



Standard Practice for Preparation of Iron Castings for Electroplating¹

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1. Scope

1.1 This practice is intended to assist electroplaters in establishing and maintaining a satisfactory pre-electroplating cycle for malleable iron, gray iron, nodular iron, and white iron castings. It is also intended to indicate certain foundry practices which will facilitate subsequent finishing. Most of the practices that follow have been based on experience with malleable and gray iron. However, since they are related to the other forms, the same practices will probably apply. Nodular iron is also known as spheroidal or ductile iron, which is defined as cast iron with the graphite substantially in spherical shape and substantially free of flake graphite.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* Specific precautionary statements are given in 2.1.

2. Reagents

2.1 *Purity of Reagents*—All acids and chemicals used in this practice are technical grade. Diluted acid solutions are based upon the following assay materials:

Hydrochloric acid (HCl):	31 mass %, density 1.16 g/mL
Hydrofluoric acid (HF):	47 mass %, density 1.186 g/mL

Caution—Use hydrofluoric acid with extreme care.

Sulfuric acid (H ₂ SO ₄):	93 mass %, density 1.83 g/mL
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Caution—Sulfuric acid should be slowly added to the approximate amount of water required with rapid mixing, and then after cooling, diluted to exact volume.

2.2 *Purity of Water*—Ordinary industrial or potable water may be used for preparing solutions and rinsing.

3. Foundry Practices

3.1 The seacoal content of the molding and facing sands should be maintained at the maximum practicable limits to minimize the occlusion of sand in the surfaces of the castings.

3.2 Upon removal from the molds, castings should be subjected to an abrading action (such as tumbling, grit blasting, or shot blasting) to remove as much as practicable of the occluded molding sand. Residual sand and scale may be removed, if necessary, by treatment in various proprietary descaling baths. These are usually based on fused caustic soda, some of which use chemical oxidizing or reducing agents and others employ electrochemical action as well. This is particularly important in the case of castings that will be annealed, to prevent the burning on of sand during this operation. Castings that will be warped or damaged by a blasting operation may be pickled in a solution containing 200 to 250 mL/L of sulfuric acid to remove occluded molding sand. See **Caution** in 2.1.

3.3 Annealed castings should be given an additional abrading as described in 3.2 to remove any scale that may have been formed, as well as graphitic carbon that may be present at the surface.

4. Nature of Cleaning

4.1 The preparation of ferrous castings for electroplating involves the following basic steps in the order named:

4.1.1 The removal of oils, greases, residual polishing and buffing compounds (if any), and shop dirt by cleaning,

4.1.2 The removal of oxide films and scales and the loosening of surface carbon by pickling or by salt bath treatment (see 3.2),

4.1.3 The removal of smut caused by 4.1.2, and

4.1.4 Activation for electroplating.

4.2 Where excessive amounts of cutting oils used in machining operations are present, it may be necessary to preclean the parts before they reach the electroplating room. This may require the use of organic solvents, vapor degreasers, washing machines of the power-spray type, emulsion cleaners, or simple alkaline soak tanks. As short a time as possible should elapse between this precleaning and the preplating cleaning cycle so as to prevent rusting of the parts. Where control of the interval is not possible, parts should be left with a slightly alkaline or very thin organic film.

5. Cleaning Solutions and Equipment

5.1 The various solutions used for the treatment of malleable and gray iron castings should be maintained by chemical analysis so far as is practicable, such as determining the free acid and iron concentrations of the acid baths and using tests

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recommended by the manufacturer, the effective components of the proprietary cleaning solutions.

5.2 All solutions should be discarded before they lose their effectiveness, based on tests and experience.

5.3 When the amount of soil is excessive, particularly where no precleaning is done, it may be desirable to double the cleaning and pickling facilities. Thus, while the first of any two particular solutions becomes heavily contaminated, the second remains relatively clean and effective for further use. When the first of a pair of solutions is discarded, it is replaced by the second solution and a fresh second solution is prepared. This system also reduces the possible carry-over of contaminants such as oil and grease into subsequent solutions.

5.4 Where doubling the facilities is impossible or impracticable, similar economies may be obtained to a degree by providing cleaner and pickle tanks with overflow dams, sumps and pumps with which the solution may be recirculated. The pump intake should be located approximately half-way down the sump to preclude returning either settled-out solid dirt or surface oil and grease to the processing tank. The outlet should be near the bottom of the processing tank at the end opposite to the overflow dam so as to create some solution turbulence (for mechanical scrubbing benefits) and to ensure flow of contaminated solution to the dam.

5.5 In electrified tanks removable electrodes should be employed in preference to using the tank as an electrode, to facilitate inspection and cleaning. To ensure good circuitry, positive contacts such as an inverted V hook for round bars should be used. In alkaline cleaner tanks, where clean contact is often a problem, submerged oversized steel tank rods are effective.

5.6 All immersion rinse tanks should be equipped with dam-type overflows to ensure skimming of oil, grease, and light dirt from the surface of the water. Water inlets should be at the bottom of the tank, and should be of a size sufficient to provide an adequate flow of water. It is desirable that submerged inlet pipes be equipped with syphon-breakers (as required by law in many areas) not only to prevent the backflow of contaminated water into the mains, but also to produce a beneficial turbulence or scrubbing action due to the air introduced with the water. Agitation by means of low-pressure, oil-free air through perforated pipes at the bottom of the tank may also be used.

5.7 Having the heating coils on the working side of tanks will assure a working surface which is free of accumulated grease and oil.

6. Procedure for Racked Parts

6.1 The following cycle may generally be used for racked parts which will subsequently be electroplated in still tanks, semiautomatic equipment, and full-automatic equipment:

6.1.1 *Precleaning*—When castings have been subjected to machining, polishing, buffing, or similar finishing processes, it is desirable and frequently essential that lubricants and finishing compounds be removed by precleaning immediately following such operations. This is especially important when the lubricants contain unsaturated oils which, upon air oxidation,

form films which are extremely difficult to remove. Precleaning methods as listed in 4.2 may be employed.

6.2 *Soak Cleaning*—In the event precleaning of a heavily soiled part is impossible or impracticable, soak cleaning to loosen oils and greases is recommended. The bath may be either an alkaline solution of such concentration as recommended by the supplier, and operated at a temperature as close to boiling as possible, or an emulsion-type cleaner operated as specified by the supplier. In either case, agitation of the solution by air or solution pumping, or movement of the part, will prove beneficial. The time may be 5 min or more.

6.3 *Rinse*—If the soak cleaner used is incompatible with the subsequent cleaner, a rinse is indicated. The supplier will normally suggest whether it is to be warm or cold, although a warm rinse (60°C) is usually desirable following alkaline soak cleaning. In any case, agitation of the rinse water is desirable; and, in the case of cold-water rinses, a spray upon leaving the tank is beneficial. The time of rinsing depends in part upon the shape of the part, but should be no less than 10 s.

6.4 *Anodic Cleaning*—The part is made the anode in a solution of a properly compounded alkaline cleaner of a concentration recommended by the supplier. The cleaner should be free-rinsing, and of high conductivity to permit a current density of 6 to 10 A/dm² at a tank potential of 6 to 9 V. The solution temperature should be from 90 to 100°C, and the cleaning time from 1 to 2 min.

6.5 *Rinse*—The supplier of a proprietary cleaner will usually indicate whether his product rinses more freely in warm or cold water. In general, rinsing should be done as described in 6.3, but preferably in a separate tank. Where practicable to do so, all rinses should be double rinses; that is, two separate rinses in succession, with the second cascading into the first for water economy.

6.6 *Acid Pickling*—This stage of the cycle is the most critical, and its operating conditions are dependent on the type of electroplating to follow. Most of the difficulties in electroplating of gray iron and malleable iron castings are caused by the free graphitic carbon, flake or nodular, which is present at the surface of the part. If the subsequent electroplating will be done under conditions causing sufficiently high hydrogen overvoltage (most acid solutions, and such alkaline solutions as copper, cadmium, or tin), a brief dip (less than 15 s) in a room temperature solution containing 200 mL/L of hydrochloric acid or 50 to 100 mL/L of sulfuric acid is usually adequate. See **Caution** in 2.1. If the electroplating will be done in an alkaline solution of low hydrogen overvoltage such as cyanide zinc, anodic treatment in acid to remove surface carbon is preferred. This is done by making the part the anode in a solution containing 250 to 350 mL/L of sulfuric acid for at least 30 s, preferably more, at a voltage sufficient to provide a current density of at least 10 A/dm². See **Caution** in 2.1. A black film of carbon smut will form during the first 15 to 30 s, then the part will become passive and the oxygen evolved on the part will remove the carbon by a combination of scrubbing and oxidation, leaving the casting relatively clean.

6.7 *Rinse*—The part should be rinsed in cold water as described in 6.3, but in a separate tank.

6.8 *Anodic Cleaning*—The casting should be subjected to anodic cleaning as described in 6.4, using either the same type of proprietary cleaner or a room temperature solution consisting of sodium cyanide (30 to 45 g/L) and sodium hydroxide (30 to 45 g/L).

6.9 *Rinse*—The part should be rinsed in cold water as described in 6.3, but in a separate tank.

6.10 *Activation*—If electroplating is to be done in alkaline solutions, such as cadmium, copper, tin, or zinc, no further treatment should be necessary. For nearly neutral or acid electroplating processes, however, parts should be immersed for 5 to 15 s in a room-temperature solution containing 50 to 100 mL of sulfuric acid. See **Caution** in 2.1.

6.11 *Rinse*—Activated parts should be rinsed in cold water as described in 6.3, but in a separate tank.

7. Variation in Procedure for Parts to be Racked

7.1 Where parts are subjected to several operations before electroplating, such as machining, forming, polishing, etc., thought should be given to possible precleaning between operations.

7.2 Mineral oils, particularly in recesses, are best removed by vapor degreasing.

7.3 Lubricating oils, buffing compounds greases, and the like, are best removed by anodic electrocleaning as described in 6.4. Heavy deposits of dried-on buffing compound may be more effectively removed by cathodic cleaning under similar operating conditions.

7.4 Castings that are heavily rusted can be pickled in a solution containing 50 to 100 mL/L of sulfuric acid and a suitable inhibitor to prevent excessive attack of the basis metal. See **Caution** in 2.1. Preferably, the solution should be operated at 65 to 95°C, and the time should be as required to remove the rust.

7.5 Very heavy scale can be removed by making the work anodic in a solution as described in 7.4, but with a suitable wetting agent instead of the inhibitor.

7.6 For castings from which molding sand has not been completely removed by the abrading processes described in 3.2 and 3.3, a dip in a water solution consisting of 125 mL/L of sulfuric acid and 125 mL/L of hydrofluoric acid at 20 to 30°C may be employed. See **Caution** in 2.1.

7.7 A suggested alternative for most of the cycle described in Section 6 is the use of one of the several proprietary processes involving molten caustics, hydrides, or alkaline salts, both with and without electrolysis. The suppliers of these processes should be consulted for details.

8. Procedure for Parts to Be Processed in Bulk

8.1 Castings to be cleaned in cylinders other than those in which the electroplating will be done should be processed through a cycle as follows:

8.1.1 *Tumble Cleaning*—Parts are cleaned by tumbling without current in a solution of properly compounded alkaline cleaner of 45 to 90 g/L at a temperature of 90 to 100°C for at least 5 min.

8.1.2 *Rinse*—Rinse for at least 1 min by tumbling in warm water, preferably agitated and overflowing.

8.1.3 *Acid Pickle*—Tumble the parts for at least 1 min in a solution of 250 to 350 mL/L of sulfuric acid at 65°C.

8.1.4 *Rinse*—Tumble in cold water, preferably agitated and freely overflowing, for at least 1 min.

8.1.5 *Activation*—Parts to be electroplated in acid solutions may be transferred to electroplating cylinders without further processing. Parts to be electroplated in cyanide solutions should be tumbled for at least 1 min in a room temperature solution consisting of 15 to 30 g/L of sodium cyanide and 15 to 30 g/L of sodium hydroxide.

8.1.6 *Rinse*—Parts activated as in 8.1.5 should be tumbled in cold water as described in 8.1.4, but in a separate tank.

8.1.7 *Storage*—If some time is to elapse between cleaning and electroplating, parts may be stored in a solution as described in 8.1.5. Castings to be subsequently electroplated in acid baths after storage must first be rinsed as described in 8.1.4, then tumbled for 1 min in a solution containing 30 to 50 mL of sulfuric acid, and rinsed again as described in 8.1.4 before being transferred to the electroplating cylinders. At best, it is not advisable to store castings for any length of time in such cyanide solutions, as salts may be retained in the pores and cause eventual spotting out.

9. Variations in Procedure for Parts to Be Processed in Bulk

9.1 Where both cleaning and electroplating will be done in the same barrel, using insulated cylinders, a cycle as described for racked work (Section 6) may be used, except that solution temperatures must be kept within the limits prescribed by the manufacturer of the barrels, and times increased by a factor of two or three to compensate for any lowering of temperature.

9.2 Electrolytic processes such as anodic cleaning and pickling should be carried out at a minimum of 12 to 15 V, so as to get the maximum current possible on the work within the temperature and current limits of the cylinder construction. Too low a current may not remove the smut and too high may damage the cylinder.

9.3 Where practicable, precleaning should be done as prescribed for racked work in 4.2.

10. Variations in Procedure for Various Types of Electroplating


10.1 *Zinc Electroplating*—Occasionally there is difficulty in the electroplating of certain castings which may be overcome by preceding the zinc electroplating with a strike such as cadmium, tin-zinc, tin, and acid zinc.

10.2 *Chromium Electroplating*—Variations in cleaning and pickling times should be investigated to find the optimum. In certain cases it may be desirable to omit any preliminary wet processing and to resort to grit blasting.

11. Test for Effectiveness of Cleaning

11.1 The most reliable test of the effectiveness of the preplating cleaning cycle is the appearance of the electroplated part and its performance in service.

11.2 A commonly used test for the removal of greases and oils is the inspection for water breaks. This is best done after

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pickling or acid dipping, as an alkali film may mask a water break. The test is not always reliable.

11.3 Wiping a part with a clean white cloth just before entry into the electroplating bath will reveal whether the smut has been removed.

11.4 An inspection of parts after just a few seconds of electroplating can reveal either a uniform color, indicating a clean surface, or blotchy areas, indicating incomplete cleaning.

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