D. SCOTT MACKENZIE, PH.D., FASM
SENIOR RESEARCH SCIENTIST–METALLURGY /// QUAKER HOUGHTON INC.

Alkaline cleaners have a wide range of applicability within the heat-treating shop to remove dirt and oil before and after heat treatment. They are cost-effective and environmentally friendly.

Cleaning for heat treatment – Part III

Third in a series ›› Among the many specifications applied to finished heat-treated goods, the cleanliness of those goods is increasingly important in appearance, performance, and customer satisfaction. In this series of articles, I'll break down the why and how of cleaning for heat treatment.

Previously, we have discussed the types of soils that occur on parts before heat treatment and after quenching. In this column, we will discuss the different types of cleaners available for heat-treatment applications.

INTRODUCTION

There are many types of cleaners that may be chosen. The cleaner chosen can either depend on the type of soil, or it can depend on the type of process washer used (spray, dunk, ultrasonic, etc.). The first classification of cleaners is based on chemistry. Alkaline cleaners are used with aggressive soils. Neutral cleaners are used when a rust inhibitor is required, and the soil is moderate. Quench oils are generally considered to be moderate soils, unless the oil has deteriorated significantly. The use of emulsion cleaners is usually dictated by the subsequent operation. In this case, an oily film, consisting of a rust preventative, is left on the part. Solvent cleaners are used when it is necessary to achieve exceptionally clean parts. Unfortunately, the use of solvent cleaning is declining because of environmental considerations, while the requirement for exceptionally clean parts is increasing.

ALKALINE CLEANERS

Alkaline cleaners consist of a blend of alkaline salts, known as builders, and surfactants. They operate in a pH range of above 7. Each salt and surfactant is added to provide specific cleaning properties within economic and other limitations. They are the most widely used cleaners due to their ability to remove a wide range of soil at low costs. The builders used in alkaline cleaner systems are hydroxides, silicates, phosphates, carbonates, borates, and organic chelants.

Hydroxides provide the highest degree of alkalinity. It is relatively inexpensive and small amounts will suffice to give the appropriate amount of alkalinity. It increases the electrical conductivity of a cleaner, which is important for electro-cleaning, and improves saponification. However, it rinses poorly and doesn't clean non-saponifiable soil very well. Aggressive rinsing is required to prevent caustic burns on parts. A 1 percent solution has a pH of 1.3. Both sodium and potassium hydroxide are used in alkaline cleaners where ferrous metals are being processed.

Silicates make up the largest portion of most heavy-duty alkaline cleaners. Sodium orthosilicate and sodium metasilicate are excellent emulsifiers, and good buffers at pH above 9. They hold soil in suspension and provide active alkalinity. Sodium metasilicate is the silicate most used in metal cleaners. This material, when formulated into an alkaline cleaner inhibits attack of the cleaner on aluminum and zinc. Silicates reduce rusting or browning of steel during electro-cleaning. Alkaline cleaners compounded for general use almost always contain silicates due to their versatility. They provide a high degree of alkalinity with little or no attack on the base metal. A 1 percent solution has a pH of 12.3.

Phosphates are used as water softeners. They also impart alkalinity and peptize the soil, which is the breaking down of large particles into smaller ones.

Carbonates serve as a low-cost source of alkalinity as well as offering some degree of water softening. They are poor cleaners but supply a fair amount of alkalinity. The major function of carbonates in metal cleaners is to aid in obtaining a free flowing, non-caking mix. Sodium carbonate, or soda ash, is by far the most widely used of the carbonates. Because of its low cost, it is used to some degree in almost all formulations. A 1 percent solution has a pH of 11.3.

Borates are used for the development of cleaners at lower pH ranges and for rust protection. They are used as a water softener and can prevent the formation of scale. A 1 percent solution of 10ml sodium tetraborate (borax) is 9.2. The use of borates is decreasing due to potential health risks.

Sulfates are used as filler. However, the use of sodium carbonate

is commonly used for this purpose since it offers a greater alkalinity.

Organic chelants sequester magnesium and calcium ions plus various heavy metal ions. They are used as replacements for complex phosphates in low- to medium-alkaline pH ranges, as well as softening hard water. Chelants in solution will also bind with iron and manganese, preventing them from forming deposits. Organic chelants find applications in areas of the country where phosphates are not permitted.

As was previously mentioned, builders and surfactants comprise the composition of alkaline cleaners. Builders alone will not clean satisfactorily. They need to be combined with a surfactant to perform efficiently. A surfactant has the property of concentrating at surfaces because it contains two separate portions: one soluble in oil and the other in water. They can penetrate the surface, prevent re-deposition of soil, and the lower surface tension of a solution.

Surfactants have a hydrophobic tail, and a hydrophilic head. The hydrophobic tail surrounds the soil, while the hydrophilic head is surrounded by water. There are three types of surfactants found in alkaline cleaners: nonionic, anionic, and cationic.

Nonionic surfactants are the most widely used type due to their versatility. By varying the nonionic surfactants, different features can be derived, such as greater detergency, greater oil solubility, and less foam.

Anionic surfactants have a negatively charged hydrophobic tail of the molecule that helps lift and suspend soils. They attack a broad range of soils and are frequently used in alkaline cleaners. Anionic surfactants are particularly effective in lifting fatty oils. Unfortunately, anionic surfactants create a lot of foam when agitated. Usually, a combination of nonionic and anionic would be found in a cleaner formula.

Cationic surfactants have a positive charge on the hydrophilic end. These surfactants can be antimicrobial, depending on the specific surfactant. In general, cationic surfactants are poor cleaners.

Nonionic surfactants are neutral, in that they have no charge on the hydrophilic end. Because of the non-polar nature of the molecule, they are very good at emulsifying oils. They are also better at lifting organic soil. Nonionic and anionic surfactants are often used together to lift particulate soils, and to emulsify oily soils. An additional benefit of nonionic surfactants is that they are non-foaming or low foaming.

BENEFITS OF ALKALINE CLEANERS

Alkaline cleaners are very cost-effective in removing a wide range of soil typically found in the heat-treating shop. They can be used both before heat treatment and after to remove the soils found prior to heat treatment, and to lift quench oils from a part after quenching. Alkaline cleaners are usually compatible with most cleaning equipment.

CONCLUSIONS

Alkaline cleaners have a wide range of applicability within the heat-treating shop to remove dirt and oil before and after heat treatment. They are cost-effective and environmentally friendly.

Should there be any questions or comments regarding this article, or suggestions for additional articles, please contact the author or editor.

ABOUT THE AUTHOR

D. Scott MacKenzie, Ph.D., FASM, is a Quaker Houghton Fellow, past president of IFHTSE, and a member of the executive council of IFHTSE. For more information, go to www.quakerhoughton.com.