Corrosion inhibitors are sometimes added after the cleaning process because brightness is a crucial factor in the metals industry. Problems may occur when the next manufacturing step prohibits inhibitors.

Alkaline Aqueous Cleaning Alternatives for Soft Metals

BY ADRIAN PULLEN

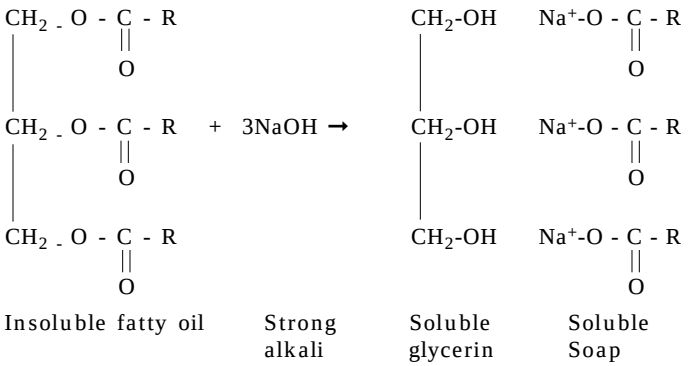
In metal parts manufacturing, the appearance of the final product is of paramount importance. In this competitive industry, the "brightness" of the part can make or break a bid regardless of the functional importance of appearance. As a result, a brightening step must often follow the actual cleaning of the part. This step is typically an acidic bath which, depending upon the part, may or may not contain an abrasive for physical buffing. The acidity (H+) serves to remove the oxide layer (MO) on the metal surface as shown in Equation 1.

Equation 1: Acidic Brightening

$$MO + 2H^{+} \rightarrow M^{++} + H_2O$$

During the cleaning step, alkaline aqueous cleaners are often used. The alkalinity of these cleaners serves as a saponifying agent for fatty oils. The saponification reaction changes the insoluble fatty oil into soluble glycerin and soap (Eq. 2). This reaction is an extremely effective method for cleaning these types of oils in an aqueous medium.

Equation 2: Saponification Reaction



Although the reaction described in Equation 2 provides a very strong driving force for oil removal, there are four potential drawbacks with this type of processing, particularly when combined with sensitive metals.

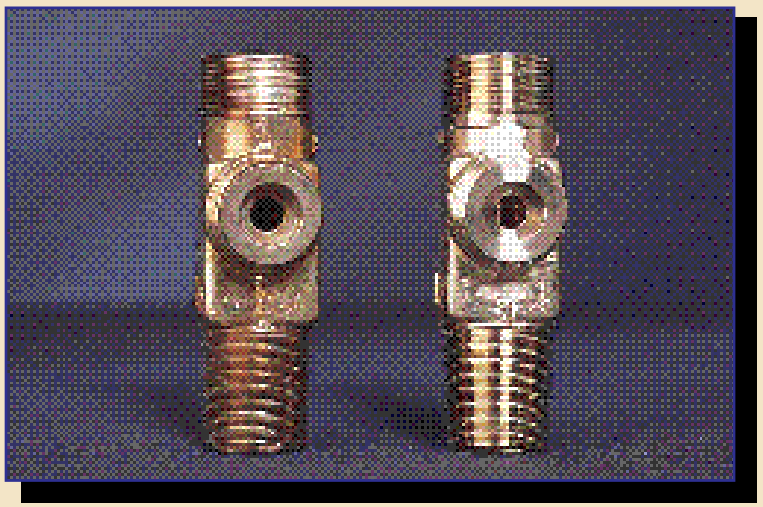
Drawback #1: The cleaning process (the saponification reaction) is not applicable to all oils. Non-fatty, such as petroleum-based, oils will not be affected by this reaction. Such oils can be emulsified by the surfactant package and, to some extent, the alkaline boosters but this action tends to be somewhat oil specific in alkaline cleaners. This fact often requires the use of several cleaning lines, each using different chemistries, when different types of oils are used.

Drawback #2: The most important potential problem is the corrosive quality of alkaline solutions with some metals and metal coatings. To minimize this, a corrosion inhibitor is usually present in alkaline cleaners. Although this limits corrosion, subsequent acidic brightening is inevitably required. Also, there are numerous instances where the corrosion inhibitors are not sufficient to prevent substantial damage to metal coatings, bimetallics or soft metals such as copper, brass and aluminum.

Drawback #3: There are applications in the medical, aerospace and electronics industries where the presence of residues cannot be tolerated and the presence of corrosion inhibitors is unacceptable. Typically, these materials operate by forming a protective layer on the surface of the part. This layer is very difficult to remove and often remains on the finished part.

Drawback #4: There are associated health and safety problems with handling acids and bases in a plant. These problems can translate into hidden costs due to insurance and special handling.

Given these limitations of alkaline cleaning, plants that are processing soft metals often turn to neutral pH aqueous cleaning. In order for the process to be competitive and serve the customer adequately, any high performance, neu-



An effective neutral pH brightening agent can make the substrate shine without adding a brightener. Here, the left valve was processed in an alkaline cleaner while the right valve was processed in a neutral cleaner with a brightening agent.

tral pH cleaner must address each of the four drawbacks.

Addressing Drawback #1: Since the solution is pH-neutral, no saponification will take place. All cleaning will be performed by strong surfactant emulsification. As a result, the formulation must have good wetting characteristics so that it can penetrate deep, narrow crevices. It must also have good emulsification properties so that oil is brought quickly into the cleaning solution. This cleaning mechanism has the major advantage of being applicable to a wider range of oils. Thus, many cleaning processes can often be collapsed to a single cleaning line.

Addressing Drawback #2: Although the corrosion effect of neutral solutions is much less than that of alkaline solutions, corrosion inhibition is still important. However, in order to address drawback #3, traditional corrosion inhibitors cannot be used. Also, in order to avoid the acidic brightening step in drawback #4, the cleaner must not only inhibit corrosion but must also brighten the part.

Addressing Drawbacks #3 and #4: To avoid the use of both traditional corrosion inhibitors and the acidic wash, a neutral pH brightening agent must be included in the formulation. This material should not only prevent corrosion without forming a layer on metal surfaces, but must also brighten the part sufficiently to obviate the necessity for the acid bath. The photo above shows the effect of a neutral pH brightening agent on a brass valve block. These valves were processed at 160°F for four minutes.

Neutral pH cleaners which successfully address these drawbacks are currently available. These cleaners have the following attributes:

- Since the cleaning mechanism is strong surfactant emulsification, the cleaner is broadly applicable and many different types of oils can be cleaned.
- As the solution is neutral, both hard and soft metals can be effectively cleaned without corrosion problems, making the cleaner more widely applicable in the plant.
- With an effective brightening agent, the cleaning and brightening steps required for soft metals are now combined into one pH-neutral step.
- As the solution is neutral and contains a brightening agent, traditional corrosion inhibitors are not required.

Of course, the product must also have minimal environmental impact and be considered essentially nontoxic. With these attributes, neutral pH aqueous cleaning can provide, in a simplified single-step process, the same excellent cleaning results of saponification with acid brightening, a two-step process. Also, both hard and soft metals can be cleaned by a wide variety of oils in the same cleaning operation. In plants where both different oils and soft metals are used, neutral pH cleaning can offer tremendous process simplification. PC

About the Author

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