

## The Canning Handbook 2005 – Extract

### PRE-TREATMENT

#### Cleaning, Pickling and Bright Dipping

*This document contains references to product examples used in specific applications. These products may not be available in all markets or countries however your local MacDermid representative can advise you of the equivalent local product.*

The importance of perfect cleaning cannot be over-emphasised, since upon the efficiency of this operation depends the adhesion of the deposited metal. Of the various processes designed to give a clean surface suitable for plating, none is more important than the removal of grease, oil and other soils, whether left from machining, stamping, spinning, pressing or polishing. Plating on to a dirty or greasy surface inevitably leads to blistering or peeling of the deposit.

The various cleaning and pre-treatment processes through which an article must pass before it may be successfully electroplated can be classified under the following headings:

- Preliminary Cleaning or Degreasing
- Pickling or Bright Dipping

Preliminary cleaning or degreasing involves the removal of heavy oils, greases and soils, and is necessary before a component can be pickled or bright dipped for the removal of oxide and scale. After the pickling step there may be some residual oil remaining on the substrate. This can occur even though the scale or rust was clean and ostensibly water-break free. If a contamination free substrate is needed, the pickle step should be followed by a water rinse, an alkaline cleaning step and an additional rinse.

After this the component is ready for polishing or other mechanical finishing. Even where an article is not mechanically finished prior to plating, it is still good practice to carry out initial degreasing and pickling before components pass to the primary cleaning stages.

- Hot Alkaline Cleaning
- Final Cleaning and Surface Activation

These stages will remove all traces of grease and any passive film to give an active surface to which the electroplated deposit will adhere.

The pre-treatment processes immediately prior to plating generally take the form of hot alkali cleaning, possibly followed by acid dipping to remove slight oxide films, then final cleaning to ensure that the component is perfectly clean. Where the final cleaning is carried out in an alkaline solution and the components are to be plated from an acid solution such as nickel, they are given a dip through dilute acid followed by water rinsing before they are placed in the plating tank.

## PRELIMINARY CLEANING AND DEGREASING

### **AQUEOUS NEUTRAL DETERGENT PRE-CLEANERS**

Aqueous neutral detergent pre-cleaners, e.g. *Metex LC Mersol / Metex LC 2000/3000 Soak Cleaner*, are employed for the removal of polishing residues and heavy soiling prior to normal cleaning before electroplating and also for interstage cleaning of articles during manufacture. Their action is to (1) modify the soils so that they can be easily removed by the subsequent alkaline cleaning stage, or (2) dissolve oils and greases.

After immersion in the *Metex LC Mersol / Metex LC 2000/3000 Soak Cleaner* a thin surface film ('hydrophobic film') may remain which can result in 'water-breaks' being apparent, particularly on unpolished surfaces. This surface film is removed by a hot alkaline soak cleaner and is no way detrimental to the cleaning cycle. The *Metex LC Mersol / Metex LC 2000/3000 Soak Cleaners* are generally used in off-plant cleaning operations.

In circumstances where the removal of heavy machine oils and swarf is necessary, prior to the final cleaning and surface activation in the electroplating cycle, the use of interstage spray-wash machines can be both efficient and economical. When operating typical spray-wash interstage cleaning units with *Sintklin EM / Masco 86* not only the removal of large quantities of oil/soil is achieved but also very good corrosion inhibition on iron and steels. In many instances multi-metal processing is possible when using this type of fully synthetic and inhibited cleaners that are free of silicates, phosphates, nitrites and oil.

The cleaners *Metex LC 2000*, *Sintklin EM* (and others where specified) are specifically formulated to achieve oil separation during the cleaning process. For this reason oil separation units should be incorporated into the build of the cleaning unit whether it be of immersion (possibly with applied ultrasound) or spray design.

### **ALKALINE CLEANERS**

Aqueous alkaline cleaners, e.g. *Metex PS Activax*, and *Metex Liquid Cleaner System (and Metex 560-L)* may be used for initial soak or electrolytic degreasing, as well as final cleaning prior to plating.

As previously stated, when large quantities of oil need to be removed, the use of an oil separation unit is recommended (a simple line diagram of this type of equipment can be found on the following pages).

Where spray or power wash degreasing is required, e.g. for the removal of oil, cutting lubricants and swarf from all metal groups in machine shop interstage cleaning operations, the *Masco 86 and Maxclean S-108* are particularly effective. These cleaners are blended with the most recent surface-active materials together with agents to disperse scum, obviate hard water precipitates, and inhibit oxidation of the cleaned metal surface. Bactericides and fungicides are also incorporated into many of the products in the interstage cleaner category together with biodegradable surfactants. Such cleaners have inherent oil displacing characteristics.

## HOT ALKALINE CLEANERS

Hot aqueous alkaline cleaners are used for the removal of grease and soils from components to be electroplated. Choice of metal cleaner to be employed is influenced by the material to be cleaned, and also by the type of soil or grease to be removed. A range of cleaners is available to meet these varying requirements and a range of examples quoted at the end of this section in the 'product summary'.

The various cleaners may be classified in order of alkalinity. As a general rule the higher the alkalinity, the more rapid will be the cleaning. Recent developments in cleaner formulation and the use of modern surfactants do, however, enable effective cleaning to be obtained with solutions having much lower free alkalinities than those formerly employed. In modern cleaner formulations soil suspending and anti-redeposition agents are also incorporated together with sequestering agents to enable the cleaner to be used effectively in hard water areas.

The effect of an alkaline cleaner is influenced by:

- The type of basis metal.
- The type and concentration of the cleaner.
- The cleaner temperature.
- The time of immersion.
- The conditions of use, i.e. immersion; ultrasonic/immersion; electrolytic (cathodic or anodic); spray.

Increasing the cleaner concentration, temperature, time of immersion, and the use of electrolytic, ultrasonic or spray cleaning will all accelerate the rate of cleaning. There are cases, however, where the concentration and alkalinity of a cleaner can have an adverse effect on the rate of cleaning. This can occur with certain synthetic and/or emulsifiable lubricants. With these lubricants, high concentrations of salts and high alkalinity will have a tendency to set the soil. Generally, the soil will become opaque white and will be removed at a very slow rate. If an identically soiled part is placed in a cold, or better yet, a warm rinse, the soil will dissolve and/or emulsify at a high rate. If this occurs, a low salt, low alkalinity and high surfactant liquid cleaner will probably perform best.

It is, however, important that the recommended concentrations given for the various cleaners are not exceeded. Operation at concentrations and temperatures higher than those recommended can result in the loss of solubility of components of the surfactant system. The components will then float to the surface or sink to the bottom and the loss of detergency will be profound.

Strongly alkaline cleaners may be used for steel, but for the non-etch cleaning of zinc and aluminium a solution having a low free alkalinity must be used.

The common metals may be classified in the following groups:

- Steel.
- Copper, brass, nickel silver and other copper based alloys, magnesium and its alloys.
- Zinc base alloy, tin, tin alloys such as pewter, Britannia metal, lead and lead alloys.
- Aluminium.

The alkaline cleaning stage is generally one part of a pre-treatment system used to prepare the surface for electroplating.

Details of the cleaners that are referred to in this pre-treatment section and others can be found within the product summary tables in the appendix.

### **Equipment for Hot Alkaline Cleaners**

For alkaline cleaners a welded steel tank is normally employed. Plastic lined, rubber lined, and also plastic tanks can be used subject to temperature limitations, but galvanised, tinned or lead lined tanks are *not* suitable. The tank is usually fitted with a weir type overflow on one end to permit grease films to be floated off the surface of the solution by raising the level. Provision for heating the solution is necessary, and this may be by means of a steel steam or high-pressure hot water coil, steel cased immersion heaters, or gas burners fitted beneath the tank.

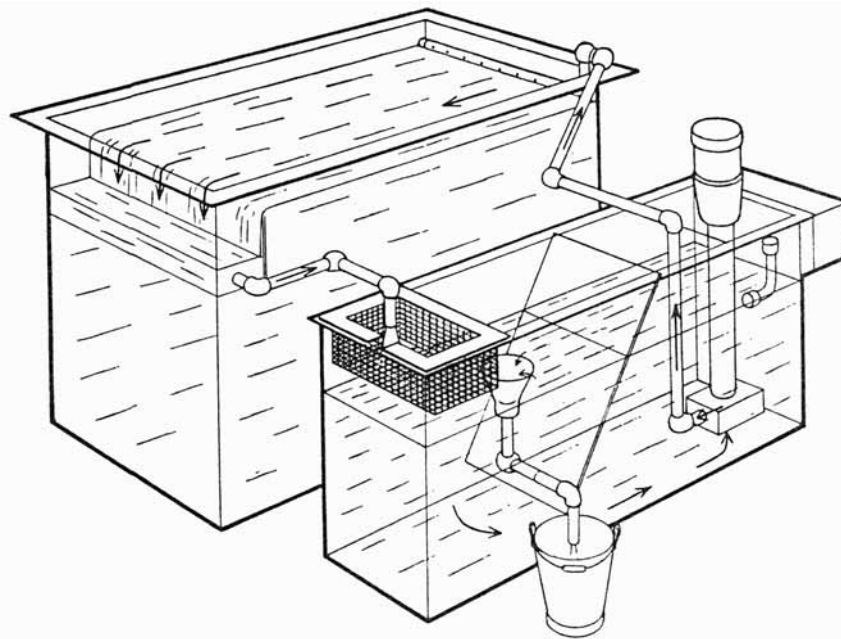
For electrolytic cleaning the tank is fitted with a middle rod carrying the articles to be cleaned and two outer rods for carrying the steel plate electrodes. For small tanks the tank itself may be used as outer electrode. For anodic cleaning the middle rod is connected to the positive and the outer rods to the negative of the low voltage direct current supply. For cathodic cleaning the middle rod is connected to the negative and the outer rods to the positive.

To prevent rusting of the plates above the solution level they may be nickel plated before use. On automatic cleaning plant, solution circulation by means of a pump or a pump with eductors may be provided, but where no-foaming or low foaming cleaners are employed air agitation can be used to provide solution movement.

### **Oil Separation Units**

Adequate oil separation plays an important role in metal-finishing pre-treatment. Effective removal of oil from the surfaces of process solutions ensures that the workpiece is not contaminated as it is withdrawn from the cleaning solution itself, hence 'down-line' process contamination is avoided. The removal of oil from the cleaning process solution may allow additional surfactant to be released into the cleaner, and hence made available to play a further role in the wetting/emulsification processes.

As stated previously, specific inter-operational cleaners (generally spray operated) have inherent oil displacing characteristics that allow the oil to become a separate and removable phase after removal from the workpiece surface. Such cleaner formulations must always be operated in conjunction with effective oil-separation mechanisms. A typical alkali-cleaning tank fitted with an oil separation unit is shown as follows:



*Oil contaminated solution flows into the separation unit where the oil separates out as an upper second phase (i.e. floating oil layer). To remove the oil layer, periodically the level of the liquid in the separation tank is raised.*

### **Barrel Cleaning**

Most hot alkaline cleaners can be used in barrel installations but the solution temperature must be kept below the maximum recommended temperature for the barrels employed. For polypropylene barrels the maximum temperature limit is 82°C, while *Perspex* barrels must not be used at higher than 70°C. Where this necessitates the operation of a solution at a temperature lower than that usually specified, it may be necessary to extend the cleaning time beyond that normally recommended in order to obtain effective cleaning. When barrel cleaning light loads, the barrels can be immersed for short periods in solutions with a higher than normal temperature but for large loads and for massive components which could cause heavy impacts as the barrel rotates, the maximum solution temperature should be reduced, to avoid distortion of the barrel.

## **TECHNIQUES AND MECHANICS FOR EFFECTIVE CLEANING**

The cleaning process can be viewed as requiring a total system sufficiently energetic to overcome the binding energy of a material to a substrate. The energy of the cleaning system is the sum of thermal, chemical and mechanical energies applied for a period of time. Therefore, if chemical energy (i.e. preferred choice of cleaner) and cleaning time are held constant, any desired reduction of thermal energy requires an increase in mechanical energy to maintain the effective cleaning capability of the system.

### **Immersion Application**

The components to be treated are totally immersed in the cleaning solution whilst being held individually on jigs or containerised in some manner (i.e. baskets, barrels or similar). Relying on heat and chemical energy alone to achieve the required degree of cleanliness may not be sufficient, particularly if there are only a few stages in the pre-treatment line.

Introducing mechanical energy by means of various forms of agitation is beneficial and assists in reducing process times. Mechanical agitation generally includes: air agitation, ultrasonics, mechanical movement and the gas scrubbing effect produced in electrolytic processes.

Mechanical energy is an extremely important factor in metal detergency since all types of mechanical actions greatly increase the speed and efficiency of soil removal. Immersion cleaners must have proper agitation. Lack of solution movement is a common cause of poor cleaning. Although air agitation appears effective, and is better than no agitation, mechanical agitation is more effective and more readily adaptable to skimming and oil removal. Ultrasonic agitation is generally the most effective source of energy for immersion cleaning of critical parts and parts with small holes. Ultrasonically agitated immersion cleaners remove impacted polishing and buffing compounds most efficiently. Electrocleaning, a form of agitation that promotes gas scrubbing by electrolysis of the alkaline cleaner, is usually limited to plating operations and requires substantial jigs and fixtures to be effective.

### **Ultrasonic Application**

The equipment for ultrasonic cleaners includes a generator, a transducer and a stainless steel tank. The transducer introduces high frequency sound waves into the liquid media. Each point in the liquid is subject to alternating negative and positive pressure as the sound waves pass by. Negative pressure causes the liquid to fracture creating cavitation bubbles. As negative pressure is replaced by positive pressure, cavitation bubbles implode, creating intense areas of pressure and temperature. It is accepted that the intensity and amount of cavitation in a given volume of cleaning solution will determine the degree of cleaning. For each cleaning operation there are variables that will affect cavitation intensity, including the type of cleaner, bath temperature, the workload, power input to the transducer and the transducer's frequency of vibration.

Transducers generally operate between the frequencies of 20–40 kHz, dependant on the type of transducer construction. Low frequencies (17-25 kHz) produce large vapour bubbles and powerful implosions for cleaning large work surfaces. Frequencies that are too low can damage fragile components; for this reason the electronics industry uses frequencies greater than 35 kHz. Also, the noise generated at the lower frequencies may be objectionable.

In some instances the transducer frequency may be varied  $\pm 3$  kHz from the nominal frequency. This technique eliminates the tendency for cavitation to occur in discrete layers, leaving layers of less cavitation in between. Special ceramic transducers can generate six different frequencies in the tank at the same time. The high frequencies produce small vapour bubbles that penetrate small crevices and loosen contaminants, while the large bubbles formed at low frequencies remove soils completely.

Just as frequency determines the intensity of the cavitation implosion, the power level of an ultrasonic system determines the amount of cavitation per unit of time and volume of solution.

As in all cleaning operations the operating temperature influences the efficiency of the operation. This is also true of ultrasonic cleaning. However, at excessive temperatures the cavitation bubbles implode with very little power because of the high vapour pressure at these elevated temperatures.

It should be noted that high density parts, such as lead or cast iron will adsorb a great deal of energy and hence limit the amount of cavitation and the depth to which the cavitation penetrates the solution. Plastics, which conduct sound poorly, are difficult to clean ultrasonically because they weaken sound waves.

The amount of soil to be removed can greatly influence the cleaning rates. Gross contamination of the liquid used in the ultrasonic application will reduce the efficiency of the ultrasonic cleaning. It is for these reasons that the bulk of the contamination is removed by immersion/spray techniques prior to the ultrasonic cleaning stage. Hence ultrasonic cleaning is never the first stage of a cleaning process or used as a single stage process.

It is generally agreed that the minimum power required to start cavitation is in the region of 0.3-0.4 watt per square centimetre. Above this threshold, additional power increases the amount of cavitation. The required amount of power will also increase as the mass/surface area of workpieces within the tank increases. The maximum output capacity of the generators is generally sufficient to produce 1.5-1.6 watts per square centimetre when the workpiece loading in the process tank is at a maximum.

Applied ultrasonics can also make water rinsing more effective, particularly on workpieces having irregular surfaces or complex internal passages. Ultrasonic rinsing helps remove residual chemistry which, otherwise, might bleed out in later finishing steps. Ultrasonics will only be effective in areas where the process solution is in permanent contact with the surface of the workpiece, so inverted 'blind-holes' which generally have air pockets during the processing will not benefit from ultrasonic cleaning.

### **Spray Cleaning Applications**

An aqueous power wash machine may be of the conveyorised automated variety or a stand alone single stage machine. In either situation these washers spray an aqueous solution across the parts to remove oil and debris. In the conveyorised plants the workpiece travels through a series of chambers, each with different cleaning and rinsing solutions. In the single stage operation the workpiece is generally contained within an open-mesh basket. This basket is then rotated, often by use of turntables, within the spray-zone or flood zone of the machine. Helical screw designs are also used for transfer of the workpiece through the spray zones on the horizontal type barrel-spray plants.

Ideally, the workpiece is blasted from all angles with the process solution at high pressure (15 - 180 psi) and at elevated temperature (ambient-65°C). The force of the spray jets, the heat and the detergency of the process solution combine to create an effective process. V-jets are generally fitted to standpipes that supply the cleaner within the process chamber. These V-jets produce a 'fish-tail' pattern and create high velocity impingement of the process solution onto the workpiece as it traverses the spray zone. Correct placement and alignment of the V-jets creates an effective and overlapping 'fish-tail' pattern in the spray zones. This applies to all process zones within a multi-stage plant. Good cleaning is achieved when high impingement forces are applied to all component surfaces given sufficient process time for the cleaner of choice.

Excess, sprayed solution is recovered and reused. All machines operate a 'closed-loop' system whereby the used solutions are not disposed of daily but can be recirculated for a week of continuous operation. Ideally the cleaning solutions are recaptured after spray impingement and circulated through an associated oil-separation tank. In these tanks the oil is allowed to float to the surface and is skimmed off with the aid of weir type mechanisms. The oils collected may then be containerised for reuse or disposal. Dirt, heavy soils and suspended particles should be filtered off by means of a series of filter traps, of reducing mesh size, which are placed in the pipework circuitry prior to the head of the circulating pump.

Many types of inter-operational cleaner used in spray cleaning are oil displacing as opposed to oil emulsifying. This means that after oil removal from the workpiece surface by means of physical and chemical forces, the oil readily separates from the water phase of the cleaner allowing it to be removed by the appropriately fitted oil-separation mechanism. Inter-operational cleaners will also have been formulated to have good foam control under a wide range of high pressures. Non-oil type inhibitor systems may be incorporated into the cleaner formulation to give the necessary anti-oxidation characteristics required when the workpiece is to be stored for a period of time prior to further processing or shipping.

Spray wash applications have the following benefits:

- More efficient cleaning compared to manual aqueous tank cleaning
- Cleaning times are reduced
- Small units are available as portable workstations
- Solvent usage can be greatly reduced or eliminated
- Cost savings compared to traditional aqueous processes
- Used as a pre-wash before on-plant electroplating pre-treatment makes for more cost effective use of the on-plant pre-treatment materials.

### **Electrolytic Cleaning Applications**

The workpiece to be cleaned is made an electrode (anode or cathode) in a solution of cleaner electrolyte. When direct current is applied, water is electrolysed into hydrogen gas at the cathode and oxygen gas at the anode. The evolution of large volumes of gas at the surface of the workpiece creates a substantial amount of agitation, especially in those areas where the soil is partially removed (easy passage of current).

The aim of electrolytic cleaning processes is the removal of particulate material, not oil. For this reason the workpiece *should* enter the electrocleaner in an oil-free condition, the bulk of the original oil/soils on the workpiece having already been removed. Slow, mild, electrolytic cleaners improve smut removal (i.e. they do not flash off and leave smut behind like a vapour degreaser).

The surfactant blend within the electrocleaner should have good detergency properties to assist the soil removal at those points where gas evolution is taking place. The same surfactant blend will be responsible for creating a controlled foam blanket on the surface of the cleaning solution. This foam blanket should allow the caustic solution entrapped within the liberated gas to drain back into the process tank and minimise any emissions into the neighbouring environment.

To obtain the required electrical conductivity the major alkali builder within the cleaner is potassium or sodium hydroxide. The hydroxide concentration is generally higher in steel cleaners than in non-ferrous cleaners. In order to prevent attack on non-ferrous material the alkali base generally has reduced hydroxide levels. This reduced Caustic Soda is combined with higher proportions of silicates for protection of the base metal and more surfactant to replace the gassing energy that is lost at the lower current densities.

Metals which when exposed to oxygen form a passive layer, such as nickel, stainless steel or aluminium, are cleaned cathodically. Brass is cleaned cathodically to avoid the dissolution of zinc from the surface of the alloy (de-zincification). However, zinc alloys are generally anodically cleaned for another reason. To prevent attack on zinc alloys by alkali electrocleaners, it is prudent to use inhibited cleaners. When silicate is used as the inhibitor, it is possible for an insoluble film to develop when the workpiece is cathodic. Hence it is preferred that the workpiece be anodic, using specially formulated cleaners under mild conditions and for short process times.

Steel may be treated anodically or cathodically. However, when treating high-tensile steels consideration should be given to the deleterious effects of adsorbed hydrogen should the workpiece be made cathodic. The trend has always been towards anodic cleaning of steel as it is considered that best adhesion of electroplate coatings is achieved by this method.

Good current distribution across the individual workpieces should be strived for when electro-cleaning, just as when electro-plating. At very high current densities, detrimental dissolution and oxidation effects become more pronounced.

## MAINTENANCE OF METAL CLEANERS

A metal cleaner may be used for a given time (which is determined by past experience) and then replaced or, alternatively, maintained for a longer period by the regular addition of metal cleaner salts and also, if necessary, the appropriate addition agents (surfactants or emulsifiers). The choice between routine replacement and maintenance of the solution by regular additions will depend on many factors, including the type of articles to be cleaned, the volume of solution employed, and, in particular, the amount and types of soil carried into the cleaner solution.

### Additions of Metal Cleaner

An efficient method of maintaining a cleaner solution in effective operation is on the basis of the 'active' alkalinity. This is determined by volumetric titration with standardised acid using phenolphthalein as indicator.

Additions of the appropriate metal cleaner salts/liquid are then made in order to maintain the active alkalinity of the solution at its initial value. In the absence of laboratory facilities, an addition of 1% w/v of the appropriate metal cleaner should be made when the cleaning efficiency falls.

When, due to the high content of oils and suspended solids in the solution, further additions of cleaner result in little improvement in the cleaning efficiency, the cleaner should be discarded and a new solution made up.

Occasionally when cleaners are worked hot, the rate of evaporation of water is such that the cleaner becomes over concentrated and a 'scum' of salted out surface active agents appears on the surface. A sample of this layer should be checked for solubility in a little cold water and if it dissolves then the main cleaner can be diluted.

'Layering' of hot cleaners can easily occur where added water floats on top of the denser cleaner. To avoid this, vigorous stirring is necessary whenever an addition of water or salts is made.

When a cleaner is too dilute, anodic etching can occur on zinc based die castings accompanied by a slimy film on high current density areas. The cleaner should be analysed and brought back up to strength.

The laboratory method and factors for each pre-treatment process are described in the relevant technical data sheet.

### Control of Cleaning Solutions

Good control of the cleaning system is necessary to obtain maximum efficiency and economy. Practical limits should be set up and adhered to in practice on the following parameters:

<b>Concentration</b>	As established by the supplier $\pm 3$ g/ltr or 0.5 % by vol
<b>Temperature</b>	$\pm 3$ °C
<b>Time</b>	Usually fixed, and should be recorded
<b>Current Density</b>	$\pm 0.5$ amp/sq.dm
<b>Dumping Schedule</b>	Based on previous experience and square metres processed

All of the control factors are easy to determine and maintain.

Concentration can be determined by use of a simple laboratory test kit (pipette, burette, etc.), a handheld refractometer or conductivity meter.

More sophisticated cleaner control procedures are available, but are rarely necessary. The most difficult parameter to control and determine is the dumping schedule. This is best done by practical experience. The chemical cost of metal cleaning is a very small fraction of the overall

finishing cost. A few defects from poor cleaning quickly offset the cost of the fresh cleaning solution. Cleaner life is directly proportional to the soil load and little else. The most important part of the cleaning solution control is record keeping. All data should be maintained and located in an area where all concerned personnel can read it.

## PICKLING AND DIPPING

The term 'pickling' in the metal industry refers to the process of cleaning in acid, usually for the purpose of removing oxide or scale. It also applies to the same treatment for the removal of sand, casting skin, or corrosion products from the surface of the metal.

'Dipping' refers to a finishing operation for producing a clean lustrous surface after pickling. It is used mainly for brass, copper and copper alloys, and entails a brief immersion in appropriate acid solutions, e.g. *Aqua Fortis Bright Dipping Acid* or *Envirodip Extra*. The term also applies to any process involving the use of other chemical 'dips' or solutions for similarly removing stains and imparting a bright surface. Before either of these treatments the metal, if greasy, must be thoroughly cleaned by any appropriate method described in the previous pages.

There are also available combined cleaning and pickling solutions, e.g. *Pickle Aid*, *Masco SZ* and *Composto 80 EM*. These enable grease, oils, oxide and scale to be removed in one operation.

Articles that have been drawn, pressed, or spun from bright cold rolled sheet without annealing retain their bright finish and require little or no pickling, but parts that have been heat treated may have scale or oxide which must be removed from the surface before the next operation.

Descaling may be effected either by pickling or by shotblasting. Pickling is usually preferable for articles that have to be plated, except those made of grey cast iron. The complete removal of scale is very important to ensure uniform deposition and good adhesion of the plated metal. Shotblasting is not always fully effective, and under some conditions may hammer particles of scale into the surface of a soft metal such as mild steel.

Pickling acids will generally remove oxide scale without difficulty, but will not deal effectively with carbonaceous pitches or charred oil residues. Hence all processed articles that have to be annealed or heat treated should be degreased to remove lubricant before they are raised to a high temperature.

All acid solutions should be selected to meet the following qualifications: (1) the metal surface should not be disturbed any more than desired and (2) the metal salt formed from the reaction between the metal and the acid must be water soluble.

Inhibitors may be used in pickling, but their use in the activation processes is usually not recommended because of the possibility of adsorbed films, which may interfere with later operations, (such as electroplating) resulting in poor adhesion or cloudy electrodeposits. The function of the inhibitor in pickling is to reduce the amount of attack in areas where the scale has been removed and to minimise hydrogen embrittlement.

Effective pickling of steel concentrates on the attack and removal of the thin black Magnetite rust film found below the heavier visible red or Ferric Oxide film on rusted steel. Red rust is a higher oxidation state and occurs at the rust/air interface on steel and adheres to the Magnetite layer. Magnetite is a lower oxidation state and occurs on rusted steel as a thin film adhering directly to the metal. When the lower

Magnetite film is removed, the red rust has nothing to adhere to and is also removed. Hence the balanced mixture of acid(s), inhibitors and surfactants used within the acid pickle should be capable of penetrating the rust layers and preferentially removing the lower Magnetite layer. In this manner the upper red rust layers are also removed.

Most pickling solutions have little or no effect on oils or greases, thus necessitating a pre-cleaning operation. Recently however, new types of detergents which tolerate acidic conditions have been employed to remove light oils and greases. These have proved successful on light contamination, but generally the work is still pre-cleaned before pickling.

Descaling, particularly of ferrous metals and those readily attacked by acid, should be undertaken when the articles are in the 'rough' condition, before they are machined, polished or finished, otherwise there is a possibility that screw threads and critical dimensions may be affected.

Difficulties of this nature may usually be overcome by using an inhibitor with the acid, to confine the action to the scale and minimise attack upon the metal, but as a general rule it is preferable to treat the articles in the early stages of manufacture. Similarly, when dealing with small brass pressings such as caps and other hollow parts which are to be nickel and chrome plated, much trouble may be avoided if they are bright dipped before being polished on the outside.

The dipping shop or room where pickling is undertaken should be separate from, but adjacent to, the plating and polishing departments. Often a considerable amount of fine acid spray is produced when pickling iron and steel, and although not poisonous it is irritating to the skin, hence large vats should be provided with an exhaust. The latter is advisable also to prevent corrosion of metal fittings in the vicinity, such as electric lamp holders and switches, and these should be protected with acid restraint paint regularly applied.

The floor of the shop must be water and acid proof.

Acid must not be disposed of by emptying vats directly down the drain, but must be neutralised.

### **Choice of Pickling or Dipping Solution**

The following solutions are described in this section:

For Iron and Steel, Group 1.

- Dry Acid Salt
- Sulphuric acid pickling
- Hydrochloric acid pickling
- Metex Skalene pickle
- Alkaline Deruster
- Hydrofluoric Acid pickling
- Pickle Aid

For Stainless Steel

- Nitric acid – hydrofluoric acid

For Copper and its alloys, Group 2.

- Dry Acid Salt

- Sulphuric acid pickling
- Aqua Fortis Bright Dipping
- Chromic acid dip
- Bright Dip Concentrate for Brass

For Aluminium, Group 4.

- Hydrofluoric acid pickling
- Dilute nitric acid

For Magnesium

- Dilute sulphuric acid or nitric acid

For Sand Removal from Castings

- Hydrofluoric acid pickling

## DRY ACID SALTS

These are powdered salt mixtures that provide an alternative to concentrated acid for many plating shop applications, e.g. *Metex M-629*. Generally such materials are supplied in polythene lined containers which are easy and safe to store and handle. It is therefore of particular advantage where the use and storage of concentrated acids in winchesters or carboys would be undesirable.

All proprietary dry acid salts dissolve in water to give an acidic solution which provides an alternative to the use of concentrated mineral acid in the preparation of acid dips and pickles.

On tin-containing brass alloys and bronzes *Metex ACS-42* & *Metex M-629 Dry Acid Salt* are particularly effective, providing an alternative to the traditional dilute acid dips. On a number of installations the use of *Metex ACS-37 Dry Acid Salt* has completely eliminated problems due to poor adhesion when leaded bronzes have to be nickel-plated.

The high activity of these dry acid salt solutions enables acid concentrations to be considerably reduced. For example, as a pickle in general pre-treatment of steel articles to be electroplated, *Metex ACS-42* or *Metex M-629 Dry Acid Salt* at 60 to 75 g/l can effectively replace 50% v/v hydrochloric acid or 10% sulphuric acid.

All dry acid salts should be stored in a dry situation and care should be taken to avoid the powder becoming wet. Contact with eyes and skin must be avoided and it is recommended that gloves and goggles be worn when handling the powder.

Additional details with respect to acid salts are quoted in the appendix product summary.

## SULPHURIC ACID PICKLING

Dilute sulphuric acid is used for the pickling or descaling of iron, steel, copper, brass, nickel-silver and other copper alloys.

For the large-scale pickling of iron and steel, sulphuric acid is generally used in preference to hydrochloric acid.

### Equipment

The acid may be contained in a lead lined or rubber lined welded steel tank; if only a small volume it may be held in a solid lead or plastic vessel; large tanks may be built in plastic lined GRP braced with a frame or in acid-resisting brickwork.

Where rubber lined tanks are used, great care must be taken to prevent the concentrated acid from coming into direct contact with the rubber.

The tank may be fitted with a zirconium or lead steam coil, a *Teflon* heating coil or lead-covered electric immersion heaters.

Metal strip and large articles are generally suspended by hooks or cradles, or if intended for plating, parts may be wired or placed on racks or jigs. Small articles are most conveniently dealt with in perforated metal or wire mesh baskets. These containers or hooks must be made of acid-resistant material, such as *Monel* metal.

### Solution Composition

The sulphuric acid concentration is usually between 5 and 10 per cent by volume.

A suitable composition is:

Commercial sulphuric acid sp. gr. 1.84	55 ml/l
Weight equivalent	100 g/l

### *Preparation of the Pickle*

The container should be filled with *cold* water to about two-thirds in capacity and the acid then added gradually in a thin stream, care being taken to avoid splashing. The bath should be stirred continuously during the addition, and finally brought up to the correct level with more water.

*Caution – The solution becomes hot during mixing, and it is important that the concentrated acid shall be added to the water and not vice versa. There is no danger in adding water to the dilute pickle.*

### *Use of Inhibitors*

For the descaling of steel, the use of an inhibitor is of advantage. For electroplating and phosphating lines and for other relatively small scale applications, the use of *Pickle Aid* is advised. The addition of 5% by volume of this material to the acid pickle will effectively prevent any attack on the basis metal during the removal of the oxide and scale. In addition, the solution is effective for the removal of oils and grease and is effectively suppressed against spray.

For large-scale pickling applications, the use of *G.P. Inhibitor 11-66* is advised. This material is added at the rate of 1 ml/l of dilute acid, for this inhibitor there is only a very slight loss in effectiveness as the temperature rises and operating temperatures in the region of 65-70 °C are typical.

By using an inhibitor, attack on the basis metal is avoided, the amount of hydrogen picked up by ferrous metals is reduced and the life of the acid solution is prolonged in that, once the scale has been removed, the chemical reaction ceases.

### *Typical procedure*

Components to be processed, after being degreased, are simply immersed in the acid until they are de-scaled. If the film of oxide is thin, i.e. merely a 'temper' colour or discolouration, a few minutes will suffice to remove it, but if heavy black scale is present, as on forgings and hot stampings, it may be necessary to pickle for half an hour in hot acid or for several hours in cold. When descaled, the articles are thoroughly swilled in running water and may be brushed or scoured if necessary before they are dried or put through the next operation.

Iron and steel should not be pickled in the same vat that is used for the treatment of the non-ferrous metals.

### *Neutralising Dip*

To minimise rusting during drying it is advisable to rinse iron and steel parts in a slightly alkaline solution after they have been pickled and swilled. A suitable dip is prepared by dissolving 10 g/l trisodium phosphate in water, which may be contained in a plain steel or plastic vessel. The articles should be swilled again in cold water before they are dried. This treatment is unnecessary for parts that are to be acid etched or anodically cold cleaned immediately after pickling and swilling preparatory to plating.

## **Solution Maintenance**

### *Acid Additions*

To keep the pickling solution in effective operation the free sulphuric acid content of the pickle should be maintained by the regular addition of sulphuric acid.

Methods for the estimation of the free acidity are given in the analytical procedures section.

Where an inhibitor is used, an addition should be made in proportion to the acid addition.

*N.B. – It is dangerous to add the strong acid to a hot solution; the bath must be first cooled. If this is not convenient, the concentrated acid should be added to about twice its volume of pickle that has been removed from the vat and allowed to cool to room temperature. This semi-concentrated acid may safely be added to the bulk of the hot pickle.*

### *Density*

A new solution should have a density of 1,060 sp. gr., 8°Bé or 12 to 13° Twaddell at room temperature, but this may increase as the pickle is used, owing to the presence of dissolved metals.

### *Metal Content*

In time the metal content of the solution will become excessive, and this will result in a reduction in pickling efficiency.

Where pickling is only carried out on a small scale it is usual to make up a fresh solution from time to time rather than to attempt recovery.

Where steel is pickled on a very large scale, the iron content of the solution may be kept within reasonable limits by means of the use of a low-temperature crystallisation process, the excess iron being removed as ferrous sulphate.

## **HYDROCHLORIC ACID PICKLING**

Cold dilute hydrochloric acid is preferred by some operators for pickling spot welded sheet steel articles or other iron and steel parts that only have a thin film of oxide on them as it leaves a somewhat cleaner surface than sulphuric acid on mild steel. It is not generally recommended for the removal of heavy scale. The pickle is rarely used above room temperature 20°C since the fumes are rather objectionable and the selection of hooks, baskets and heating coils which will withstand the action of the hot acid presents a problem. However it should be remembered that given the correct processing and plant circumstances operation of the acid pickle in the region of 30-40 °C would be permissible. This significantly increases the rate of effective pickling and the use of an appropriate acid inhibitor should produce an adequate foam blanket to assist the reduction in fumes.

### **Solution Composition**

For general purposes the usual concentration is:

Commercial hydrochloric acid sp. gr. 1.14 – 150 to 200 ml/l

For aircraft steels the concentration must not exceed 10 per cent by volume, and the pickling of high tensile alloy steels is prohibited altogether in some Government process specifications.

## Equipment

Rubber-lined welded steel tanks are the most suitable containers for large volumes of the pickle, and heating (if required) may be accomplished by means of silica cased immersion heaters, a hot water jacket or *Teflon* heating coils. Plastic tanks are satisfactory for the cold acid; lead or lead-lined vats are not recommended.

For the suspension of articles *Monel* metal or acid-resisting phosphor bronze hooks and baskets are generally used, but these alloys do not last indefinitely in the hot pickle. For the cold acid, brass baskets are also suitable.

## Operating Procedure

Hydrochloric acid pickle is used in the same manner as dilute sulphuric acid for descaling, an inhibitor, *Pickle Aid* or *G.P. Inhibitor 11-66* may be added to restrain its action on the ferrous metals. There is no difficulty in mixing, and the concentrated acid may be added directly in any required amount to the pickle bath, whether the latter is cold or warm. Iron and steel articles that are to be dried after descaling should be rinsed and put through a dilute trisodium phosphate "Neutralising Dip."

## METEX SKALENE PICKLE FOR IRON AND STEEL

General mineral acid pickling is not always suitable for certain types of steel and may cause serious embrittlement or even spontaneous cracking of hardened springs and tool steels. In such cases a composite pickle such as *Metex Skalene* should be used. This is formulated to minimise hydrogen embrittlement and is carefully inhibited so that the pickling action virtually ceases when the rust or scale is removed.

*Metex Skalene* is particularly suitable for pickling machined or fabricated parts of critical dimensions, and material treated in this way is less prone to rust than when ordinarily pickled.

Normally these articles should be descaled when in the 'rough' condition, but it sometimes happens that the presence of scale is not observed until the work enters the plating shop. A typical instance is that of nuts or bolts turned from bright hexagonal bar, the original surface being left on the flats. When the finished articles are cleaned and zinc plated it is often found that the screw threads cover immediately, but that the zinc will not deposit on the flats owing to the unsuspected presence of indrawn scale at the bottom of surface flaws in the steel. Ordinary acid pickling is impracticable owing to the risk of damaging the threads, but *Metex Skalene* may be used with safety. *Monel* metal baskets are recommended for holding small articles. The solution is generally used cold, as supplied and should be contained in a polythene, polypropylene, rigid PVC or rubber lined tank. If necessary the pickle may be heated to a temperature of 45 to 50°C to accelerate its action for the purpose of removing heavy scale.

Additional proprietary mixed acid pickles that are used in various applications are referred to in the appendix product summary.

## ALKALINE DERUSTER

The use of an alkaline deruster, e.g. *Alkaline Deruster Salts* or *Metex LC Deruster*, enables iron and steel components to be rapidly descaled without the danger of attack on the basis metal during the removal of the oxide. The process is especially suitable for use on precision parts and where etching of the surface must be avoided. Immersion alkaline derusting can also be employed for the treatment of high tensile and hardened steels which are susceptible to hydrogen embrittlement.

*Alkaline Deruster Salts* and *Metex LC Deruster* contain sodium hydroxide but cyanide-free and non-toxic.

The solution may be used:

1. For the immersion or electrolytic removal of rust.
2. For the removal of welding scale and other heavy scales. For this application the addition of sodium cyanide is necessary. The treatment is electrolytic, generally with the employment of periodic current reversal.

### Additional Uses of Alkaline Deruster

Whilst these type of materials were originally introduced for the treatment of ferrous metals, they are being widely used, with considerable advantage, on non-ferrous metals, for example, for the removal of oxide films from copper and copper alloys such as brass and also for second stage electrolytic cleaning.

*Alkaline Deruster* may also be employed:

1. As a cyanide-free second stage electrolytic cleaner for steel and copper and its alloys
2. For the removal of phosphate coatings by simple immersion.
3. As an *alkaline paint stripper* using a concentration of 100 g/l and a temperature of 80 to 99°C.

### Equipment

The solution of *Alkaline Deruster* is contained in a plain welded steel tank provided with means of heating, e.g. a plain steel steam coil, *Teflon* heating coils, steel cased immersion heaters or gas burners under the tank.

For electrolytic derusting, steel plate outer electrodes should be provided together with a rod from which the work is supported. Gentle air agitation is recommended for immersion derusting and paint stripping.

The *Alkaline Deruster* solution has cleaning properties. Articles which are generally free from oil or grease may therefore be processed directly in the derusting solution without prior degreasing. Where, however, a considerable number of oily or greasy components are to be processed, to avoid the danger of excessive contamination of the derusting solution it is recommended that the articles be first degreased in an alkaline cleaning solution, e.g. *Clepo 644-L* or *Masco 245-DM*. The parts should then be thoroughly rinsed in clean running water before being placed in the *Alkaline Deruster* solution for a period of 30 seconds to 15 minutes depending upon the amount of rust to be removed.

### **Treatment of High Tensile Steels**

Many specifications specifically exclude the use of acid even with inhibitors present. With *Alkaline Deruster*, rust and heat treatment scales on high tensile materials are removed under alkaline conditions either by simple immersion or by the use of periodic reverse. A ratio of 1:2 for the cathodic/anodic cycle (i.e. 10 seconds cathodic, 20 seconds anodic) will remove the scale with a minimum amount of hydrogen absorption. This does not mean that hydrogen embrittlement is prevented but it does offer a means of eliminating the need for acid treatment for the removal of heat treatment scale.

### **Spray Suppression**

The *Alkaline Deruster* contain a spray suppressing constituent, but, where the solution is being used electrolytically and it is necessary to reduce spray evolution, then an extra addition of *Spray Suppressant M1108* should be made to the extent of 0.12 to 0.5 ml/l of derusting solution. Occasional additions of *Spray Suppressant M1108* should be made to maintain the foam blanket over the solution surface.

## **HYDROFLUORIC ACID PICKLING**

This treatment is used for sand castings, for the removal of traces of sand after the bulk has been removed mechanically. It is particularly advantageous for hydraulic valves and engine parts where residual particles of sand would affect the mechanism.

### **Solution Composition**

A suitable solution composition is:

Hydrofluoric acid (60% sp. gr. 1.23) 100 m/l

Where hydrofluoric acid is not readily obtainable the acid may be generated in solution from a fluoride salt which is more easily procured, a suitable formula being:

Sodium fluoride 100 g/l

Commercial sulphuric acid (sp. gr. 1.84) 70 m/l

The sulphuric acid is poured cautiously into cold water, and the solution allowed to cool, after which the sodium fluoride is added and the mixture stirred until it has all dissolved.

### **Equipment**

For the dilute hydrofluoric acid pickling solution, a rubber-lined, PVC-lined, or polythene tank may be used.

Great care must be taken when handling hydrofluoric acid-containing solutions. This acid is extremely corrosive and in contact with the skin will produce burns which are very difficult to heal. Burns due to contact with weak acid may be apparent only after several hours. Rubber or PVC gloves, together with goggles, should be worn.

Polythene measures and containers should be used for handling the acid.

Copper hooks or wire may be used for holding large castings, and *Monel* metal baskets for smaller parts.

### **Operating Procedure**

#### *Castings*

The castings are generally immersed in the cold solution for 10 to 30 minutes, then swilled and brushed if necessary. When the metal is brass or bronze it is an advantage to bright dip the articles subsequently in *aqua fortis bright dipping acid*. This improves the appearance and effectively removes any particles of sand that have been loosened but not wholly dissolved or dislodged by the pickle.

#### *Aluminium*

Aluminium and its alloys (Group 4) may be pickled in dilute hydrofluoric acid solution to remove casting skin, oxide or anodic films. On removal from the pickle the articles are swilled in water and should afterwards be rinsed in concentrated nitric acid to remove any discolouration from the surface, and again swilled.

Reference to several proprietary pickling and deoxidising products, e.g. Deox 2001/2003 (some of which are nitric acid free) for aluminium can be found in the appendix product summary.

## **PICKLING OF MAGNESIUM ALLOYS**

Either dilute sulphuric or nitric acid may be used, a suitable strength being from 5 to 10 per cent by volume. These light alloys are readily attacked and should not be immersed for more than half a minute in the cold acid. They should then be removed, swilled, inspected, and, if necessary, re-dipped.

A stainless steel or polypropylene tank should be provided for nitric acid.

## **PICKLING OF STAINLESS STEEL**

For the pickling of austenitic nickel-chromium stainless steels, the following solution may be used:

Nitric acid (59% 1.37 sp. gr.)	250 ml/l
Hydrofluoric acid (60% sp. gr. 1.23)	35 ml/l

The container is filled to two-thirds its capacity with cold water and the nitric acid, and then the hydrofluoric acid added with care. The precautions advised in the previous section on hydrofluoric acid pickling should be observed.

### **Equipment**

For this solution PVC plastic lined, or polythene containers may be used. Where the solution is used cold, fume extraction is not generally required.

### **Operating Procedure**

The solution may be used cold with an immersion period of 5 to 15 minutes. Where heavy scale is to be removed, then the solution may be used at 40 to 50°C to obtain more rapid pickling. This may, however, result in slight surface attack on the stainless steel.

Reference to similar proprietary blended materials, e.g. *Deox 3020* may be found in the appendix product summary

## **PICKLE AID**

### **For Combined Pickling and Degreasing Solutions**

*Pickle Aid* is an additive for hydrochloric, sulphuric or phosphoric acid pickles, to permit cleaning and pickling in one operation. It contains inhibitors which are effective over long immersion periods, emulsifiers to assist in oil and grease removal and accelerators to ensure that rust and scale are removed in the shortest time without risk of attack on the basis metal.

Oils and greases are removed in hot solutions, so that in many cases the use of vapour degreasing prior to pickling may be eliminated. Polished articles should, however, be pre-cleaned, for example in *Metex LC 3000* or *New Dimension ND-7*, as polishing residues may not be removed by the *Pickle Aid* solution.

This process is particularly effective for the cleaning and descaling of steel components having burnt-in greases or lubricants.

### **As a Spray Suppressant**

*Pickle Aid* may also be used as an accelerator and fume reducer in cold acid dips. Under these conditions a foam blanket will be formed with *Pickle Aid* concentration as low as 0.5 to 1 ml/l of final solution. *Note: the acid will not be fully inhibited until the standard concentration of 5 per cent by volume is achieved.*

### **Equipment**

Where *Pickle Aid* is used, the container is as for ordinary acid pickling. For example, a rubber or plastic lined tank, a rigid polythene or acid-resisting GRP container. Lead lined tanks may be used for sulphuric acid and phosphoric pickling solutions. With rubber and also plastic lined tanks, the operating temperature should not exceed 70°C.

Where rubber lined tanks are used for sulphuric acid pickling solutions, care must be taken to ensure that the concentrated acid does not come into direct contact with the rubber lining.

Other supplementary packages that are used in general pickling operations, e.g. Additivo DEC are referred to in the appendix product summary.

## **BARREL PICKLING**

The descaling of small iron and steel parts is often more effective and rapid if they are treated in a revolving barrel, instead of in baskets immersed in a still vat. Dilute hydrochloric or sulphuric acid may be used, but *Metex Skalene* is to be preferred for this purpose. Hardwood barrels having copper bands are generally employed, but rubber lined barrels are also satisfactory. The acid should be cold, and the time necessary depends on the thickness and tenacity of the scale, but it is generally a matter of from 10 to 30 minutes.

When treating small cup-shaped or welded articles, an addition of washed granite chippings is useful, as the scouring action removes the oxide when it has been loosened by the pickle.

### **BRIGHT DIPPING OF COPPER ALLOYS**

After being pickled in dilute sulphuric acid, metals such as brass, nickel-silver, copper and its alloys are usually dipped in *aqua fortis bright dipping, acid*, chromic acid-based solutions, or

more commonly a peroxide based bright dip, e.g. *Envirodip Extra*, to impart a bright clear surface. Due to a combination of environmental, and health and safety issues, the use of *Aqua Fortis*, and chromic acid based processes is on the decline.

## **AQUA FORTIS BRIGHT DIPPING ACID**

### **Solution Composition**

The term *aqua fortis bright dipping acid* refers to a mixture of nitric acid and sulphuric acid that is generally obtained ready for use. Alternatively, it may be prepared as follows:

For a final volume of	1 litre
Water	350 ml
Commercial sulphuric acid (sp.gr.1.84)	500 ml
Nitric acid (59% sp.gr.1.37)	185 ml
Sodium chloride (common salt)	1½ g

To prepare the solution the sulphuric acid is added to the cold water slowly and with stirring, care being taken to avoid excessive over-heating. When the solution has cooled to room temperature, the required volume of concentrated nitric acid can then be added followed by the addition of sodium chloride. Both sulphuric acid and nitric acid are extremely corrosive and must be handled with great care.

## Equipment

Suitable containers for *aqua fortis bright dipping acid* are made of glass, polythene, rigid PVC or stainless steel. The stainless steel containers must be of a quality suitable for nitric acid (e.g. Firth Vickers *Staybrite F.D.P. grade*), and where fabricated vessels are used the type of welding employed must be suitable for this application.

Where plastic containers are employed it is usual to stand the vessels in an outer container of cold water.

During the bright dipping operation considerable quantities of red/brown NO<sub>(x)</sub> fumes are evolved: it is, therefore, essential that efficient fume extraction be provided. In a large number of countries it is necessary to incorporate a scrubber in the exhaust system as the discharge of nitrous fumes into the atmosphere is regulated and a licence may be required to operate this type of process. Users should check the local regulations.

Articles may be wired as for plating, or if small, placed in wire mesh or perforated sheet metal dipping baskets made of stainless steel, *Nichrome* wire or aluminium. Heavy articles may be suspended from stainless steel or *Nichrome* wire hooks.

*Monel* metal, brass, other copper alloys and ordinary steel are attacked by *aqua fortis bright dipping acid*.

## Bright Dipping Procedure

### 'Fizzing'

The first operation in bright dipping is the immersion of the articles for a few seconds in old or 'spent' *aqua fortis bright dipping acid* to which has been added a small proportion of hydrochloric acid.

This preliminary dip is known as 'fizz' in the trade. It is contained in a plastic tank and is prepared by adding 10 ml of concentrated hydrochloric acid to each litre of old *aqua fortis*, or if the latter is not available, to new *aqua fortis* that has been diluted with an equal volume of water. The action of the acid on the metal gives rise to red/brown NO<sub>(x)</sub> fumes which should not be inhaled, and it is for this reason that an efficient exhaust must be provided. After immersion for a few seconds the articles are removed, swilled, redipped if necessary until the surface is quite clean, and then placed in the *aqua fortis*.

### Bright Dipping

For the bright dip itself the *aqua fortis bright dipping acid* is used undiluted, and again the time of immersion is for a few seconds only. A little experience is required to obtain the best results, but the essential factors are that the articles shall be kept moving continuously in the acid and that the dipping shall be as brief as possible. The skilled operator judges the necessary time of immersion by the effervescence of the acid (which is apparent when the articles have been introduced for two or three seconds).

Prolonged immersion etches the surface of the metal and diminishes the brightness of the finish. Articles wired in bunches are generally moved vertically up and down in the acid, whereas baskets containing small parts are partly rotated to and fro by a quick turn of the wrist.

On removal, the articles are rinsed immediately through two or three cold running water swills, neutralised to prevent staining, again well rinsed through running water, and then dried out. As a neutralising dip, a solution containing 25 g/l of sodium cyanide or sodium carbonate may be used. Sodium cyanide is the more effective as a neutraliser and stain preventer, but where it is used care must be taken to avoid any carry-over of acid into the cyanide dip.

Bright dipped work must not be left in the dipping shop where it will rapidly become tarnished if exposed to acid fumes. Articles that are not to be plated are generally dried in hot boxwood

sawdust or in a centrifugal dryer, and the bright finish may be preserved by protecting it with a transparent lacquer or an inhibitor e.g *Metex M667*.

## **CHROMIC ACID DIP FOR BRASS, COPPER AND ITS ALLOYS**

A chromic-sulphuric acid pickle, sometimes referred to as 'red dip' from the colour of the solution, is useful for descaling copper rich alloys, particularly when the scale consists mainly of cuprous oxide, which is not readily soluble in ordinary sulphuric acid pickle.

It is widely used for the descaling and brightening of plumbers' brassware. The solution cleans the surface, leaving a colourless passive film which provides a measure of protection against subsequent surface discolouration.

The solution is more restrained in its action than *aqua fortis bright dipping acid*, but does not impart so bright a finish.

This solution may also be used for removing stains or tarnish from machined brass articles having screw threads or fine dimensional limits. For this purpose the chromic acid content should be reduced to 10 g/l.

### **Solution Composition**

A suitable solution composition for general purposes is:

Commercial sulphuric acid sp. gr. 1.84	50 ml/l
Chromic acid†	40 g/l

\*For articles to fine dimensional limits reduce the chromic acid content to 10 g/l.

Sodium dichromate may be used as an alternative to chromic acid. 60 g/l sodium dichromate is equivalent to 40 g/l chromic acid.

(To prepare the solution, sulphuric acid is added slowly with stirring to the appropriate volume of cold water. The chromic acid or sodium dichromate is then dissolved in the dilute sulphuric acid solution.

## Equipment

For this solution lead lined, plastic, or stainless steel containers may be used. No objectionable fumes are evolved, but the operator should wear gloves and an apron to protect hands and clothing. For handling the work either stainless steel or *Nichrome* hooks and baskets may be used.

## Operating Procedure

The dip is used cold. A few minutes immersion is generally sufficient, and prolonged pickling should be avoided, otherwise the metal will become etched and pitted.

## BRIGHT DIP CONCENTRATE FOR BRASS (Nitric Acid free)

This chromic acid-based bright dip solution, supplied as a liquid concentrate, removes scale from the surface of copper, brass and other copper alloy components giving a semi-bright finish with a passive film which provides a measure of protection against corrosion, staining or discolouration. Whilst the finish obtained is not as bright as that produced by aqua-fortis bright dips; a smoother effect is produced and the brightness is greater than that which can be obtained from the use of the simple chromic acid/sulphuric acid solution described above.

The *Bright Dip Concentrate* is less critical in use than aqua-fortis bright dip acid and does not give rise to fumes. This process does contain chromic acid and the necessary precautions when handling this solution should be taken.

## Solution Composition

*Bright Dip Concentrate* is supplied as a liquid concentrate that is diluted with an equal volume of water before use.

## Equipment

For this solution plastic or plastic lined containers, stainless steel or lead lined tanks may be used. Fume extraction is not necessary, neither is external cooling of the container required. For handling the articles, stainless steel or *Nichrome* baskets or jigs may be used.

## Operating Procedure

The bright dip is used at room temperature and the usual immersion time is 5 to 120 sec.

Prior to bright dipping the components should be degreased in a hot alkaline cleaner, either soak or electrolytic. Any grease carried into the bright dip will seriously reduce the efficiency of the dipping operation, and adversely affect the working life of the solution.

1. Degrease as above
2. Swill cold running water.
3. Swill cold running water.
4. Immersion in *Bright Dip Concentrate* with work or solution movement, e.g. air agitation hand or mechanical work movement.
5. Swill cold running water.
6. Swill cold running water.
7. Dry: hot water, hot air, centrifuge, etc.

Very tenacious heat scale is best removed prior to bright dipping, by immersion in warm, 49 to 60°C, 10% by volume sulphuric acid solution.

## **Solution Maintenance**

Additions of the concentrate should be added at regular intervals. The amount will depend on the quantity of water dragged in, the time and quantity of work processed and the quantity of solution dragged out.

As a guide, if drag-out is low, an addition of approximately 25 ml of concentrate should be made for every square metre of work processed. If the losses are high, 75 to 100 ml of concentrate should be added for every square metre of work processed.

## **ENVIRODIP EXTRA**

As an alternative to the above nitric acid and chromic acid containing processes, peroxide based bright dips are used to produce a bright surface on brass components. These processes also work on copper and other copper alloys although the brightness may not be as good and the process suitability needs to be evaluated in each case. Peroxide based bright dips do have some distinct advantages over the other processes due to the fact that the brightness is brought about by the controlled chemical polishing of the brass surface without excessive dissolution of metal. Parts processed in *Envirodip Extra* can subsequently be plated, oxidized, soldered or lacquered. The high lustre produced by *Envirodip Extra* is superior to that obtained in the conventional chromic or nitric acid based bright-dips. *Envirodip Extra* is not a direct replacement for these solutions, longer immersion times and extra process tanks are required for optimum results.

### **Advantages of Envirodip Extra:**

#### *Non-Fuming*

It operates without the hazard of toxic nitric oxide fumes. A built-in surfactant eliminates any mist so that normal ventilation is required.

#### *Brilliant Levelled Finish*

Its controlled polishing action eliminates the danger of overetching, a major problem in nitric acid based bright-dips. Bright work of consistent quality is the result.

#### *No Nitric Acid, Chromic Acid or Cyanides*

It eliminates the handling of these hazardous and toxic chemicals making for a safer operation.

#### *Clean Active Surface*

It produces a surface that will accept subsequent finishing operations such as plating, oxidizing, soldering and lacquering.

#### *Resists Tarnishing*

Surfaces remain bright under normal conditions for extended periods of time.

#### *Works on wide range of copper alloys*

It can be used with good results on a variety of copper alloys.

#### *Rack or Barrel*

It can be used in a manual operation or in an automatic machine. Parts may be racked (with rod agitation) or done in bulk (barrel).

## **Operating Parameters**

### *Solution make-up*

The operating solution is made up by adding 30% by volume of *Envirodip Extra* to water (30 litres of *Envirodip Extra* per 100 litres of total volume) and 0.6% by volume of SG 1.84 Sulphuric Acid (0.6 litres per 100 litres).

Provision for both heating and cooling of the *Envirodip Extra* solution is strongly recommended.

### *Operating range*

25 - 35% by volume *Envirodip Extra*

0.5 - 0.7% by volume of Sg 1.84 Sulphuric acid

**NOTE:** It is important that the sulphuric acid concentration be maintained in the above range at all times. If the solution rises to pH 5.0 or above, there may be a rapid break-down of the *Envirodip Extra* solution. Recommended practice requires titration of the solution both prior to and following use of the bath. See “Analysis of sulphuric acid” for the correct method of adjusting the solution.

### Temperature

38° - 46°C **DO NOT** exceed 50°C

Cooling of the bath will be required when continuous production is being run. For best results, a bath loading of 1.2dm<sup>2</sup>/litre should not be exceeded.

### Time

1 - 5 minutes

Brightness is dependent upon immersion time in the solution and alloy composition. A normal treatment of 2 minutes at 43°C will produce an excellent lustre on brass. Although levelling will continue to increase with longer treatment time, chemical consumption will be excessive for the slight increase in levelling. The finish on copper is bright but to a lesser degree than 70/30 brass.

### Agitation

Mechanical component movement.

## Equipment

<b>Tanks</b>	PVC, polypropylene, polyethylene, 304 or 316 stainless steel
<b>Heaters</b>	quartz, teflon or 316 stainless steel
<b>Cooling Coils</b>	304 or 316 stainless steel
<b>Ventilation</b>	required
<b>Fixtures, Racks &amp;</b>	polypropylene, pvc, nylon, or stainless steel Baskets

## Process Cycle

Parts must be free of scale, oil and other soils to ensure uniform brightening.

1. Alkaline soak clean.
2. Cold water rinse.
3. Activate in 5-10% by volume sulphuric acid, room temperature, 1 - 2 minutes.
4. Cold water rinse.
5. Chemical polish in *Envirodip Extra*, 43°C, 1 - 5 minutes.
6. Cold water rinse.
7. Anti-tarn dip in a solution of 5% by volume sulphuric acid plus 1% by volume *Metex M667* Anti Tarnish, at room temperature, 15-30 seconds.
8. Cold water rinse.
9. Dry.

For water conservation, rinse water can be counter-flowed starting at step 8 and including steps 6 and 4

### SECOND STAGE OR SURFACE ACTIVATION CLEANING

The cleaning operations must be capable of imparting an effectively clean surface to the metal if satisfactory adhesion of the deposit is to be obtained when the articles are electroplated.

The function of the hot alkaline cleaner is essentially the removal of grease and extraneous dirt. Some form of pickling to remove rust or scale, and finally a further treatment to remove any slight stains, tarnish, and incipient rust or oxide film usually follows this preliminary cleaning. In some cases this oxide film is so thin as to be imperceptible, rendering the surface 'passive,' so that deposition of certain metals upon the substrate is impossible until the invisible film of oxide has been removed.

With the majority of plating processes a second stage or final electrolytic cleaner is employed for the removal of residual oxide or grease films.

## CYANIDE CONTAINING CLEANERS

The most successful and universal second stage cleaners are those containing cyanide, i.e. *Klenewell* and *Kleenax*.

## NON-CYANIDE CLEANERS

In many plating shops it has become necessary to avoid the use of cyanide containing solutions so the following cleaners may be successfully employed in a pre-treatment line as second stage surface activation cleaners:

### **Metex PS Activax Cleaner**

*Metex PS Activax Cleaner* may be used as a second stage cathodic, cathodic/anodic, or anodic cleaner on non-ferrous metals .

### **Metex PE Anodax, Metex LC100 and Metex Liquid Cleaner System (incl Metex 560-L)**

These cleaners may be used for a second stage anodic clean on both ferrous and non-ferrous metals. They are particularly effective for the removal of surface smut from steel.

### **Metex PE E 5**

*Metex PE E5* has been specially formulated as a non-cyanide second stage cleaner for copper alloys, zinc base alloy die-castings and has also found a wide general use.

### **Alkaline Deruster**

*Alkaline Deruster* - though originally introduced for rust removal, is extremely effective as a second stage cleaner and surface activator on both ferrous and non-ferrous metals. This material may be used as a non-cyanide cleaner or with the addition of sodium cyanide. For steel, where maximum activation is required, *Alkaline Deruster Salt* is used at a concentration of 150-200 g/l with the addition of

50 g/l of sodium cyanide. Where cyanide cleaning cannot be employed, *Alkaline Deruster Salt* may be used at 75 g/l.

For brass and copper, *Alkaline Deruster Salt* is used at 60 g/l, the articles being made anodic or cathodic followed by an anodic flash if solution contamination results in surface films being produced on the article surface.

### **Metex PE Emphax Cleaner**

*Metex PE Emphax cleaner* may be used as a second stage anodic cleaner on ferrous metals.

### **Acid Etching**

For iron and steel components on which a slight etching or roughening of the surface is advantageous, an electrolytic *Acid Cleaner* (etch) may be used as an alternative to an alkaline final cleaner. This process is used for the preparation of components which are to receive a heavy deposit of nickel, but is not generally employed on highly polished articles intended for bright deposition. Neither is it suitable for components having riveted or folded joints in which the acid may be trapped - see below.

The original method of final cleaning involved scouring the articles with a hand brush dipped in water and powdered pumice, a practice still adopted for some purposes. In most cases, however, the need for scouring is eliminated by the use of a second stage electrolytic acid cleaner.

### *ANODIC SULPHURIC ACID ETCHING OF IRON AND STEEL*

Anodic etching in sulphuric acid is an extremely effective method for the second stage cleaning of iron and steel articles which are to be electroplated. It is employed where maximum adhesion of the deposit is required.

A fairly concentrated sulphuric acid solution – 77 per cent w/w (sp. gr. 1.7) - is used for general purposes where only a light etch is required. This solution is often described as an 'Acid Cleaning Solution for Steel'. This process was formerly widely used for the pre-treatment of steel

components, it has, however, to a large extent been replaced by the use of a second stage alkaline cleaner such as *Klenewell and Metex LC100*.

Where a deeper etch is required, for example, in heavy nickel plating or hard chromium plating, then the more dilute solution 30 per cent w/w sulphuric acid (sp. gr. 1.22) is used.

## HIGH CONCENTRATION ACID ETCH FOR STEEL

The use of a high concentration anodic sulphuric acid etch ensures effective cleaning of steel with only a slight loss in surface brightness. Whilst on mild steel, alkaline second stage cleaning is now generally preferred, acid cleaning or etching is often employed on high carbon or alloy steels, on steel forgings, and on articles made from black steel sheets which have been pickled but not polished before electroplating. Anodic etching effectively removes any grey smut left over after pickling to give a silver-white etched surface.

### Equipment

For the sulphuric acid etch solution a steel tank lined with chemical lead is employed. The tank is fitted with a middle copper anode rod from which the work is suspended. For cathode, either the lead lining of the tank or separate lead plates may be employed.

A switch should be fitted into the positive lead to enable the current to be broken before the articles are withdrawn from the tank.

### Solution Composition

Commercial Sulphuric acid, sp.gr.1.84	750 ml/l
[Weight Equivalent	1380 g/l]
Chromic acid	6 g/l

### Solution Preparation

The solution may be prepared as follows:

750 ml (2¼ volumes) of the sulphuric acid are added to 333 ml (1 volume) of water in which the chromic acid has been dissolved. Because there is a volume contraction this will produce 1 litre (3 volumes) of acid etching solution at the required density of 1.7 sp. gr. *The concentrated acid must be poured very slowly into the cold water, as the solution will become hot during mixing. The solution should be stirred whilst acid additions are made and great care taken to avoid splashing.* The bath should be well stirred and then allowed to cool before use.

### Operating Parameters

<i>Anodic Current Density</i>	8 to 10 amp/dm <sup>2</sup>
<i>Voltage</i>	6 volts.
<i>Temperature</i>	Ambient.
<i>Time</i>	30 seconds to 1 minute.
<i>Solution Density</i>	1.7 sp. gr., 140° Tw.

### Operating Procedure

Before etching, the articles should be cleaned and, if necessary, pickled to remove any grease and scale. After etching they should be rinsed through two running cold water swills, the swills being air agitated in order to obtain rapid removal of the acid. To conserve the use of water the two rinses may be arranged in counter-flow sequence.

After thorough rinsing the articles may be transferred directly to a nickel, acid zinc or other acid plating solution. If the articles are to be plated in a cyanide type solution, such as copper, cadmium or zinc, then the work, after rinsing, may be immersed in a solution containing 25 g/l or sodium cyanide before being placed in the plating solution.

With the proper application of the sulphuric acid etch, the surface of the steel will become uniformly grey in colour. This condition is indicated by vigorous gassing.

### **Solution Maintenance**

The density should be maintained at approximately 1.7 sp. gr. As the bath takes up moisture from the air there is a tendency for the density to fall, and this should be corrected from time to time by the addition of concentrated sulphuric acid. Before adding the latter it may be necessary to take out a quantity of the acid etching solution to make sufficient room. The acid then removed can generally be utilised as a pickle after further dilution. An occasional addition also of 3 g/l of chromic acid should be made to allow for that decomposed, when a change in the colour of the solution from red to green shows this to be required.

### **ACID ETCHING OF STEEL AND IRON BEFORE HEAVY DEPOSITION**

The acid etching solution already described for general work is designed to give a very slight etch, which is barely perceptible and does not appreciably roughen the surface of the metal.

For heavy nickel plating involving deposits of at least 0.125mm (0.005in) for the building up of worn parts, the primary consideration is perfect adhesion. Slight surface roughness is a minor matter, since the articles are almost invariably ground after plating. The general practice, therefore, is to etch comparatively deeply, thus affording a good key for the electrodeposited nickel. For this purpose a more dilute acid is used, namely sulphuric acid, 30 per cent w/w (sp.gr.1.22). The equipment is identical to that employed for ordinary acid etching and the operation is the same except that the articles are immersed for a longer period and the higher conductivity of the dilute acid gives a much higher current density.

### **Solution Composition**

Commercial Sulphuric Acid, sp. gr. 1.84	206 ml/l
Weight equivalent	380 g/l

### **Solution Preparation**

A 30% sulphuric acid etch is prepared by adding 206ml (1 volume) of sulphuric acid sp. gr. 1.84, to 824ml (4 volumes) of cold water contained in a lead-lined tank, for every 1 litre (approx. 4.75 volumes) of the dilute acid.

*The sulphuric acid must be poured slowly into the cold water, and the solution, which becomes very hot during the mixing, must be well stirred and then allowed to cool before it is used.*

### **Operating Conditions**

<i>Anodic Current Density</i>	20 to 30 amp/dm <sup>2</sup>
<i>Temperature</i>	Ambient.
<i>Time</i>	2 minutes after vigorous gassing commences.
<i>Solution Density</i>	1.22 sp. gr., 44° Tw.

## **Solution Maintenance**

Occasional additions of concentrated sulphuric acid are necessary to maintain the density of the solution.

### *PRE-TREATMENT SYSTEMS*

As indicated in the earlier part of this section, the preparation of articles for electroplating requires removal of all types of surface contamination and the activation of the surface, so that when the article is transferred to the electroplating solution, an adherent electrodeposit can be obtained.

The surface contaminants which have to be removed include inorganic matter, such as oxides (tarnish, rust or scale) and extraneous dust or organic matter (oils, greases and other components) arising from cutting or pressing lubricants or from temporary preservatives applied to the article to prevent corrosion occurring between fabrication and electroplating.

The majority of articles requiring an electroplated finish need to be polished; this introduces further contamination of both inorganic and organic types, i.e. abrasives together with the greases and waxes used to constitute the polishing composition.

In order to provide effective surface preparation, a complex pre-treatment system is often required involving the following stages:

#### Pre-Cleaning and Pickling followed by:

- First stage alkaline cleaning,
- Intermediate dips to remove oxide or smut,
- Second stage or surface activation cleaning,
- Final dips prior to immersion in the plating solution.

The highly sophisticated drawing and pressing lubricants used in today's high speed manufacturing processes are more effective, longer lasting and often adhere more tenaciously to the metal surface than those used a few years ago; they are also more difficult to remove. In addition, there is an increasing use of pre-polished steel that is plastic coated to provide protection of the steel surface in storage and during the process operation. Whilst the film is easy to remove, some form of contamination and/or adhesive may remain on the steel surface which is difficult to remove in the normal cleaning operation.

To meet these situations, many new metal cleaners have been developed with formulations which incorporate the latest developments in surface active chemistry to give improved soil penetration and emulsification, better water softening and soil re-deposition prevention. These cleaners effectively meet the demand for rapid removal of the oils, greases and other lubricants now being used in metal fabrication and polishing. They are more efficient than earlier formulations; are used at lower concentrations and have a longer working life. Also many of the previously used powdered formulations are gradually being replaced by more effective and more eco-friendly liquid proprietary products.

As it is not possible to quote pre-treatment sequences that cover all permutations and possibilities we recommend that each requirement be discussed in detail with our local technical representative or service centre.

Typical Pre-treatment Sequences

Basis Metal	Soils	Pre-clean – if required	1 <sup>st</sup> Stage clean	Oxide Removal if required	2 <sup>nd</sup> Stage clean	Subsequent Treatment
Steel and Ferrous alloys	Oils, greases, light polishing residues.	<b>Metex LC 2000, Clepo 644-L, Masco 245-DM, or Solvent clean.</b>	<b>Metex PS Activax, Metex PE Emphax or Metex Liquid Cleaner System (Metex LCS)</b> anodic or cathodic.	50% volume hydrochloric acid.	(a) <b>Metex PE Emphax*</b> (b) <b>Metex PE Anodax*</b> (c) <b>©Metex LCS*</b> (d) <b>Alkaline Deruster*</b> (e) <b>Klenewell*</b> * anodic	If prior to nickel plating – dilute acid dip.
	Oils, greases, together with rust and scale.	<b>Metex LC 2000, Clepo 644-L, Masco 245-DM, or Solvent clean.</b>	<b>Metex PS Activax, Metex PE Emphax or Metex Liquid Cleaner System (Metex LCS)</b> anodic or cathodic.	(a) None	<b>Alkaline Deruster</b> with periodic reverse current	
				(b) 50% volume hydrochloric acid with <b>Pickle Aid.</b>	<b>Metex LCS</b> anodic. <b>Metex PE Emphax</b> anodic.	
Brass, Copper and Copper Alloys	Light oils, greases or polishing compositions.	<b>Metex S-486, Clepo 644-L, Metex LC 3000 or Solvent clean.</b>	<b>Metex PS Activax, Metex PS 55</b> cathodic or Soak.	-	(a) <b>Metex PS Activax,</b> anodic, cathodic/ anodic (b) <b>Klenewell,</b> cathodic. (c) <b>©Metex PE E5,</b> anodic/cathodic.	If prior to nickel plating – dilute acid dip. Leaded brasses and tin containing brasses – <b>Metex ACS-37 Dry Acid Salt.</b>
Zinc Base Die-casting	Release agents, light polishing residues, machine oils.	<b>Metex LC Mersol, Metex LC 3000, Metex SU-486 or Solvent clean.</b>	<b>Metex S-426</b>	-	(a) <b>Metex PE E5</b> anodic / cathodic (b) <b>Klenewell,</b> cathodic	Dilute acid dip – <b>Metex M-629 Dry Acid Salt</b>
	Unpolished.	-	<b>Metex S-426, Metex PS Activax,</b> cathodic.	-	<b>Metex PE E5</b> anodic / cathodic	Dilute acid dip – <b>Metex M-629 Dry Acid Salt</b>
Aluminium	(a) Non-etch.	<b>Metex LC Mersol, Metex LC 3000 or Solvent clean.</b>	<b>Minco. New Dimensions ND-7 Supreme</b>	-	<b>Minco.</b>	For removal of surface oxidation – <b>Deox 2001 / 2003</b> or Sulphuric acid plus <b>66 Micro Etch</b>
	(b) Satin finish.	<b>Metex LC Mersol, Metex LC 3000 or Solvent clean.</b>	<b>Minco. New Dimensions ND-7 Supreme</b>	-	<b>Aluclean 245-SA.</b>	

## PRE-CLEANING

Where the surfaces of the articles are grossly contaminated with oil, grease or a polishing composition, then solvent degreasing or aqueous pre-cleaning with *Metex LC 2000 / 3000* may be necessary.

For the removal of large quantities of oil, a preliminary hot alkaline cleaning stage with an oil separation unit can be used.

### TYPICAL CLEANING CYCLES

On the following pages typical cleaning cycles are given for a number of commonly used materials.

## NICKEL PLATING OF MILD STEEL

### A – General Method

1. Pre-clean, *Metex LC 2000* soak cleaner if necessary.
2. *Metex PS Activax* anodic or cathodic cleaner.
3. Water swill.
4. Dilute hydrochloric acid dip (up to 50 per cent by volume).
5. Water swill.
6. *Klenowell* second stage anodic cleaner.
7. Water swill.
8. Dilute acid dip, 10 per cent weight sulphuric acid or 10 to 30 per cent volume hydrochloric acid.
9. Water swill.
10. Nickel plate.

### B – Where a cyanide-free cleaning line is required

11. Pre-clean, *Metex LC 2000* soak cleaner if necessary.
1. *Metex PS Activax* anodic or *Metex LC 100* anodic or cathodic.
2. Water swill.
3. Dilute hydrochloric acid dip (up to 50 per cent by volume).
4. Water swill.
5. Second stage anodic clean, *Metex Liquid Cleaner System* (incl *Metex 560-L*).
6. Water swill.
7. Dilute acid dip, 10 per cent weight sulphuric acid or 10 to 30 per cent by volume hydrochloric acid.
8. Water swill.
9. Nickel plate

### **C - Use of a sulphuric acid etch to ensure maximum adhesion of deposit**

1. Pre-clean, *Metex LC 2000* soak cleaner if necessary.
2. Metex PS Activax or Metex LC100 anodic or cathodic cleaner.
3. Water swill.
4. Hydrochloric acid dip (up to 50 per cent by volume) with *Pickle Aid*, if necessary to remove rust or scale.
5. Water swill.
6. Water swill.
7. Sulphuric Acid Etch (see 'anodic sulphuric acid etching of iron and steel')
8. Water swill.
9. Electroplate.

The strength of the sulphuric acid etch, stage 7, will depend upon the application. As an alternative to this sequence *Alkaline Deruster* with cyanide may be used.

### **D – Energy Saving Cleaning Line**

1. First stage Cleaner No. 45 or Masco 245-DM soak or anodic.
2. Water swill.
3. Dilute hydrochloric acid dip (up to 50 per cent by volume).
4. Water swill.
5. Second stage, *Klenewell* anodic.
6. Water swill.
7. Dilute acid dip, 10 per cent weight sulphuric acid or 10 to 30 per cent by volume hydrochloric acid.
8. Water swill.
9. Nickel plate.

## **CADMIUM AND ZINC PLATING OF MILD STEEL**

### **A – Rack Plating**

1. Pre-clean, *Metex LC 2000* soak clean if necessary.
2. Clepo 644-L or Masco 245-DM soak or Metex PS 55 / Metex LC100 soak or anodic cleaner.
3. Water swill.
4. Dilute hydrochloric acid dip (up to 50 per cent by volume), with *Pickle Aid*.
5. Water swill.
6. Second stage anodic clean *Metex Liquid Cleaner System* - See notes overleaf.
7. Water swill.
8. Water swill.
9. Cadmium or cyanide zinc plate.

### **Notes**

Where smut removal is a problem with hardened components and on hard rolled steels it is recommended that periodic reverse current cleaning be employed for stage 6 using *Alkaline Deruster + cyanide* in place of *Metex LCS*. Alternatively the electro-cleaner may be made up using the silicated *Metex 560-L* caustic base to which is added the required quantity of *Tensid EM* or alternative surfactant package.

### **B – Barrel Plating**

1. Pre-clean, Metex PS Activax, Metex PE Emphax or Metex LCS soak clean.
2. Clean, Metex PE Emphax, Metex LC100 or Metex LCS anodic cleaner.
3. Water swill.
4. Hydrochloric acid dip (50 per cent by volume) with *Pickle Aid*.
5. Water swill.
6. Water swill.
7. 25 g/l sodium cyanide or sodium hydroxide dip.
8. Cadmium or zinc barrel plate.

**Notes**

Anodic cleaning is generally used for stage 2 but a cathodic cleaner can be used if smut removal is a problem.

With hardened steels the use of *Alkaline Deruster + cyanide* is advised in stage 2 in place of *Metex PE Emphax, Metex LC100 or Metex LCS* anodic cleaner.

On scaled steel it may be necessary to include an acid pickling stage with the appropriate water swills between the two alkaline cleaners at stages 1 and 2.

Where the same cleaner must be used for both cleaning stages, the use of *Metex Liquid Cleaner System* is advised.

Where fuming problems occur with hydrochloric acid stage 4, dilute sulphuric acid (10 per cent by volume) may be used at 40 to 50°C.

## PLATING ON HIGH CARBON STEEL

With steels containing more than 0.35 per cent carbon and with case-hardened steels there is a tendency for hydrogen embrittlement to occur during the cleaning stages and also during the plating process itself.

Where steels of over 100 h bar (65 ton/in<sup>2</sup>) tensile strength have been given severe mechanical working after tempering, it is advisable to apply stress relieving treatment after the preliminary cleaning and pickling stage. Suitable stoving temperatures for high tensile steels are 130 to 210°C for 60 minutes, or at just below tempering temperatures, for 15 to 30 minutes. For case-hardened components stoving at 170°C for 60 minutes is advised.

A suitable cleaning sequence for case-hardened steel is:

1. Pre-clean, e.g. *Metex LC 2000* soak cleaner if necessary.
2. *Metex PS Activax* anodic cleaner.
3. Warm water swill.
4. Cold water swill.
5. Sulphuric acid etch, one minute.
6. Water swill.
7. Water swill.
8. *Klenewell* second stage anodic cleaner.
9. Water swill.
10. Dilute acid dip 10 per cent weight sulphuric acid, 10 to 30 per cent by volume hydrochloric acid or *Metex M-629 Dry Acid Salts*.
11. Water swill.
12. Electroplate.

Alternative sequence with *Alkaline Deruster*.

1. Pre-clean, *Metex LC 2000* soak cleaner if necessary.
2. *Metex PS Activax* anodic cleaner.
3. Warm water swill.
4. Cold water swill.
5. *Alkaline Deruster* 150 g/l + sodium cyanide 50 g/l 55°C, periodic reverse current 10 amp/dm<sup>2</sup>.
6. Cold swill.
7. Dilute acid dip, 10 per cent weight sulphuric acid, 50 to 15 seconds or *Metex M-629 Dry Acid Salts*.
8. Cold swill.
9. Electroplate.

## PLATING ON CAST IRON AND MALLEABLE CASTINGS

On cast iron and malleable iron castings, cleaning of the surface may result in slight dissolution of the ferrous constituents and the production on the surface of a film of free graphitic carbon. In preparing the surface for electroplating, care must be taken to avoid any attack which might result in the formation of a film of graphite, or, alternatively, the articles must be cleaned in *Alkaline Deruster* or electrolytically etched in a 30 per cent weight sulphuric acid etch until the surface is clean. Care must be taken in regards to the exposure time in an alkaline deruster solution. An extended exposure could result in the dissolution of iron and the formation of a carbon smut.

In the anodic sulphuric acid etch process, on etching, a black carbon smut is formed in the first few seconds, but after the surface becomes passive the oxygen evolved will tend to lift the carbon film and leave the surface in a clean condition.

Where possible the articles should be scoured with pumice powder after etching.

Suitable sequences are given in the section on plating High Carbon Steel.

## PLATING ON STAINLESS STEEL

Before stainless steel can be electroplated it is necessary to remove the passive oxide film from the surface. For this purpose it is usual to use a special nickel solution which simultaneously activates the surface and deposits a thin coating of nickel. After treatment the articles can then be transferred to a normal plating solution for the required deposit to be applied.

Two special nickel strike solutions are employed, based upon nickel sulphate and nickel chloride respectively. The nickel chloride solution operates at a lower current density than the sulphate solution, but is more susceptible to iron contaminations.

### Nickel Chloride Strike for Stainless Steel

#### *Solution Composition*

Nickel chloride	240 g/l
Pure Hydrochloric Acid sp. gr. 1.18	86 ml/l

#### *Equipment*

For this solution a steel tank lined with special quality rubber, e.g. *Vulcron*, should be used or alternatively a plastic tank. All nickel anodes should be used.

### *Operating Conditions*

<i>Current Density</i>	3 amp/dm <sup>2</sup> .
<i>Temperature</i>	Room temperature.
<i>Time</i>	2 to 3 minutes anodic followed by 6 minutes cathodic.

### *Operating Procedure*

Articles should be cleaned and, if necessary, etched in a 30 per cent weight sulphuric acid solution for 3 minutes at 6 volts. In place of an initial anodic treatment, the stainless steel articles may be immersed in the solution without current for 15 minutes before being made cathodic for 6 minutes.

If required, separate tanks may be used for the anodic and cathodic stages. This will reduce the rate of build-up of chromium and iron in the solution.

## **Nickel Sulphate Strike for Stainless Steel**

### *Solution Composition*

Nickel Sulphate	225 g/l
Commercial Sulphuric Acid sp. gr. 1.84 [Weight Equivalent]	27 ml/l 50 g/l]

### *Equipment*

A rubber or plastic lined mild steel tank should be used, or alternatively a plastic or plastic lined fibreglass tank. One rolled nickel anode in the tank is generally sufficient to maintain the metal content of the solution and the remainder of the anodes (necessary to provide adequate anode area) should be chemical lead.

### *Operating Conditions*

<i>Cathode Current Density</i>	16 to 22 amp/dm <sup>2</sup>
<i>Temperature</i>	35 to 40°C.
<i>Time</i>	5 to 10 minutes.
<i>Solution Density</i>	1.160 sp. gr., 32° Tw.

### *Operating Procedure*

Before treatment in the nickel strike solution the articles should be cleaned and then treated as described above.

## NICKEL PLATING OF BRASS AND OTHER COPPER ALLOYS

### A – General Method

1. Pre-clean, *Metex LC 3000* soak cleaner if necessary.
2. *Metex PS Activax* or *Clepo 644-L* soak or *Metex PS 10-15* soak or cathodic/anodic.
3. Water swill.
4. *Klenewell* or *Kleenax* second stage cathodic cleaner. On nickel silver, *Kleenax* preferred.
5. Water swill.
6. Dilute acid dip, 10 per cent weight sulphuric acid, or 10 to 30 per cent volume hydrochloric acid.
7. Water swill.
8. Electroplate.

### B – Alternative method where a cyanide-free cleaning line is required

1. Pre-clean, *Metex LC 3000* soak if necessary.
2. *Metex PS Activax* or *Clepo 644-L* soak or *Metex PS 10-15* soak or cathodic/anodic.
3. Water swill.
4. Second stage, *Metex PE E5* anodic or cathodic/anodic cleaner.
5. Water swill.
6. Dilute acid dip 10 per cent weight sulphuric acid, or 10 to 30 per cent volume hydrochloric acid.
7. Water swill.
8. Electroplate.

## NICKEL PLATING OF COPPER

For the cleaning of copper articles prior to nickel plating the sequence B given above for brass is recommended with the employment of *Anodax Metal Cleaner* at 25 g/l as a second stage cleaner (4).

## NICKEL PLATING OF LEADED BRASS

To reduce the possibility of poor adhesion or blistering when plumbers' brassware and other leaded brasses such as free-turning alloys are nickel plated, particularly where bright nickel plating solutions are used, the following processes are recommended:

1. Pre-clean, e.g. *Metex LC 3000* soak cleaner.
2. *Metex PS Activax* or *Clepo 644-L* soak or *Metex PS 10-15* soak or cathodic/anodic.
3. Water swill.
4. *Klenewell* second stage cathodic cleaner, alternatively *Metex PE E5* anodic cleaner.
5. Water swill.
6. Dilute acid dip *Metex ACS-37* Dry Acid Salt.
7. Water swill.
8. Nickel plate.

Alternatively, the leaded brass components may be given an initial copper deposit from an acid copper solution before being nickel-plated. Where an acid copper solution is used, it is essential that the components be swilled well between the copper and nickel-plating stages, to reduce the possibility of any carry-over of copper solution into the nickel plating solution.

## COPPER AND NICKEL PLATING ON ZINC BASE ALLOY DIE-CASTINGS

1. Pre-clean, e.g. *Metex LC Mersol*, *Metex SU-486* or *Metex LC 3000* followed by a swill or solvent degrease if necessary.
2. *Metex S-426* soak.
3. Water swill.
4. *Metex PE E5* anodic cleaner. Alternatively *Klenewell* second stage cathodic cleaner.
5. Water swill.

6. Acid dip: *Metex M-629 Dry Acid Salt*, 2.5% by volume hydrofluoric acid or 0.5% by volume sulphuric acid – until gassing just commences. (For automatic operation a more dilute hydrofluoric acid solution may be required).
7. Water swill.
8. Water swill.
9. Cyanide copper strike.\*
10. Water swills.
- 11A. Cyanide copper plate, e.g. *Cuprobrite*
- 11B. Pyrophosphate copper plate, e.g. *Pyromac*  
or
- 11C. Bright acid copper plate, e.g. *Cumac*
12. Water swill
13. Acid dip – 10 per cent weight sulphuric acid.
14. Water swill.
15. Nickel plate.

- Where zinc base diecastings are plated in large numbers it is advisable that, even before cyanide copper plating, the diecastings be initially flash coppered in a copper 'strike.' The use of a copper 'strike' reduces the possibility of zinc contamination of the main copper solution. Where an acid or pyrophosphate copper solution is employed, a preliminary cyanide copper flash is essential.

# PLATING ON ALUMINIUM AND ITS ALLOYS

## The Bondal Process

The *Bondal* process is a treatment for aluminium and its alloys which enables direct dull or bright nickel deposits to be applied without intermediate brass or copper plating. It involves the use of special alkaline cleaners *Minco Cleaner* and *Bondal Cleaner*, followed by a unique solution *Bondal Dip* or *Bondal CF*, the cyanide-free version of the standard *Bondal Dip* solution. The process is simple to operate and has an additional advantage over earlier processes in that the nickel plated articles do not need to be stoved prior to chromium plating.

The *Bondal Dip* treatment produces a film on aluminium or aluminium alloy, which may be plated directly with nickel, copper (pyrophosphate or cyanide), brass or silver, chromium (sulphate catalyst type, e.g. *Zonax*), tin, zinc or cadmium. *Bondal CF* was developed to meet modern process requirements. It is a cyanide-free process which produces a film with the same composition and characteristics of the standard *Bondal* process. It produces less effluent dragout than the standard process and is formulated for continuous operation.

Nickel may be applied to a wide range of aluminium alloys including those containing up to 5 per cent copper, 9 per cent manganese or 13 per cent silicon. Where deposits other than those mentioned above are required, it may be necessary to apply an initial deposit of nickel.

The process sequence is described on the following pages.

## Bondal Cleaner

For general purposes *Bondal Cleaner* is used as a cold cathodic cleaner, but for bright nickel deposits of thicknesses greater than 25 microns (0.001in) and for industrial coatings, the use of *Bondal Cleaner* without current is advised.

## Equipment

For *Bondal Cleaner* a plain welded steel tank should be used. Where used as an electrolytic cleaner the tank should be fitted with a work rod connected to the negative of a 4 to 6 volt direct current supply. For anode either the tank itself or preferably separate steel plates may be used.

### **Solution Composition**

Bondal Cleaner 50 g/l

For bright nickel deposits below 13 microns (0.000 5 in) and for alloys containing more than 9 per cent silicon, the following concentration is advised:

Bondal Cleaner 25g/l

### **Solution Preparation**

To prepare the solution, the tank should be filled two-thirds full of water, the necessary weight of *Bondal Cleaner* added, and the mixture stirred until all the salts are dissolved. The solution is finally made up to level by the addition of more water.

### **Operating conditions**

- (a) Electrolytic treatment
- |                    |                   |
|--------------------|-------------------|
| <i>Temperature</i> | Room temperature. |
| <i>Voltage</i>     | 4 to 6 volts.     |
| <i>Time</i>        | 1 to 3 minutes.   |
- (b) Immersion Treatment
- |                    |                   |
|--------------------|-------------------|
| <i>Temperature</i> | 40 to 50°C        |
| <i>Time</i>        | 10 to 20 seconds. |

### **Solution Maintenance**

If the *Bondal Dip* or *Bondal CF* is being maintained as recommended and any deterioration is noticed in the excellent adhesion normally given, the *Bondal Cleaner* should be discarded and a fresh solution made up.

## **BONDAL CF**

The solution is supplied ready for use and must not be diluted. For improved performance on difficult to plate alloys, an addition of *Bondal CF Conditioner* should be made to the process tank. An addition of 2-4 ml/l should be added. Suitable materials for construction of the process tank are plastic, or rubber-lined steel. The use of mild air agitation is recommended.

#### *Maintenance of the Bondal CF solution*

*Bondal CF* is designed for continuous operation rather than use on a "use and dump" basis. The process must be regularly analysed and maintained. *Bondal CF Conditioner* must be added at the rate of 4-6 ml for every litre of *Bondal CF* maintenance additive.

## BONDAL DIP

This solution is supplied ready to use and it is only necessary to pour the liquid into the tank, which should be of steel, rubber or plastic. The solution is used at room temperature. It is an immersion process and no electric current is needed.

The *Bondal Dip* must be kept well mixed. The tank may be fitted with air agitation pipes or, alternatively, the solution should be stirred manually, daily, before use. This stirring will prevent striation of the solution.

### *Maintenance of the Bondal Dip*

The *Bondal Dip* has a long life. It may be used to exhaustion and then discarded and a fresh solution made up. Alternatively, the strength of the solution may be maintained by the addition of special powder mixtures. Where the *Bondal Dip* solution is used without maintenance additions it will be possible to treat a minimum of 2m<sup>2</sup> of surface per litre using a 2 minute immersion time before it is exhausted, but in practice, areas up to 15m<sup>2</sup> per litre are usually achieved depending on the type of aluminium processed and the nature and concentration of impurities dragged into the solution.

For every 1m<sup>2</sup>/l aluminium processed add to the *Bondal Dip*, 20g/l of *Bondal Addition Agent* and *Bondal Activator*. When maintaining by analysis, additions should be made to keep the solution to the following standards:

*Bondal Addition Agent* 75 g/l. *Bondal Activator* 100 g/l.

### **Standard process sequence for electroplating on aluminium castings containing more than 5% silicon**

1. Degrease in trichloroethylene liquor/vapour degreaser or soak clean in *Minco Aluminium Cleaner*, 65 to 80°C for three to five minutes preceded if necessary by an aqueous pre-clean, e.g. *Metex LC Mersol* or *Metex LC 3000*.
2. Cathodic clean in *Bondal Cleaner* solution at room temperature. Time, one to three minutes.  
For thick bright nickel deposits or for plate whose purpose is functional rather than decorative, the *Bondal Cleaner* should be used warm without current, the immersion time for this non-electrolytic cleaning is 10 to 20 seconds at 40 to 50°C.
3. Rinse in cold running water.
4. *Nitric Acid/Fluoride dip*. Dip in 50 per cent (by volume) nitric acid containing either 5% hydrofluoric acid or 50–75 g/l of ammonium bifluoride. Suitable containers are plastic containers, or mild steel tanks lined with a suitable plastic. Solution temperature range, 15 to 30°C. Time, 30 seconds to 1.5 minutes.
5. Rinse in cold water.
6. *Bondal Dip* or *Bondal CF dip*. The immersion in *Bondal Dip* should produce a uniform film all over the aluminium. If a patchy film forms, this is indicative of either over-cleaning or under-cleaning, and these preliminary operations should be checked. Solution temperatures range, 15 to 30°C. Time, one to two minutes.
7. Rinse in cold running water.
8. Rinse in cold running water.
9. Electroplate in dull nickel such as *Nivo* or a bright nickel such as *Nimac*.

Methods of analysis for *Bondal Dip* and *Bondal CF* are given in their respective technical data sheets.

### **Modification to the standard process**

On certain magnesium alloys, particularly those having high silicon and/or copper contents, a double *Bondal Dip* treatment is advised, as this gives even better adhesion of the nickel plate.

After the cold rinse, stage 5, the following modified sequence is employed:

6. *Bondal Dip* or *Bondal CF* (30 to 45 seconds).
- 6a. Cold rinse.
- 6b. *66 Microetch* (50 g/l *66 Microetch Powder*, 10 ml/l sulphuric acid, ambient temperature, 30 sec – 1 minute).

- 6c. Cold rinse.
- 6d. *Bondal Dip* or *Bondal CF* (10 to 15 seconds).

### Standard process sequence for electroplating on aluminium extrusions

1. Degrease in trichloroethylene liquor/vapour degreaser or soak clean in *Minco Aluminium Cleaner*, 65 to 80°C for three to five minutes preceded if necessary by an aqueous pre-clean, e.g. *Metex LC Mersol* or *Metex LC 3000*.
2. Cathodic clean in *Bondal Cleaner* solution at room temperature. Time, one to three minutes.

For thick bright nickel deposits or for plate whose purpose is functional rather than decorative, the *Bondal Cleaner* should be used warm without current, the immersion time for this non-electrolytic cleaning is 10 to 20 seconds at 40 to 50°C.

3. Rinse in cold running water.
4. *66 Microetch Dip*. Dip in a solution containing 50 g/l *66 Microetch Powder* and 10 ml/l sulphuric acid. Use plastic or plastic lined tanks for this process. Solution temperature range is 15 to 25°C and the immersion time is 2 – 6 minutes.
5. Rinse in cold running water.
6. Rinse in cold running water.
7. *Bondal Dip* or *Bondal CF dip*. The immersion in *Bondal Dip* should produce a uniform film all over the aluminium. Solution temperature range, 15 to 30°C. Time, one to two minutes.
8. Rinse in cold running water.
9. *66 Microetch Dip*. As in stage 4. Immersion time 40 – 60 seconds.
10. Rinse in cold running water.
11. *Bondal Dip* or *Bondal CF Dip*. As stage 7. Immersion time 20 – 40 seconds.
12. Rinse in cold running water.
13. Rinse in cold running water.
14. Electroplate in dull nickel such as *Nivo* or a bright nickel such as *Nimac*.

### Articles having unpolished areas

On aluminium spinnings or pressings which have some portion, e.g. the base, not polished, it is advisable to etch in *Kelco Cleaner* before polishing.

### Deposition of metals other than nickel

#### *Hard Chrome Plating on Aluminium*

Hard chromium can be deposited directly on to aluminium or certain of its alloys after the standard *Bondal* or *Bondal CF* process sequence as stated above. Solutions containing sulphates only as catalysts must be used, e.g. *Zonax* type. High speed chrome solutions such as *MACrome* can only be used over a nickel or copper undercoat. When depositing chromium directly, connection must be made to the work before being placed in the chromium plating solution. It is also sometimes advisable to 'strike' for a few seconds at approximately double the current density normally used before the voltage is lowered.

For parts of large bulk it is recommended that rinse stage 8 or 13 in the standard process sequence be used warm, so that the parts enter the chrome solution at the correct temperature. In the preparation of aluminium alloys it has been found preferable to use the following mixed acid dip in place of the 50 per cent nitric acid dip specified in stage 4 of the standard procedure.

Nitric acid 59% sp. gr. 1.37	3 parts by volume.
Hydrofluoric acid, 60% sp. gr. 1.23	1 part by volume.
Water	4 parts by volume.

For this solution a tank lined with a suitable plastic should be employed. Fume extraction is advisable on large containers. Acid containers should be covered when not in use.

### *Copper and Brass*

These metals can be deposited from the normal cyanide type solutions such as *Cuprobrite* copper or *Zonax* brass, using the standard *Bondal* sequence on to the majority of alloys. Acid copper solutions cannot be used.

Copper deposits from the pyrophosphate solution, i.e. *Pyromac*, can be applied directly to the *Bondal* pretreated aluminium surface.

### *Tin*

Deposition from sodium stannate solutions is not possible, but acid tin solutions based on stannous sulphate have been used successfully. For maximum resistance to corrosion it is recommended that an initial deposit of copper from a *Pyromac* pyrophosphate solution be applied to the *Bondal* pretreated aluminium surface, before bright tin plating in *Tinmac* solution.

### *Silver*

Silver has been deposited satisfactorily from standard cyanide solutions such as *Zonax* and *Argentax*, directly on to aluminium after the standard *Bondal* sequence without striking. On alloys where this is not possible, an undercoat of nickel or copper should be used.

### *Cadmium and Zinc*

Both these metals have been plated successfully from normal bright cyanide solutions, such as *Mirromac* and *Kadamax*, directly on to aluminium treated by the standard *Bondal* process sequence.

### *Gold*

It is recommended that an undercoat of nickel be used prior to deposition of gold.

## **Jigging**

It is advisable to use jigs or wires made from aluminium alloy or, alternatively, plastic coated jigs with aluminium tips. For many applications copper wire can be used, but there is a possibility that the bimetallic effect between the copper and the aluminium may affect the adhesion of the plate applied around the contact area. The use of copper wire should therefore be tried out on a few articles before proceeding with large scale production.

## **DIPS AND RINSES**

In the cleaning sequences described in the preceding pages, reference is made to the use of dilute acid dips, cyanide dips and water rinses (swills).

### **Dilute Acid Dips**

Dilute acid dips are used to remove oxide and scale and to provide the necessary activation of the surfaces to be electroplated. Where articles are to be electroplated in an acidic solution such as nickel or acid copper, the use of a prior dilute acid dip serves an additional purpose in ensuring that any alkaline film present after the cleaning stage is neutralised.

As a final acid dip prior to electroplating it is usual to use a 10 per cent weight sulphuric acid dip 60 ml/l. Alternatively a dilute hydrochloric acid dip may be used having a concentration of 10 to 50 per cent by volume, depending upon the surface condition of the articles to be processed.

*Metex M-629* and *Metex ACS-37 Dry Acid Salt* dissolve in water to give an acidic solution which provides an alternative to the use of concentrated mineral acids in the preparation of acid dips and pickles. They are replacements for most plating shop acids.

## Cyanide Dips

A solution of sodium or potassium cyanide is useful for the removal of stains from copper, brass, nickel-silver and most copper alloys. Articles made of these non-ferrous metals that have been degreased in a hot alkaline cleaner or become tarnished, may be put through a cyanide dip composed of 25 to 40 g/l sodium cyanide per litre of water.

The solution should be contained in a welded steel tank and be covered when not in use.

Non-ferrous metal articles which are to be plated in a cyanide or alkaline solution may be given a dip in sodium cyanide solution prior to electroplating to remove any slight tarnish film. It is, however, more usual to use a second stage electrolytic cleaner, e.g. *Klenewell*, before plating.

Cyanide is useful for many other cleaning purposes where the problem is the removal of stains or corrosion products, not grease.

Copper or brass anodes that have become 'furred' or encrusted may be cleaned by immersing them for five or ten minutes in cyanide solution. They should afterwards be swilled and, if necessary, scoured with a bristle brush and wet pumice powder.

Bronze finishes, such as 'oxidised' copper, can usually be removed by a cyanide dip without etching the surface of the metal.

Other uses include the cleaning of mechanisms and delicate parts such as old clock movements and fittings that have become corroded and discoloured, and cannot be pickled in acid.

Cyanide solutions are extremely poisonous, hence new operatives should be acquainted with the fact and warned of the necessity of obeying all safety instructions at all times. It is good practice to wash the hands in clean water after any contact with the solution and before eating food.

Articles that have been pickled must be thoroughly swilled before they are put through a cyanide dip, and care taken that acid is not introduced from hollow work, otherwise decomposition of cyanide will take place with the liberation of deadly hydrogen cyanide (prussic acid) gas.

## WATER RINSING OR SWILLING

Ineffective cleaning and rinsing are together responsible for the majority of failures that occur in electroplating. The processes for cleaning have already been reviewed, but no matter how carefully these operations are carried out, the results may be unsatisfactory if the articles are subsequently rinsed in contaminated swill water. In preparing the layout of a plating or dipping shop, one of the primary considerations should be the provision of an adequate supply of water and a sufficient number of swill tanks. For most purposes, running cold water is preferable to still water, as the latter soon becomes contaminated and requires frequent changing.

When the workpiece has been cleaned it is covered with the contaminated cleaning media, that in most cases must be removed prior to the next chemical stage of the finishing process sequence. Dependant upon the nature and chemical character of the next stage of processing, such cleaning media residues may have a detrimental effect to some degree, and hence water rinsing becomes an important consideration in the finishing process.

## Drag-in factor

A first consideration may be the amount of cleaning process solution that is being brought into the rinsing tank. The manner and orientation, in which the workpieces are jugged or transported within closed perforated barrels, baskets or other, has a large influence with respect to the volume of cleaner solution carried over to the rinse stage. Every effort should be made to ensure that where blind holes or cup shaped surfaces exist there is a facility provided which will allow the free drainage of such surfaces. Equally if the components are containerised the perforations of the barrels or baskets should be made as large as is possible to create free drainage, without detriment to maintaining the long-term strength of such containers or loss of the components themselves. The maximisation of drainage into the cleaner process itself is all-important and

adequate 'dwell-times' should be placed into the process sequence at all relevant stages. However, prolonged dwell-times in association with specific chemistries may result in oxidation of the workpiece surface (tarnishing or bluish rusting) or the drying on of tenacious, less soluble cleaner residuals. Each installation will require a compromise to be established in order to get the best balance between lowest possible drag-in factor without associated and detrimental surface effects. The use of water mist jets over the cleaner tank to prevent drying can be very advantageous and should be considered when plant design and layout allows.

### **Temperature factor**

Using rinse water at elevated temperatures increases the rinsing effectiveness and also increases the solubility of the cleaner residuals taken away from the surface of the workpiece. If a two tank rinse cycle is used it is best that any heat input be applied to the first tank as this is particularly advantageous in removing dried on residuals, plus the increased solubility effect. For the most part the cleaner residuals are removed from the surface by the process of diffusion, which itself is restricted at low temperatures and where no additional heat input is made into the rinse water.

### **Water replenishment factor**

The level of contamination within the rinse tank is not only a factor of drag-in but, to an equal extent, also the amount of flow of fresh water into the rinse tanks. In trying to keep the rinse contamination levels at acceptable levels at all times there are several considerations to be borne in mind:

- Water flow pattern
- Water flow rate
- Use of multiple rinse tanks
- Water cost
- Methods of control

To maximise the use of fresh water the water flow pattern and good mixing is very important. The fresh water input is generally at the bottom of the tank and may make its entry via sparge-pipes or baffle plates, particularly if there is no additional mechanism for water mixing. The water inlet is placed at the opposite end to the water exit, which normally takes the form of an overflow trough built into the tank side. Such overflow troughs allow the easy removal of any oil residues and rinse water surface debris, thereby reducing the possibility of surface pickup when the workpieces are removed from the tank. Reliance on entrance and exit of the workload to create efficient mixing of the waters is not highly recommended.

### **Cascading/Countercurrent flow**

When more than one rinse tank is used there is a tremendous increase in rinsing efficiency. Where possible, tanks should be subdivided to create additional water rinse stages and each division may be cascaded into its neighbour in the direction towards the start of the process line. Cascading or countercurrent flow essentially means that water from one rinse stage is transferred to a previously used water rinse stage. This allows for the best economic use of the water available. Here again, at each stage of the countercurrent flow the effective mixing of the incoming water is extremely important.

### **Spray technique**

Spray rinsing has advantages particularly in removing bulk surface contamination. This may be applied within a specialised tank which only operates for a specified duration whilst the work is at this particular station. Most often the small amount of water used in these spray systems goes to

sewer or into the water recirculation cycle if fitted. Such spray systems generally allow a reduction in the overall flow rate of fresh water onto the finishing plant. Both the design and equipment (pumps, spray jet types and automation, etc.) used to construct an effective spray facility require adequate consideration and consultation with all parties involved.

### **Mechanical agitation**

Without the application of mechanical agitation, the removal of the cleaner which is in contact with the surface of the workpiece will only take place by the process of slow diffusion. Mechanical agitation may take the form of air agitation, movement of the workpiece or the movement of the rinse water itself (via pumping facilities, mechanical stirrer or other). Withdrawal and reimmersion is an excellent way of breaking down the surface chemical concentration gradient, (a practice readily carried out on manual process lines) which can be assimilated on automatic lines if processing time allows.

The use of an ultrasonic rinse (water with no chemicals) improves rinsing and can cut overall cleaning time.

Some observations made regarding the use of ultrasonics in water rinses are:

- Rinsing becomes more effective as temperature of the rinse water increases.
- Ultrasonic cleaning in cold water is about equal to hot water rinsing without agitation.
- Ultrasonic rinsing in hot water (approximately 65° C) is most effective.

For the removing or neutralising of chemical contamination within micro cavities, recesses, blind holes or folded metal joints ('Dutch Seams') the introduction of ultrasound into the water rinse stage at the correct power and frequency levels can be very beneficial.

### **Rinse water aids**

The use of carefully blended mixtures of surfactants and hydrophobic film-formers are often used in final rinse waters. Such additives accelerate the drying out process by reducing the amount of water carried over on the surface of the articles and minimise the tendency for water staining, especially where hard water is used. Each processing circumstance will vary and this may dictate the choice of rinse water aids to be used. The individual application should be discussed with our technical support and local customer service personnel.

### **The Drying process**

In consideration of cleaning only or interstage cleaning, if the switch has been made from solvent cleaning to aqueous cleaning, there will be an extended time in which the components remain wet, and action is needed to speed up the water removal process. In general the common methods used are evaporation, displacement and mechanical removal.

**Evaporation** of rinse water or the cleaning medium (as in inter-operational cleaning) under ambient conditions is slow, and dependent upon the ambient temperature, humidity and passage of air current. In most cases the improvement in the speed of drying is brought about by implementing *hot air recirculation*, in which heated air is circulated within a large chamber: make-up air is continuously introduced to replenish moist air which is slowly extracted.

**Displacement methods** include capillary or slow pull drying. This may be brought about by the hot workpiece being extracted slowly from equally hot deionised water (possibly, with incorporated anti-oxidant inhibition system). The surface tension of the water in effect peels the water off the workpiece. If a residue-free surface is not essential, the use of water displacing oils may be considered. The remaining oil film would then act as a rust inhibitor and thereby give the

required protection during packaging, shipping or until the workpiece is required for the next stage of manufacture.

**Mechanical removal** is very effective and generally combines both the use of heat and air convection. The use of Air Knives directs a high-pressure airflow that blows the aqueous residuals off the workpiece. All high-pressure air lines must be fitted with filters or traps to catch water and oil that may have originated within the compressor lubrication system. Failure to use uncontaminated air may result in the workpiece becoming resoiled. The use of centrifugal dryers combines the use of physical forces, air movement and heat to achieve an efficient drying method. However, it should be remembered that when using a centrifuge system some surface abrasion of the workpiece normally occurs either during the load/unload stage or at the start/stop of the spin cycle.

## **Safety Considerations**

When used with a few simple precautions alkaline and acid processes used in pre-treatment are safe to the environment and to personnel.

The materials safety data sheet issued by the supplier gives the user the necessary information.

## **Safety Tips:**

When making up acid tanks, never add water to the concentrated acid; always add the acid slowly to the water (at ambient temperature) with continuous stirring to avoid any spattering. This is especially true in making up sulphuric acid tanks since the concentrated sulphuric acid, if not handled properly, can react violently.

Similarly, when making up alkaline cleaners using liquid concentrates always add the liquid concentrate to the water (at ambient temperature) with continuous stirring.

When making up alkaline cleaning solutions from powdered materials (e.g. Emphax cleaner), add the dry cleaner directly into the warm tank (45°C maximum) with good agitation without first predissolving the powdered cleaner in water. Violent eruptions can occur when powdered cleaner is added directly to hot water. Eruptions can also occur if large quantities of cleaner are added directly to the tank in one charge instead of dissolving portions of the cleaner at a time.

Avoid breathing fumes from acids and dust from powdered alkali cleaners, since respiratory problems can occur. Use an appropriate respirator for the job at hand.

In handling chemicals always wear protective clothing and equipment, including eye protection (goggles or face-shield).

It is always safer to use warm water (45°C maximum) than hot water in making up alkaline cleaners.

In case of injury, contact a physician as soon as possible. Give first aid immediately. See supplier's literature for guidance.

If spillage of any chemical does occur never let it remain on the floor. Always clean up a spill as quickly as possible to avoid any further reaction with any other chemical with which it may come in contact.

Do not allow personnel to work over hot solutions without adequate precaution.

**NEVER WORK ALONE!**

## Biodegradability - Ecotoxicology

Biodegradability refers to the bacterial decomposition of a chemical. For both manufacturer and user of industrial cleaners the major concern is the biodegradability of the surfactant content. For surfactants the bacterial decomposition takes place in two steps.

1. Primary biodegradation:- loss of surfactant properties e.g. Foaming
2. Ultimate biodegradation:- complete degradation of the compound to carbon dioxide and water

The actual mechanism of biodegradation of a surfactant is still not known exactly. The main factors affecting the biodegradation are the physical size of the molecule and degree of branching of the hydrocarbon chain within the molecule. Having knowledge of the surfactant molecular structure and the typical oxidation processes that take place during biodegradation, it is possible to predict which surfactant molecule types will biodegrade readily and those that will be slower.

Branched chain alkyl phenol ethoxylate  
Branched chain fatty alcohol ethoxylate  
Linear fatty alcohol ethoxylate  
Fatty acid alkanolamides  
Fatty acids

Hard (not so readily biodegradable)

↓  
Soft (more readily biodegradable)

A surfactant should ideally be highly effective and relatively inexpensive to produce. The selection of raw materials thus plays a crucial role. However, complete and rapid biodegradability as well as good ecotoxicological properties are also required since most of the surfactant ends up in wastewater after use. Much of today's surfactant product development work now focuses on the use of renewable raw materials sources, such as carbohydrates and fats as in rape seed or sunflower oil

For all of our new product developments that contain nonionic surfactant material we **will not** incorporate any of the harder nonionic surfactant materials, namely the alkyl phenol ethoxylate material.

The development of a surfactant containing pre-treatment is a critical balancing act between the required application properties, biodegradability, ecotoxicology and cost. Working closely as we do with the major worldwide manufacturers of surfactant material enables us to meet the future requirements of our clients, with due care and attention for the environment.

Pre-treatment and associated processes

**Product Reference**

**Steel/Copper Soak Cleaners (\*)**

<b>Product</b>	<b>Application</b>
<b>Metex PS Activax</b>	Powdered product. For rack and barrel. Effective removal of large volumes of mineral oils, tenacious lanolin greases and soils. May also be used on brass.
<b>Metex PS Extra</b>	Powdered product. For rack and barrel. Effective removal of large volumes of mineral oils and recommended for use where oil separators are not used. May also be used on brass.
<b>Clepo 644-L</b>	Liquid product. Principally a first stage soak cleaner for steel, copper and brass, which will cope with large amounts of oil. Use with ultrasonics for effective removal of polishing compounds or heavy soils. Use of traditional oil separation units to extend process life.
<b>Metex LC 2000</b>	Liquid product. Highly concentrated and ideal for removing large volumes of oil. Inherent oil displacing characteristics - use oil separation units. Free from inorganic salts.
<b>Metex Liquid Cleaner System</b>	Liquid product. Potassium and Sodium bases available and used with 'Tensid EM' to give required surfactant concentration. Also used as an effective electrolytic cleaner.
<b>Masco 245 DM</b>	Liquid product. A highly alkaline, non silicated spray/immersion cleaner base that is highly effective in removing press and stamping lubricants from steel and stainless steel. Use with surfactant blends 'Add cleaner 501' for immersion and 'Add cleaner 503' for spray.
<b>Add Cleaner 501 &amp; 503</b>	Liquid product. Additive surfactant blends for use in alkaline cleaning systems eg. Masco 245 DM. 'Add cleaner 501' is specific for cleaning by immersion and 'Add cleaner 503' is specific for spray cleaning application.

(\*) The products listed above are given only as an example of a wider available product range that can be considered for use in metal finishing pretreatment.

Pre-treatment and associated processes

**Product Reference**

**All Metal Soak Cleaners (\*)**

Product	Application
<b>Metex PS 55</b>	Powdered product. Effective in the rapid removal of grease, heavy mineral oils, vegetable oils, cutting fluids, drawing, printing and brightening residues. All metals including Magnesium.
<b>Metex S-426</b>	Powdered product. Inhibited against attack on zinc, aluminium and brass metals. Use for removal of Chlorinated and Sulphurised oils, general drawing and polishing compounds.
<b>Metex PS 10-15</b>	Powdered product. Promotes rapid penetration of soils and effective emulsification. Animal and vegetable fats saponified. For soak/electrolytic cleaning of steel and copper alloys.
<b>Isoprep 44</b>	Powdered product. Principally a first stage soak cleaner. No attack on sensitive substrates and organic finishes. Ability to form stable emulsions with the majority of oil soils.
<b>Aluclean 400</b>	Liquid product. Mixed alkali cleaner base suited for multi-metal application. To assist oil removal 'Add Cleaner' additives will be required. The choice of additive will be dependent upon the required emulsification property.
<b>ND-7 Supreme</b>	Liquid product. All-purpose alkaline cleaner and degreaser. Safe on most metals and alloys and no effect on rubber, neoprene, nylon and glass. Best used with agitation or ultrasonics at elevated temperature for improved efficiency. The use of ancillary oil-separation units is advantageous.
<b>OC 893</b>	Liquid product. Used as first stage stearate, oil and polishing composition remover giving inhibition against corrosion both during and after processing. Second stage electro-cleaning recommended on plate-lines after use of OC 893.

**(\*) The products listed above are given only as an example of a wider available product range that can be considered for use in metal finishing pretreatment.**

Pre-treatment and associated processes

**Product Reference**

**Steel Electro-cleaners (\*)**

Product	Application
<b>Metex PE Emphax</b>	Powdered product. High conductivity, heavy-duty anodic cleaner for steel. Effective removal of heavy oil and grease contamination. Re-deposition of soils is prevented and on standing the major oil contaminants are released for ease of removal via weir and oil separator mechanism.
<b>Metex PE 50</b>	Powdered product. Economical cleaner for rack and barrel application. Good detergency and emulsifying power will remove heavy oil contamination, grease and soils. Enables large quantities of oil to be removed via weir and oil separator mechanism
<b>Cleaner 10-55</b>	Powdered product. Combines effective cleaning with high desmutting properties. Complex phosphates ensure rapid rinsing and reduce hard water problems.
<b>Metex PE Anodax (**) Anodax NF</b>	Powdered product. Generally used as a second stage, high current density cleaner where good smut removal properties are required. 'NF' version contains no surfactants in order to gain low-foam build up during high current density operation.
<b>E. 1000</b>	Powdered product. Excellent second stage medium current density electro-cleaner (Anodic or Cathodic) for steel. Exceptional emulsifying capability for oils and grease.
<b>Metex LC 100</b>	Liquid product. Major application is the electrolytic cleaning of steel either in rack or barrel application. Ideal for twin stage electrolytic application used for the cleaning of steel wire-work prior to zinc plating.
<b>Metex Liquid Cleaner System (incl Metex 560-L)</b>	Liquid product. Potassium and Sodium bases available and used with 'Tensid EM' to give required surfactant concentration. Also use on Copper substrate.

**(\*) The products listed above are given only as an example of a wider available product range that can be considered for use in metal finishing pretreatment.**

Pre-treatment and associated processes

**Product Reference**

**General Purpose Electro-cleaners (\*)**

Product	Application
<b>Metex PE E5</b>	Powdered product. Predominantly used as the second stage electro-cleaner for zinc base alloys, brass and mixed metals. Specifically balanced to prevent the anodic attack on zinc base die castings and considered to have wider operating windows than those of 'Anozyn' and Metex 'EN 340'.
<b>Klenowell</b>	Powdered product. Cyanide base for effective <b>second stage</b> cleaning of brass and steel. Removes light oxides and promotes good adhesion of electro-plate deposit.
<b>Metex PS 10-15</b>	Powder product. Promotes rapid penetration of soils and effective emulsification. Animal and vegetable fats saponified. For soak/electrolytic cleaning of steel and copper.

(\*) The products listed above are given only as an example of a wider available product range that can be considered for use in metal finishing pretreatment.

Pre-treatment and associated processes

**Product Reference**

**Buffing Compound Removers (\*)**

Product	Application
<b>Metex SU-486</b>	Powdered product. Primarily used as the first stage soak cleaner in the removal of polishing compounds from zinc base die-castings. Very effective when used with ultrasonics.
<b>Metex LC Mersol</b>	Liquid product. Neutral cleaner ideal for off plant cleaning and removal of polishing residues. Very effective when used with ultrasonics.
<b>Metex LC 3000</b>	Liquid product. Neutral cleaner ideal for off plant cleaning and removal of polishing residues. Very effective when used with ultrasonics. <u>No adverse affect on sensitive metals (e.g. Zinc and Aluminium).</u>

(\*) The products listed above are given only as an example of a wider available product range that can be considered for use in metal finishing pretreatment.

Pre-treatment and associated processes

**Product Reference**

**Derust & Descalers (\*)**

Product	Application
<b>Alkaline Deruster</b>	Powdered product. Used for the derusting and descaling of iron and steel, with or without cyanide. Also used for the second-stage electrolytic cleaning of copper. No attack on base metal. Will remove phosphate scale from tanks and other equipment.
<b>Aldecon DP</b>	Liquid product. A sulphuric acid based composite heavy-duty pickle for use by immersion. Formulated to minimise the possibility of hydrogen embrittlement. Elevated operating temperature and effective wetting system accelerate heavy scale removal.
<b>Metex Skalene</b>	Liquid product. A composite acid pickle for immersion use, specifically formulated for the heavy duty descaling of iron and steel. Effectively wetted and inhibited so that the pickling action virtually ceases when the rust and scale is removed. Particularly useful for machined and fabricated components.
<b>Multiprep 506 (*)</b>	Liquid product. Organic acid based activator and pickle. Ideal for cast iron, HSLA steels, leaded steel, leaded brass and the activation of Kovar, nickel and brass.
<b>New Dimension ND 10</b>	Liquid product. Organic acid rust remover and cleaner. Ideal for removing rust, tarnish and oxides from iron, steel, stainless steel, aluminium, brass and copper. A safe alternative to many mineral-acid pickle applications. Can be used to passivate SS per ASTM A 967
<b>Steel Cleaner 301</b>	Liquid product. A composite acid product for use in spray application where products of oxidation require to be removed from stainless steel or mild steel parts.
<b>Masco SZ</b>	Liquid product. This buffered acid material is blended with synthetic surfactant materials. At relatively low operating temperature both degreasing and deoxidation of iron, steel and stainless steel may be carried out.

**(\*) The products listed above are given only as an example of a wider available product range that can be considered for use in metal finishing pretreatment.**

Pre-treatment and associated processes

**Product Reference**

**Spray Cleaners - Intrestage Cleaners (\*)**

Product	Application
<b>Canclean SPA 2</b>	Powdered product. Very effective low temperature, low concentration spray cleaner for both phosphate lines and inter-stage situations. Possible to incorporate conditioners required on phosphate lines.
<b>Masco 86</b>	Liquid product. Boron free, reacted amine and surfactant containing inhibited cleaner for iron, zinc and aluminium. Mixed amine base and inhibitor packages give high value of inhibition against corrosion. If unacceptable on aluminium use Maxclean S-108.
<b>Sintklin EM</b>	Liquid product. Nitrite, boron and oil free synthetic cleaner for most metals. Indoor storage of 10 weeks can be achieved on ferrous material. Ideal for centralised wash plants having effective bactericide and fungicide incorporated. Used by several automotive OEM's.
<b>Phos Stripper 103</b>	Liquid product. A highly alkaline material that may be used for the spray cleaning of steel. Recommended for the removal of heat treatment surface oxides on steel which have been formed in the atmosphere after unloading from the furnace. May also be used where residual phosphate coating requires to be removed.
<b>Sintklin F</b>	Liquid product. Boron free phosphate based inhibited cleaner for iron. Inhibition package equal to Sintkiln EM and additional complexor is good where hard water is used. Can be used in where uniform surface activity is required prior to heat treatment.
<b>Maxclean S 108</b>	Liquid product. Highly silicated all metal spray wash cleaner which is ideal as first stage cleaner on phosphate lines or for interstage processing where mixed metals are processed. Additional; surfactant packages (e.g. Add Cleaner 503 Spray) may be used for heavy oil removal purposes.

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Pre-treatment and associated processes

**Product Reference**

**Dry Acid Salts (\*)**

Product	Application
<p><b>Metex M-629 Dry Acid Salt</b></p>	<p>Powdered product. A sulphate, fluoride and surfactant containing material blend. General purpose, use as immersion only or electrolytic. May be used as an additive to mineral acids pickles to give more effective processing in the derusting/descaling operation.</p>
<p><b>Multiprep 502 Dry Acid Salt</b></p>	<p>Powdered product. General purpose and may be used as an additive to mineral acids pickles to give more effective processing in the derusting/descaling operation.</p>
<p><b>Metex ACS-DAS Dry Acid Salt</b></p>	<p>Powdered product. General purpose. Material may be used with other mineral acids as part of a combined pickle for specific requirements.</p>
<p><b>Metex ACS-19 Dry Acid Salt</b></p>	<p>Powdered product. General purpose. Material may be used with other mineral acids as part of a combined pickle for specific requirements.</p>
<p><b>Metex ACS-37 Dry Acid Salt</b></p>	<p>Powdered product. General purpose and most suitable where leaded base materials are being processed. Material may be used with other mineral acids as part of a combined pickle for specific requirements.</p>

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Pre-treatment and associated processes

**Product Reference**

**Aluminium Soak/Electro-cleaners (\*)**

<b>Product</b>	<b>Application</b>
<b>Minco</b>	Powdered product. Non-etch cleaner use prior to anodising, electroplating or electropolishing. Caustic & silicate 'free'. Well balanced surfactant blend incorporated and is very effective when used in conjunction with Ultrasound for a wide range of sensitive metals.
<b>Bondal Cleaner</b>	Powdered product. Generally used as the second stage cleaner within the 'Bondal' Process. The cleaner may be used by immersion only or electrolytic techniques (refer to technical data sheet SF24202 & SF 24195).
<b>Kelco</b>	Powdered product. For frosting aluminium operate the Kelco at a temperature of 70°C or higher, depending upon the degree of etching required.
<b>Alprep 230</b>	Liquid product. Effectively removes oil and soil. May be operated at high temperatures without etching the aluminium base material. 'Silicate free' formulation and free rinsing characteristics produce stain free and film free surface. Generally used prior to zincate conversion coating application but should be considered for all non-etch cleaning requirements.
<b>Aluclean 400</b>	Liquid product. Mixed alkali cleaner base suited for multi-metal application. To assist oil removal 'Add Cleaner' additives will be required. The choice of additive will be dependent upon the required emulsification property.
<b>Aluclean 245 SA</b>	Liquid product. Particularly suitable for cleaning and light etching aluminium and its alloys. The product may be used in immersion or spray processing. Add Cleaner 501&503 surfactant blends are available if detergency is required.

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Pre-treatment and associated processes

**Product Reference**

**Aluminium Etchants (\*)**

<b>Product</b>	<b>Application</b>
<b>Aluminium Etchant ELE</b>	Liquid product. Long-life etchant which works well at aluminium concentrations in excess of 100 g/l. Balanced formulation and sequestering agents produce very smooth, matt, satin etch. Typically used as the second stage on anodising lines. Refer to TDS for specific maintenance issues.
<b>Aluclean 245 SA</b>	Liquid product. Particularly suitable for cleaning and light etching aluminium and its alloys. The product may be used in immersion or spray processing. Add Cleaner 501&503 surfactant blends are available if detergency is required.

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Pre-treatment and associated processes

**Product Reference**

**Aluminium Deoxidisers (\*)**

Product	Application
<b>66 Micrco Etch</b>	Powdered product. Looked upon as replacement for nitric acid or chromate based desmuts for most alloys. Also may replace nitric acid used for stripping of first zincate layer when double zincating using 'Bondal' or 'Alzinate'. May be modified to good effect on difficult alloys by use of additional acids or fluoride based salts
<b>Aluminium Desmut DS</b>	Liquid product. Powerful 'peroxide and chromate free' descaler/deoxidiser and long life desmut process. May be used for pre and post aluminium etch application. Use for softening anodised coatings prior to stripping in alkali solutions.
<b>Alprep 290</b>	Liquid product. Contains no chrome or nitric acid. Used successfully on a wide range of aluminium alloys. Main use is on zincate lines where in conjunction with 'Alprep 291' or '66 micro-etch' eliminates the need for use of nitric acid.
<b>Deox 2001</b>	Liquid product. 'Phosphate and Nitrate free' blend of mineral acids used for deoxidising aluminium. Spray or immersion treatment. The type of aluminium being processed should be referred back to head office for preferred choice of deoxidiser.
<b>Deox 2003</b>	Liquid product. Blended mineral acids, fluorides and surfactants used for deoxidising aluminium. Spray or immersion treatment. The type of aluminium being processed should be referred back to head office for preferred choice of deoxidiser.

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## Product Reference

### Aluminium Zincate Conversion Coatings and Stripper(\*)

Product	Application
<b>Bondal</b>	Liquid product. Most widely used and accepted zincate process. Produces multi-metal conversion coating on a wide range of aluminium alloys. Modified 'double-zincate' process produces maximum bond strength of electroplate deposit. Low viscosity process solution gives commercial advantages over many simple high-density processes.
<b>Bondal CF</b>	Liquid product. Preferred process for finishers wishing to eliminate 'cyanide' containing processes. Performance and achieved 'bond-strengths' are comparable to those achieved when using standard Bondal on pure aluminium and a wide range of alloys. Low metal concentrations reduce dragout for greater economy in use.
<b>Alzinate</b>	Liquid product. Simple dilution and replenishment. Well accepted process in 'memory disc' application where thin active films are produced on a wide range of alloys. Minimum etching of aluminium and low metal concentration solution gives excellent economy in use.
<b>Alprep 291 A/B</b>	Powder & Liquid. Nitrate, fluoride, borate and phosphate free process. Direct replacement for 50% by volume nitric acid when stripping zinc immersion deposits in the processing of aluminium prior to electroless nickel and others.

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Pre-treatment and associated processes

**Product Reference**

**Acid Inhibitors and Cleaners (\*)**

<b>Product</b>	<b>Application</b>
<b>Pickle Aid</b>	Liquid product. May be used with hydrochloric, sulphuric and phosphoric acids (singular or mixed). Inhibitors are effective over long immersion periods and at prolonged high temperatures. Surfactant material assists with soil removal plus acceleration of scale removal.
<b>Inhibitor GP 11-66</b>	Liquid product. Designed for use in all types of non-oxidising acids in generally large scale pickling plants. Preferred inhibitor for high temperature sulphuric acid pickling and far more stable than Thiourea based alternatives.
<b>Cangalv Inhibitor 1</b>	Liquid product. Preferred product for use in hydrochloric acid pickles on hot dip galvanising lines. Allows steel tanks to be used, giving slow iron build-up and extended acid life.
<b>Masco SZ</b>	Liquid product. This buffered acid material is blended with synthetic surfactant materials. At relatively low operating temperature both degreasing and deoxidation of iron, steel and stainless steel may be carried out.
<b>Composto 80 EM</b>	Liquid product. Inhibited phosphoric acid based cleaner and oil remover. May be used also for the acid pickling of steel prior to phosphating and similar processes.

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