



Standard Practice for Preparation of Low-Carbon Steel for Electroplating¹

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This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 This practice is intended as an aid to electroplaters in setting up a suitable cleaning cycle preparatory to electroplating of low-carbon steel (Note 1) containing less than 0.35 mass % of carbon and to indicate some of the precautions that must be taken to maintain this cycle in good operating condition.

NOTE 1—The preparation of high-carbon steel for electroplating is covered in Guide B242.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.3 *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.*

2. Referenced Documents

2.1 ASTM Standards:²

B242 Guide for Preparation of High-Carbon Steel for Electroplating

B322 Guide for Cleaning Metals Prior to Electroplating

3. Nature of Cleaning

3.1 The preparation of low-carbon steel for electroplating involves three basic steps in the following order:

- 3.1.1 Removal of oil, grease, and caked-on dirt,
- 3.1.2 Removal of scale and oxide films by “pickling,” and
- 3.1.3 Removal of any smut left on the surface after step 3.1.2 and activation of the steel.

¹ This practice is under the jurisdiction of ASTM Committee B08 on Metallic and Inorganic Coatings and is the direct responsibility of Subcommittee B08.02 on Pre Treatment.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard’s Document Summary page on the ASTM website.

3.2 Removal from the steel of fabricating lubricants and finishing compounds may have to be undertaken by “precleaning” before the articles reach the electroplating room. The remainder of the operations should immediately precede the electroplating. In some instances separate removal of smut may not be necessary as in the case of parts which are barrel-electroplated and tumbled.

4. Cleaning Solutions and Apparatus

4.1 All solutions should be subject to chemical control, including determinations of the free acid and iron contents of the pickling solutions and acid dips, and such tests of the cleaning solutions as recommended by the manufacturer.

4.2 Based on tests and experience, all solutions should be discarded before they have lost their effectiveness.

4.3 To conserve cleaning and pickling solutions and to ensure continuous operation when heavy production is involved, doubling of facilities in the same line of operation may be desirable. This arrangement will result in a high degree of contamination of the first of two solutions of the same kind while the second ones will be sufficiently clean to continue to use. It will also reduce the degree of contamination of subsequent solutions, for example, by oil and grease.

4.4 As an alternative to the procedure described in 4.3, the cleaner and pickle tanks may be provided with a large dam overflow and a pump having its intake placed about half-way down the overflow dam between the accumulated grease and oil on top and the settled-out solid dirt at the bottom, and having its outlet placed near the bottom of the tank at the end opposite to the dam overflow.

4.5 Separate tank electrodes, removable from the tank for inspection and cleaning, should be used. Contact hooks for the electrodes should be of the inverted V-type for round tank bars and should be of sufficient size to carry the required current.

4.6 Rinse tanks should be arranged with a dam overflow, and any water inlet other than a spray should be placed so as to ensure thorough circulation of the water and a large working surface free from grease accumulation. An adequate flow of water is essential.

4.7 Heating coils should be placed on the work-piece side of the tank in order to assure a working surface free from grease accumulation.

5. Procedure for Racked Parts

5.1 The cycle described in 5.2 to 5.6 should be used for the preparation of racked parts subsequently electroplated in still tanks, agitated tanks, semi- and full-automatic equipment, except in those cases described in Section 6.

5.2 *Precleaning*—In general, it is necessary to remove fabricating lubricants, buffering compounds, and other soils by precleaning. This precleaning may be accomplished with alkaline soak cleaners, cleaners designed to remove buffering compounds (including the use of ultrasonic cleaners), alkaline spray cleaners, and the use of chlorinated solvents such as trichloroethylene and perchloroethylene in vapor-type degreasing equipment, or by use of cold chlorinated solvents if vapor equipment is not available. Precleaning normally should be accomplished as soon as possible after fabrication because many stamping lubricants and buffering compounds become much more difficult to remove if allowed to age on the steel surface and can chemically attack the substrate causing etching.

5.3 *Electrocleaning*—The part to be cleaned should be anodically (reverse) electrocleaned in a solution of a suitably compounded, free-rinsing, high-conductivity steel electrocleaner, at a concentration of about 45 to 90 g/L. The current density should preferably be between 5 and 6 A/dm² and the tank voltage about 6 V. The temperature should be between 60 and 90°C. The time of cleaning following an effective precleaning operation is usually between 1 and 4 min. If proprietary cleaners are used, the recommendations of the manufacturer should be followed.

5.4 *Water Rinse*—Immerse the part to be cleaned in clean, overflowing water for a minimum of 15 s. If possible, air agitation of the water rinse should be provided. If the water is very cold, below 10°C, slight warming is beneficial. A fresh water spray on the part as it enters and leaves the rinse tank helps ensure complete rinsing.

5.5 *Acid Pickling*—Pickle the part in a solution of 150 to 500 mL of concentrated, 31 mass %, hydrochloric acid (density 1.16 g/mL) diluted to 1 L, 100 mL of concentrated, 93 mass %, sulfuric acid (density 1.83 g/L) diluted to 1 L, or a solution of proprietary acid salts at room temperature, for a sufficient length of time to remove all oxides, rust, or scale. (**Warning**—The acid should be added to the approximate amount of water required and then after thorough mixing, diluted to exact volume.)

5.6 *Alkaline Descaling*—In place of acid pickling (5.5) it is sometimes found that alkaline descaling may be more practical. Such solutions are operated at about 40°C and average current density of 2 to 5 A/dm². A typical bath composition may be as follows:

Sodium hydroxide	180 g/L
Sodium cyanide	120 g/L
Chelating agent (EDTA-NTA gluconates)	80 g/L

When using this method it must be followed by a water rinse (5.4), an acid dip (5.5), and water rinse (5.4).

5.7 *Water Rinse*—Rinse the part again, as described in 5.4 but in a separate tank.

6. Variations in Procedure for Racked Parts

6.1 Consideration should be given to separate precleaning between manufacturing operations; for example, between gear-cutting and deburring operations, and between drawing or stamping and buffering operations.

6.2 Vapor phase degreasing with chlorinated solvents is an excellent way to remove mineral oil from recesses such as overlapping joints that cannot be cleaned by any other method.

6.3 Plants with limited facilities sometimes omit precleaning especially with work that is not too heavily soiled. This is permissible; however, electrocleaning time may have to be increased and it is almost always necessary to change electrocleaners more frequently. Likewise, close control is necessary to ensure proper electrocleaner concentration at all times.

6.4 While pickling in strong hydrochloric acid or acid salts in accordance with 5.5 is suitable for most oxide conditions, including heavy annealing scale, welding marks, or wheel burns, it may sometimes be preferable to use hot sulfuric acid (about 100 mL of concentrated, 93 mass %, sulfuric acid (density 1.83 g/mL) diluted to 1 L) containing a suitable inhibitor to protect the steel from over pickling (see **Warning** in 5.5). The acid temperature may vary between 50 and 70°C. When inhibitors are used, a second alkaline cleaning operation, preferably electrocleaning, should follow pickling to remove any adsorbed inhibitor.

6.5 Heavy scale may be removed more rapidly by making the part to be pickled either anodic or cathodic in a 50 to 100 mL of concentrated, 93 mass %, sulfuric acid (density 1.83 g/mL) diluted to 1 L or proprietary acid salt solution at a temperature of 50 to 65°C and an average current density of about 4 A/dm² (see **Warning** in 5.5). Anodic pickling avoids hydrogen embrittlement. Cathodic pickling provides a brighter surface provided the acid is not contaminated with heavy metals such as copper, tin or lead.

6.6 In addition to acid pickling, scale may be removed by shot-blasting, tumbling, or sandblasting. These methods avoid hydrogen embrittlement but may work-harden the surface.

6.7 When there is a lapse of time between the final rinsing operation (5.6) of the preparatory cleaning process and electroplating, arrangements should be made for temporary storage of parts. Those which are to be electroplated in a cyanide solution may be stored in a solution of 15 to 30 g/L of sodium cyanide and an equal amount of sodium hydroxide at room temperature. Those which are to be electroplated in an alkaline solution such as alkaline tin, should be stored in a solution containing 8 g/L of sodium hydroxide at room temperature. Storage time for parts to be nickel electroplated should be minimized but, if necessary, they may be held in clean cold water for a very short time (3 or 4 min, depending on water quality).

7. Procedure for Parts in Bulk

7.1 The cycle described in 7.2 to 7.5 should be used for cleaning part to be electroplated in barrels, hand-operated or automatic, except in those cases described in Section 8.

7.2 *Alkaline Cleaning*—Clean the parts by tumbling with or without current, in a solution of 30 to 60 g/L of a suitable alkaline cleaner at 60 to 90°C. Anodic electrocleaning at about 2 to 4 A/dm² may supplement tumbling for more effective cleaning.

7.3 *Water Rinse*—Rinse the parts in clean, overflowing water. Air agitation of the rinse water is beneficial. If the water is very cold, rinsing is improved by some warming.

7.4 *Acid Pickling*—Pickle in a solution of 150 to 500 mL of concentrated, 31 mass %, hydrochloric acid (density 1.16 g/mL) diluted to 1 L at room temperature. Other suitable pickling solutions are proprietary acid salts and 50 to 150 mL of concentrated, 93 mass %, sulfuric acid (density 1.83 g/mL) diluted to 1 L (see **Warning** in 5.5).

7.5 *Water Rinse*—Rinse the parts again as described in 7.3, using a separate tank.

8. Variations in Procedure for Bulk Parts

8.1 Two water rinses after both cleaning and acid pickling are beneficial in many barrel electroplating operations. This serves to ensure more complete rinsing and thus prevent carry-over of cleaners or acids into subsequent tanks.

8.2 Heavily scaled parts such as heat-treated nuts and bolts may require pickling in strong inhibited sulfuric acid (see 6.4). Tumble-pickling is preferred to immersion-pickling in bulk because the tumbling action increases the rate of scale and oxide removal.

8.3 *Storage*—If parts must be stored after cleaning and pickling prior to electroplating, the procedure described in 6.7 should be followed.

NOTE 2—Additional information on procedures for cleaning of low-carbon steel prior to electroplating may be found in Guide B322.

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