## Formability

AK Steel 17-7 PH Stainless Steel in Condition A can be formed comparably to Type 301 stainless steel. It work hardens rapidly and may require intermediate annealing in deep drawing or in forming intricate parts. Springback is similar to that of Type 301.

This alloy is extremely hard and strong in Condition C. Therefore, fabrication techniques for such materials must be used.

## Weldability

The precipitation hardening class of stainless steels is generally considered to be weldable by the common fusion and resistance techniques. Special consideration is required to achieve optimum mechanical properties by considering the best heat-treated conditions in which to weld and which heat treatments should follow welding. This particular alloy is generally considered to have poorer weldability compared to the most common alloy of this stainless class, AK Steel 17-4 PH Stainless Steel. A major difference is the high Al content of this alloy, which degrades penetration and enhances weld slag formation during arc welding. Also, the austenite conditioning and precipitation hardening heat treatments are both required after welding to achieve high strength levels. When a weld filler is needed, W 17-7 PH is most often specified. More information can be obtained in the following way:

"Welding Stainless Steels," FDB #SF-71.

## Heat Treatment

### Heat Treating and Annealing

For in-process annealing, the alloy should be heated to 1950 ± 25°F (1066 ± 14°C) for three minutes for each 0.1" (2.5 mm) of thickness, and air cooled. This treatment may be required to restore the ductility of cold-worked material so that it can take additional drawing or forming. Although most formed or drawn parts do not require re-annealing prior to hardening, annealing is required on severely formed or drawn parts to be heat treated to Condition TH 1050 if full response to heat treatment is required. Annealing is unnecessary in the case of the RH 950 heat treatment.

### Equipment and Atmosphere

Selection of heat-treating equipment depends to some extent on the nature of the particular parts to be treated. However, heat source, atmosphere and control of temperatures are the primary considerations.

Furnaces fired with oil or natural gas are difficult to use in the heat treatment of stainless steels, particularly if combustion control is uncertain and if flame impingement on the parts is possible. Electric furnaces, gas-and oil-fired radiant tube furnaces or vacuum furnaces generally are used for heat treating this material.

Air provides a satisfactory furnace atmosphere for heat-treating and annealing operations. Controlled reducing atmospheres such as dissociated ammonia or bright-annealing gas introduce the hazard of nitriding and/or carburizing or decarburizing and should *not* be used. Bright annealing may be accomplished in a dry hydrogen, argon, or helium atmosphere (dew point approximately –65°F {–54°C}), if a cooling rate, approximately that obtained in an air cool can be used. Dry hydrogen, argon, or helium (dew point approximately –75°F {–59°C}) may be used for the 1750°F (954°C) heat treatment outlined for Condition RH 950, and will provide an essentially scale-free surface. At heat-treating temperatures of 1400°F (760°C) and lower, scale-free heat treatment in a dry hydrogen, argon, or helium atmosphere is difficult to achieve. A vacuum furnace is required for complete freedom from scale or heat discoloration.

Multiple exposures to a nitrogen atmosphere during annealing or quenching from vacuum may result in a surface layer of uniformly distributed small nitrides. These inclusions tend to decrease fabricability in subsequent cold-forming operations. Furnace loads should be such that cooling to 1000°F (538°C) may be effected within eight minutes to achieve best results.

It is necessary to cool this material to a temperature of –100°F (–73°C) for a period of eight hours when heat treating to the RH condition. While commercial equipment is available for refrigeration at this temperature, a saturated bath of dry ice in alcohol or acetone maintains a temperature of –100 to –109°F (–73 to –78°C) without control equipment.

Annealing at 1950°F (1066°C) or austenite conditioning at 1750 or 1400°F (954 or 760°C) in molten salts is not recommended because of the danger of carburization and/or intergranular penetration. However, hardening at 900 to 1200°F (482 to 649°C) has been done successfully with a few salts of the hydride or nitrate types.

**Cleaning Prior to Annealing or Heat Treating**

Thorough cleaning of parts and assemblies prior to heat treatment greatly facilitates scale removal and is necessary for the development of uniform properties. Removal of oils and lubricants with solvents also assures that the steel will not be carburized from this source. Carburized 17-7 PH Stainless Steel will not respond properly to heat treatment.

Cleaning may be accomplished by the following two-step procedure:

1. Vapor degrease or solvent clean. This step removes oil, grease and drawing lubricants.

2. Mechanical scrubbing with mild abrasive cleaners, Oakite 33 or similar proprietary cleaners to remove dirt or other insoluble materials. All traces of cleaners should be removed by rinsing thoroughly with warm water.

A light, tightly adherent, uniform-appearing oxide after heat treatment is evidence of proper cleaning.

**Coatings**

Protective coatings offer little advantage in reducing oxidation of the metal surface during heat treatments if the parts are thoroughly cleaned. However, when thorough cleaning is impractical, coatings may be beneficial. If such coatings are used, extreme caution must be exercised to provide free air circulation around the coated parts, or carburization may result.