MILANCO INDUSTRIAL CHEMICALS

METAL CLEANING PART II

ALKALINE CLEANERS (AND ACID CLEANERS)

Milanco, Inc. manufactures metal cleaners falling into four main categories:

1. Alkaline
2. Acid
3. Neutral
4. Solvent and Emulsion

This course will deal mainly with alkaline cleaners, but will discuss acid, neutral, and solvent and emulsion cleaners as well. The iron phosphate cleaners which make up the bulk of the acid cleaners are covered in great length in the Phosphatizing Course. In this course, we will cover various metal cleaners, the differences between some cleaners, what to look for during a plant survey, how Milanco's' products are applied, and how to choose the right cleaner.

Alkaline Cleaner is a term given to a class of proprietary chemical blends which consists of alkaline salts, wetting agents and sequestering (chelating) agents. Alkaline salts cover a broad group of chemicals including caustic soda (NaOH), caustic potash (KOH), phosphate, silicates, carbonates and borates. This group of materials is said to be alkaline because they fall in the 8 to 14 pH scale. Just what is pH? This term is used often in the chemical industry. Therefore, it is important that you obtain as clear a picture as possible of its meaning. We will endeavor to avoid the chemist's definition which states, in complicated language, that pH is the measure of the INTENSITY of an acid or alkali. Just as amperage is the measure of electrical intensity or temperature the measure of heat intensity, pH measures the degree of intensity of acidity or alkalinity, This definition further states that pH is a numerical log function with each successive unit being ten times more intense. If we look at the accompanying chart, we might be better able to understand the underlying concept of pH chemistry.

The measuring scale of pH runs from 0 to 14 as indicated on the chart. The middle 7 in the series represents the neutral point. Pure water is neutral. Any number below this digit of 7 indicates acidity and any digit above this figure indicates the alkalinity of a solution. As the pH number get further from 7, the intensity of the acid or alkali becomes greater.

The following examples will give you an idea of how this log function works in practice.

EXAMPLE: If a tank of neutral water (pH 7) takes a pint of acid to bring the pH down to 6, it will take 10 pints to bring the pH from 7 to 5, and 100 pints to bring the pH from 7 to 4, etc. Naturally, the reverse on the pH *scale is also true*. If 1 pound of alkali increases the neutral pH of a solution to a pH value of 8, it would take 10 pounds to increase the pH from 7 to 9, and 100 pounds for a pH increase from 7 to 10. The factor of 10 continues all the way up and down the pH scale.

ANOTHER EXAMPLE: This factor of 10 is also applicable when neutralizing an acid or an alkali. An acid solution that would take 100 ounces of alkali to change the pH from 2 to 7 would require only 10 ounces to go *from 3 to 7, 1 ounce for a change* from 4 to 7, 1/10 ounce alkali to go from 5 to 7 and 1/100 for a change from 6 to 7. There are exceptions to this straight log function (10 factor) when certain acids are used because of the buffering action of the salts formed.

Two new words--salts and buffer--have entered our realm of chemistry, and of course, they have need for explanation. A salt is formed whenever an acid and an alkali are mixed,

HCl	+	NaOH	→	NaCl	+	H_20
Hydrochloric Acid		Sodium Hydroxide		Sodium chloride (common table salt)		Water

One item not indicated in the above reaction is the formation of heat. When an acid and an alkali are mixed a heat of reaction will be formed. Depending on the quantities and concentrations of these chemicals, care should always be exercised in their mixing as violent reactions and bubbling are possible, some reactions bordering on explosiveness.

Another word you will hear from time to time is buffer. We have discussed the formation of salts. Some of these salts resist pH changes in solution and are called buffers.

It's evident, from these examples, that the further the pH is from the neutral point of 7, the more difficult it is to change the pH. This explains why you cannot use pH as an indication of concentration.

Relative pH values of several alkaline materials:

	0.1% Solution-at 80°F
Sodium Hydroxide	12.0 pH
Soda Ash	11.6 pH
Phosphate	10.0 pH
Borax	8.5 pH

The **first** general group of chemical materials that are formulated into a cleaner are alkaline in nature and are also selected for additional specific benefits that are rendered by that particular product. For example:

Silicates - form colloids (solids) which are insoluble but have excellent soil dispersing properties. In the presence of acids these materials become very insoluble and difficult to rinse. This could be highly unacceptable in the electroplating field for example.

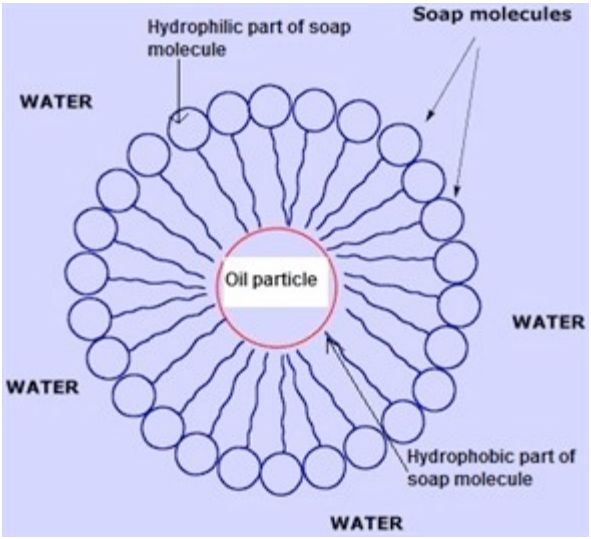
Phosphates - noted as good hard water sequestrants, which means that they hold metals salts in solution. They also provide excellent dispersion and detergency in the water. Phosphates lower surface tension and allow better rinsing.

Soda Ash - water conditioning--also provides reserve alkalinity.

Sodium Hydroxide (Caustic Soda) - Workhorse of the alkaline cleaners.

The **second** general group of chemicals which are incorporated in the make-up of a cleaner are wetting agents. Wetting agents fall into two categories, soaps and synthetic detergents called surfactants. Soaps are long chain molecules that are soluble in water. These molecules have one end of the molecule that is soluble in oil (hydrophobic) and the other end that is soluble in water (hydrophilic). It is able to hold the oil in solution by forming an emulsion of the oil droplets

in the water. It is important to note that soaps can be made insoluble in hard water which causes them to lose detergency. Synthetic detergents are a large group of various complex chemicals. Synthetic detergents can act like soaps, but basically their job is to make water wetter. By this action, improvement of the penetration of water wettable soils is achieved. A lowering of surface tension at the metal-to-soil bond is facilitated by synthetic detergents. These qualities allow for more efficient and expedient soil removal.



The **third** and final group of chemicals generally formulated into a cleaner are the sequestering or chelating agents. These products have two functions:

1. Softening water which makes for better rinsing and cleaning.
2. Holding iron or other metals in solution, and keep them from redepositing on the surface being cleaned. This property can prolong the life of the cleaning bath

Alkaline cleaners depend on their detergency - lifting the soil from the surface by displacing it with surface active materials which are easily rinsed off - for cleaning.

We have discussed the three major components of a cleaner, especially an alkaline cleaner. But why do I use an alkaline cleaner? What are the benefits, if any?

Advantages of using an alkaline cleaner:

1. Very economical.
2. Acts on a variety of soils.
3. Broad spectrum of alkaline cleaners to choose from.
4. Leaves a desirable surface after cleaning.
5. Rinses with water.
6. Non-flammable.
7. Generally, little waste disposal problems.
8. May be formulated as a no rinse product to leave a rust-inhibiting film on the surface

Disadvantages of an alkaline cleaner:

1. Usually requires elevated temperatures.
2. Mechanical action necessary.

3. Undesirable effects on non-ferrous metals (caustic on aluminum).
4. Some soils cannot be dissolved by detergent.
5. Possible foam.
6. Slower than solvency.

There are three variable factors which determine cleaning- time, temperature and concentration. A change in any one of these three variables will necessitate a change in the other two. A decrease in temperature will necessitate an increase in time or concentration or both. Likewise, a shortening of the cleaning time will necessitate an increase in temperature or concentration of the cleaning solution

Milanco, Inc. manufactures a second class of proprietary blends known as ***Acid Cleaners and Acidic Chemistries***. Acid cleaners are a blend of mineral acids or their salts, solvents, surfactants, chelating agents, and inhibitors. The inhibitors control the action of the acids on certain metals. Acid cleaners are used mainly for rust and oxidation removal, and all types of scale removal. They basically fall into three types of acids: phosphoric, hydrochloric, and sulfamic or sulfuric acid. These products are used by soaking, spraying, or hand application for the following processes:

1. Rust removal.
2. Heat treat scale removal.
3. Deoxidizing of metal surface.
4. Dissolving soil solids (boiler hard water scale, insoluble spray washer scale).
5. Brightening of the metal surface (i.e. aluminum or copper)

Advantages of an Acid Cleaner:

1. Can be economical (energy savings, fast reactivity).
2. Less metal loss on some softer metals
3. Leaves smooth surface.
4. Can be used on plastic surfaces prior to painting

Disadvantages of an Acid Cleaner:

1. A waste treatment system is usually required to neutralize the product.
2. Heavy metals tend to dissolve and stay dissolved in the acid cleaning systems.
3. The acid chemistry can attack soft metals and cause rusting on ferrous metals

A third class of proprietary cleaners we will cover is called ***Neutral Cleaners***. These cleaners will generally be in the pH range between 6 and 9. They rely on a blend of organic solvents either from oil or from natural sources (such as lemon or orange oils), emulsifiers, surfactants, wetting agents, chelators, and dispersants. A majority of these products are formulated to work at lower temperatures and reduce wastewater treatment issues. These products are easier to use and may cost a little more for the initial purchase, but they will save money over the life of the products.

Advantages of a Neutral Cleaner:

1. Can be economical (lower temperature)
2. Less metal loss on some softer metals

3. Easy to rinse
4. Impact of carryover into the rinse stage is much less
5. Easier disposal due to more neutral pH

Disadvantages of a Neutral Cleaner:

1. Works better with light soils
2. May have to increase time or concentration to get proper cleaning
3. May be difficult to titrate with conventional chemicals
4. Easier to contaminate the bath with soils from incoming parts

The fourth and final class of proprietary cleaners we will cover is ***Emulsion and Solvent Cleaners***. These cleaners can be either straight organic solvents or blends of organic solvents, emulsifiers and wetting agents. These cleaners mainly depend on their solvency (ability to dissolve the soil) for cleaning. Most of them leave a protective film to prevent rust or oxidation. There are basically *three types of solvent based cleaners:*

1. Straight Petroleum (aliphatic, aromatic)
2. Non Flammable solvents used in vapor degreasing or in immersion or ultrasonic tanks
3. Emulsifiable solvents (petroleum solvents and surfactants and soaps) that mix with water.

The first two work on a straight solvency basis, the ability to dissolve a particular soil. The third class of solvent cleaners works on the mechanism of emulsification which was discussed a little earlier. In weighing one cleaner against another one should be familiar with the advantages and disadvantages of that particular class of cleaner.

Advantages of Solvent Cleaners:

1. High speed penetration - fast pre-cleaning.
2. Low temperature use - ambient to 150° F
3. Selectivity on certain soils - asphalt, tar, high melting waxes.
4. Loosens varnishes, paints.
5. Fast evaporation - removes excess cleaner from surface, leaves neutral surface.
6. Rust protection can be imparted by some products.

Disadvantages of Solvent Cleaners:

1. High cost
2. Residues may not be tolerated.
3. Flammable, some may be toxic.
4. Unsuitable for some soils.
5. May require special equipment.
6. Waste disposal could be a problem.
7. Buffing compounds - removal of a soluble component may leave inert abrasives which can become extremely difficult to remove in final cleaning. The use of slow solvents is recommended here.