Stress corrosion cracking prevented by shot peening

Research studies, plus application on specific plant problems, by a number of chemical companies indicate that controlled shot peening can minimize the possibility of stress corrosion occurring. Some users have specified that the surface of new vessels be shot peened at the fabricator's shop prior to delivery. However, shot peening can be done in the field.

Stress corrosion cracking of stainless steel or other alloys may take place when an adverse environment, such as chlorides, is present. One way to decrease the possibility of stress cracking is to keep chlorides to a very low level in the product being handled and in surrounding materials such as pump or valve packing.

A second way to reduce the likelihood of stress corrosion cracking is the selection of an alloy that is not susceptible to this type of failure. One such alloy is the recently developed 26-1 alloy containing 26% chromium and 1% molybdenum. Another one is a Japanese-developed alloy containing 26% nickel and 24% chromium.

The third approach to avoidance of stress corrosion cracking is shot peening of the metal surface to remove residual tensile stresses. This method has been used by one of the major chemical companies to overcome some problems where stress corrosion cracking occurred on silicon copper and stainless steel tank bottoms. The stress cracking has not reoccurred in the more than a year since the tank was shot peened. In one plant the tank bottom was also heat treated which may have had a beneficial effect in avoiding the stress cracking.

Metal forming operations such as machining, drilling, casting, extruding, forming, lapping, welding and grinding set up residual surface tensile stress. This is, in effect, a “pulling apart” of the surface grains, with resultant lessening of the grain cohesiveness. Stress corrosion cracking can occur at the weakened boundaries. Placing equipment on stream and subjecting it to weight, pressure and dynamic loading aggravates the condition.

Regardless of whether it is done in the shop or in the field, controlled shot peening calls for expertise. It is exacting work requiring individual testing and evaluation, planning, proved procedures, along with special equipment, to assure uniform surface layer compression. Cast steel shot is normally used in the peening operation although stainless steel shot and glass or ceramic beads can be used.

The cause of intergranular corrosion is totally different from that of stress corrosion, yet the two can and very often do occur simultaneously. The highly controlled, intense shot peening employed to prevent the former, actually serves to prevent both.

Intergranular corrosion affects austenitic stainless steels of the 18-8 type as well as other nickel-containing ferrous alloys although strides have been made in developing new alloys of these types which possess comparatively low susceptibility. In the stainless steels, "sensitization" takes place following heating to between 1000 and 1500°F, which coincides with the temperature range of many of today's processes. In this range, the chromium precipitates as a carbide along the more or less continuous grain boundaries and away from the surface. Loss of chromium at the surface grain boundaries invites attack and so-called "intergranular" corrosion.

To protect against it, procedures are utilized involving high intensity peening and extended coverage to break up the surface grain structure so that, when chromium carbide precipitation occurs, there is a larger concentration and more uniform dispersion of it in the matrix at the surface where it can render necessary corrosion protection.

Welding is a sensitizing operation in itself, but controlled high intensity shot peening with extended coverage provides the required protection against intergranular attack.

*Shot peening service is furnished by Metal Improvement Co.*