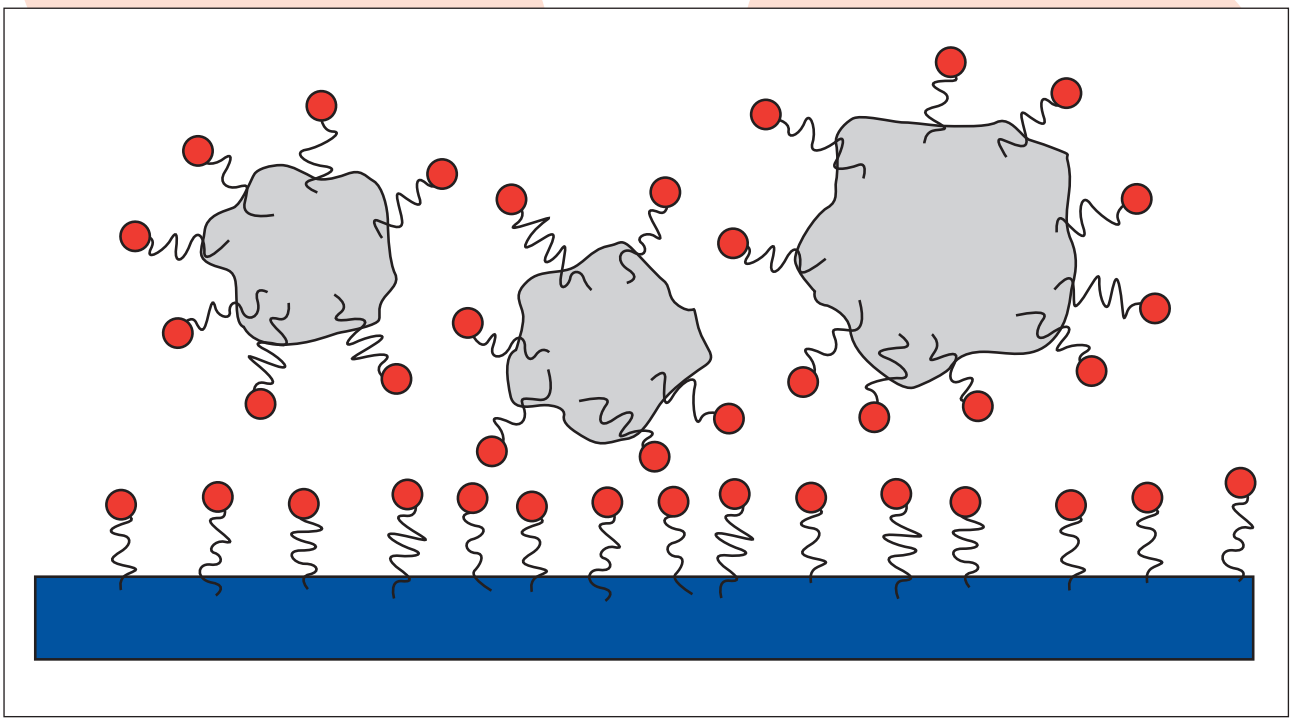
The result of this process is that the surface tension of the water is reduced, allowing the cleaning solution to cover the surface to be cleaned, depositing a layer of surfactant. The grease and dirt then become covered with the surfactant molecules (as illustrated above).

2. Lifting the Soil from the Surface

Once the surfactant molecules have attached themselves to the dirt particles, the electrical charge carried by the hydrophilic head begins to take effect. The following two diagrams clearly illustrate the way in which this electrical charge allows the dirt to be removed from the surface. In it we will use negatively charged or anionic detergent particles as an example, although, in principle these behave similarly to non-ionic and amphoteric surfactants.



You will notice from the illustration that the dirt particles are becoming detached from the surface.



Once the grease and dirt has started to leave the surface it begins to form into droplets which float clear of the surface. This is caused by the electrical charge of the surfactant particle.

As each of the particles are negatively charged, just as in magnetism, the similar charges repel each other. This means that the surfactant molecules on the cleaned surface repel those molecules attached to the dirt particles, causing them to float from the surface.

Once the surfactant particles are attached to the dirt particles, they remain attached and continue to break them into ever smaller droplets, eventually forming an emulsion of dirt and cleaning solution.

Although the scientific reaction we have just described effectively releases dirt from a surface it has adhered to, in practice, it can only be fully achieved with the assistance from a mechanical process i.e. using a mop, scrubbing brush, abrasive pad or rotary cleaning machine.

3. Keeping the Dirt in Suspension

When the dirt has been removed from the surface, it is deposited in the cleaning solution, away from the newly cleaned surface. As the surfactant molecules are still attached to the dirt particles, the process of repulsion continues.

This prevents the dirt particles grouping together and being re-deposited onto the newly cleaned surface. Again, the surfactant molecules present on the clean surface will continue to repel those molecules attached to the dirt preventing flocculation.

The next time you are using a detergent, try to visualise the cleaning molecules as they are illustrated above and working in the way described. You will quickly grasp the way in which surfactants work and appreciate the important job they perform in all cleaning tasks.

Types of Surfactants

As we have said earlier, although, essentially, all surfactants perform the same task, it is worth considering the differences between the four different types. With all cleaning tasks, you must consider the type of detergent you should use in order to clean the surface in question in the most effective way possible. One way of doing this is by considering the strengths and weaknesses of each type.

Category	Strengths	Weaknesses
Anionic	Wetting properties. Effective at lifting dirt. Effective at soil suspension. Effective in hard water. Good foam formation. Inexpensive.	Can cause skin dermatitis. Can't be used in acid products. Can't be mixed with cationics.
Cationic	Good disinfecting properties. Reduces static electricity. Good fabric conditioners.	Poor wetting properties. Poor at removing grease. Poor soil suspension. Can't be used with alkalis. Can't be used with anionics. Expensive.
Non-Ionic	Wetting properties. Effective at lifting dirt. Effective at soil suspension. Low foaming. Easily rinsed. Can be used in all conditions. Can be blended with other groups	
Amphoteric	Wetting properties. Effective at lifting dirt. Can be used in all conditions. Improves when blended with other groups (synergism). Non-toxic and do not harm skin.	Expensive. May be a loss of detergent activity in neutral solutions.

Other Important Detergent Additives

Now we have dealt with the way in which surfactants work, we can now look at some of the other chemicals that are added to detergents to perform specific tasks. The main groups are as follows:

Builders

These are alkaline chemicals that influence the effectiveness of a cleaning agent in one or both of the following ways:

- They combine with calcium ions in hard water to form water-soluble salts, preventing the adverse effects of calcium.
- They enhance the emulsifying and dispersing properties of the detergent.

The more complex phosphates, such as sodium tripolyphosphate, are present in many detergents and perform both of the functions above. Many liquid detergents contain less complex phosphates and function in the second of the ways described.

Foaming Agents

These increase or stabilise the foam produced by detergents. Foaming is generally used to indicate surfactant activity or to increase the effectiveness of detergents when cleaning non-horizontal surfaces. Foams will dissolve soil particles and hold them in suspension while continuing to act on the surface.

Foam Stabilisers

Foam stabilisers increase the length of time foams are effective. This is useful when cleaning large areas of vertical surfaces, allowing the foam to stay in contact with the surface for longer.

Corrosion Inhibitors

These are materials that are added to detergents to protect surfaces from excessive wear during cleaning. Sodium silicate is the corrosion inhibitor most commonly used in detergents.

Chelating Agents

Chelating agents are added to detergents to reduce the effect of calcium salts in hard water and increase the effectiveness of the detergent.

Optical Brighteners

These are added to detergent blends used for cleaning fabrics and upholstery. They increase the amount of light reflected from the cleaned surface, making it brighter in appearance and cleaner.

Types of Detergent

Organic Solvents

Organic solvents can be added to detergents to increase their ability to dissolve oil and greasy deposits on surfaces. The various substances that can be dissolved are dependent on the particular solvent additive. They are most commonly associated with specialised cleaning products for use on soft furnishings and carpets. However, care must be taken when using cleaning agents containing these solvents, as they can easily damage the surface which is being cleaned.

The two most common organic solvents that cleaning staff may be aware of are:

Acetone - which will remove lipstick, paints and varnishes and is most commonly associated with nail polish remover, and….

Tetrachloroethelene - which will remove fat, oil, wax, tar and paint.

It should be noted that organic solvents can give off harmful fumes and are highly flammable. Therefore, extreme care should be taken to ensure staff are adequately trained and protected before using products that contain organic solvents and they should only be used in well-ventilated areas.

There are many other chemicals that can be added to specialised cleaners that are nor generally found in the cleaning products used for everyday cleaning. Examples of these are oxidising agents, conditioners, enzymes and corrosion inhibitors.

It is worth noting that although dyes and perfumes are added to most cleaning products they have no effect at all on their effectiveness, they are only added to make the product look and smell more pleasant.

Degreasing Agents

Degreasing agents are strong alkalis, e.g sodium hydroxide, that can be applied on their own or as an active ingredient of a cleaning agent. They are primarily used to remove heavy or baked on deposits of fat and grease and most commonly associated with heavy duty kitchen degreasers such as oven cleaners.

They are particularly effective for cleaning heavily soiled kitchen grills and hoods. However, used on their own they are extremely corrosive and will damage most surfaces and, as such, it is far safer to use ready mixed cleaning products (JANGRO Oven Cleaner, JANGRO Heavy Duty Kitchen Degreaser) that contain the degreasing agents as an active ingredient.

Extreme care should be taken when using products that contain strong degreasing agents as they can have a corrosive effect on body tissue exposed to them.

Acid Cleaners

Certain deposits found on surfaces are insoluble in water. This presents a particular problem when attempting to tackle them with what are, essentially, water-based cleaning solutions. The most common problem associated with this is the build of limescale in sanitary and washroom areas.

The limescale is made up of calcium based salts that are insoluble in water. However, these salt deposits are soluble in acid and, as such can only be effectively removed using acid-based cleaning.

Weaker acids such as citric acid and acetic acid (lemon juice and vinegar) can be used as cleaning agents and can be effective, but they will have a limited effect on larger deposits. These types of deposits can be tackled using cleaning agents containing stronger acids, such as hydrochloric, phosphoric and sulphuric acids.

Care should also be taken when using acid-based cleaners that they are not allowed to come into contact with powders or liquids containing bleach as this will generate chlorine gas. In extreme cases this can lead to death.

Abrasives

There are a whole range of abrasive cleaning products available on the market today. Their effectiveness relies on the mechanical cleaning action of the abrasive particles they contain. These particles are usually added to a thick viscous detergent fluid that is applied to the surface being cleaned. The liquid is then worked into the surface, forcing the abrasive particles against the surface and removing any dirt or grease deposits from it.

Care should be taken prior to cleaning to ensure that the surface being cleaned will stand up to the abrasive action of the product, without having an adverse effect on its overall appearance.

Also, after cleaning with abrasives, the surface will need to be rinsed fully using plenty of clean water.

Abrasive cleaning agents include:

Metal Cleaners

These are available in liquid, paste, cream and impregnated wadding forms. The abrasive material is very fine, usually pumice, and can be used on highly polished metal surfaces. The fine particles will gently remove any dirt, scratches or tarnishing, leaving a bright clean finish.

Some metal cleaners also contain solvents such as white spirit and overuse of these types of cleaners can lead to deterioration in the appearance of the object being cleaned.
Also, metals such as brass and bronze can be treated with lacquers, which will reduce the need for the use of abrasive metal cleaners.

Cream Cleansers

Again, fine abrasive particles are used in conjunction with a detergent liquid. These cleaners are moist commonly used for cleaning vitreous enamel sanitary fittings. Their use on acrylic fittings should be carefully considered, as the degree of abrasiveness may have an adverse effect on the surfaces.

Cleaning Paste

Cleaning pastes are usually packaged in tubs and contain far coarser abrasive granules than cream cleansers. They are not usually used on a routine basis and should be used only for localised soil removal, such as washable graffiti, encrusted food etc.

Cleaning Powder

Abrasive cleaning powders are very coarse cleaning granules that have detergent properties when added to water. When water is added to them, they act in much the same way as pastes and should be used in the same way.

Bio-Enzyme Cleaners

Bio-Enzyme cleaning products are a relatively new addition to the detergent family and are unique in the way they deal with soil.

They are made up of a cocktail of live bacteria and enzymes, held in suspension within a solution. The bacteria attack the dirt, grease and grime on the surface being cleaned and eat away at it. The enzymes within the solution "digest" the soil within the solution, leaving little or no residue.

The bacteria contained within the solution can live on the surface after cleaning and can continue attacking any remaining dirt particles.

As the active ingredients within the cleaning solution are living organisms, care must be taken when preparing cleaning solutions that they are not too hot as this will kill the bacteria, rendering the solution ineffective.

Oxygen Bleach

Again, this revolutionary approach to cleaning is a relatively new concept that, for the first time, allows you to "bleach" stains from fabrics, without damaging the dyes within them.

The active ingredient contained within these products is sodium percarbonate, an excellent detergent and bleaching agent based on hydrogen peroxide. It is a good cleaning and bleaching agent at normal temperature, and has strong fungicidal effect. The product itself is a white particle powder, non-toxic, non-flammable, non-explosive, easy to get damp and soluble in water.

Oxygen bleach is excellent for cleaning and removing organic stains such as coffee, tea, wine, fruit juices, foods, sauces, grass and blood etc from fabrics, plastics, fibreglass, porcelain, ceramics, wood, carpets, asphalt, concrete, etc. It can also can be used for destaining and deodorising and is efficient, safe and economical.

Preparing Cleaning Solutions

The ratio of cleaning product to water is expressed as the dilution rate. The suitability of cleaning solutions for specific cleaning tasks is directly influenced by the rate of dilution. These dilution rates are indicated on the product label.

They are expressed as follows:

1:10 500ml per 5 litres of water
1:50 100ml per 5 litres of water
1:200 25ml per 5 litres of water

...and so on.

Preparing the Actual Solution

When preparing cleaning solutions, there are a number of ways in which the product can be dispensed or decanted into the water. These are:

200ml Vending Cup
Therefore, for 50ml of product will require 1/4 cup.

Using a 25ml Pump Dispenser
Therefore, for 50ml of product you will require 2 shots.

Using a 20ml cap (5 ltr container cap)
Therefore, for 50ml of product you will require 2 1/2 capfuls.

General Considerations When Selecting Detergents

Here are some general tips when considering the use of detergents on the surfaces found within most buildings:

- Neutral detergents should be used wherever possible.
- Use of stronger alkali cleaners should only be used to remove heavy or ingrained grease an oil deposits.
- Alkali cleaners should not be used routinely on any surface.
- Harsh abrasives will scratch softer surfaces. Make sure that surfaces requiring abrasive cleaning are able to withstand the cleaning process used.
- Acid cleaners should only be used to tackle limescale buid-ups or deposits and should not be routinely used.
- Metal polishes should only be used to remove tarnish and oxidation. General cleaning should be undertaken using an appropriate metal cleaner.
- Wax-based polishes should only be used on wooden furniture and fittings. Synthetic surfaces should be polished using a multi-surface polish.

Product Labelling

In order for cleaning solutions to be effective, they need to be prepared at various dilution rates for different tasks, usually depending on the level and type of soiling is present.

Manufacturers of cleaning products must, by law, provide adequate information on packaging to allow cleaning operatives to prepare cleaning solutions correctly.

On product labels, you will be provided with a description of what the product can be used for, dilution rates, first aid measures, an indication of its pH value and a telephone contact number for further information. The information provided is a legal requirement.

In addition to this, all manufacturers must provide customers with a Safety Data Sheet outlining the main ingredients and hazards associated with its use. *(Further information can be found in the Health and Safety Awareness Guide).*

Further Information

Your local Jangro supplier will be able to provide you with advice and guidance on the safe and efficient use of Jangro products. Our representatives can offer guidance on the most appropriate products for use in your particular work situation.

The following charts and tables can be found in the Appendices section of the manual:

Detergent Selection by Floor Type Appendix I

Detergent Selection by Floor Type

Appendix I

Floor Type	Suitable	Unsuitable
Sealed Wood **Sealed Wood Composite** **Sealed Cork**	Solvent-based detergents Neutral detergents	Alkaline detergents Abrasive powders
Magnesite	Solvent-based detergents Neutral detergents	Strong alkaline detergents Abrasive powders
Concrete	Neutral detergents Alkaline detergents Solvent-based detergents	None
Granolithic	Neutral detergents Alkaline detergents Solvent-based detergents	None
Terrazzo **Marble**	Neutral detergents Mild alkaline detergents Mild abrasive powders	Acid-based detergents Solvent-based detergents
Natural Stone **Granite** **Limestone** **Sandstone** **Quartzite** **Slate**	Neutral detergents Alkaline detergents Abrasive powders Solvent-based detergents	Acid-based detergents
Quarry Tile	Neutral detergents Alkaline detergents Abrasive powders	Solvent-based detergents
Brick	Neutral detergents Alkaline detergents Solvent-based detergents	None
Cement	Neutral detergents Alkaline detergents	Solvent-based detergents
Mastic Asphalt **Pitch Mastic**	Neutral detergents Alkaline detergents	Solvent-based detergents
Linoleum	Neutral detergents Alkaline detergents	Strong alkaline detergents Abrasive powders
Sealed Cork Carpet	Neutral detergents Solvent-based detergents	Strong alkaline detergents
Thermoplastic tile **PVC tile** **Flexible PVC** **Rubber**	Neutral detergents Mild alkaline detergents	Strong alkaline detergents Abrasive powders
Iron and Steel	Neutral detergents Solvent-based detergents	None
Aluminium	Neutral detergents Solvent-based detergents	Strong alkaline detergents
Glass	Neutral detergents Mild alkaline detergents Mild abrasive powders	Strong alkaline detergents Coarse abrasive powders
Seamless Vinyl	Neutral detergents Alkaline detergents Solvent-based detergents	Abrasive powders
Anti-Static Flooring	Neutral detergents Anti-Static detergents Mild alkaline detergents Fine abrasive powders	Strong alkaline detergents