Aluminate Solutions Ltd

Introduction to Aluminium

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History, Analysis and Uses of Aluminium

HOW ALUMINIUM WAS DISCOVERED

The art of pottery making was developed in northern Iraq about 5300 B.C. The clay used for making the best pottery was made up largely of a hydrated silicate of aluminium. Other aluminium compounds such as “alums” were widely used by the Egyptians and Babylonians as early as 2000 B.C. In vegetable dyes, various chemical processes and for medicinal purposes. However, it was generally known as the “metal of clay” and for thousands of years could not be separated by any known method from its link with other elements.

Historical terms dictate that aluminium is a relatively new metal which was isolated early in the 19th century. In 1782 the famous French chemist, Lavoisier, stated it was the oxide of an unknown metal. This observation was repeated by Sir Humphrey Davy in 1808, and Sir Humphrey gave it the name “aluminum” which he felt sounded more scientific than “metal of clay”. His spelling is still used in North America but the rest of the world uses the spelling “aluminium”, following the suggestion of Henri Sainte-Clair Deville, is used. In 1809 Davy fused iron in contact with alumina in an electric arc to produce an iron aluminium alloy; for a split second, before it joined the iron, aluminium existed in its free metallic state for perhaps the first time in world history.

In 1825 H.C. Oerstedt, a Dane, produced a tiny sample of aluminium in the laboratory by chemical means. Twenty years later the German scientist, Frederick Wohler, produced aluminium lumps as big as pinheads. In 1854 Sainte-Clair Deville had made improvements in Wohler’s method and produced aluminium globules the size of marbles. He was encouraged by Napoleon lll to produce aluminium commercially and at the Paris exhibition in 1855 aluminium bars were exhibited next to the crown jewels. It was not until 31 years later, however, that an economical way of commercial production was discovered.

On February 23, 1886, Paul L.T. Heroult arrived at the same process in France. However, he did not at first recognise its significance. He worked along another line in the improvement of aluminium alloys. In 1888 the German chemist, Karl Joseph Bayer, was granted a German patent for an improved process for making Bayer aluminium oxide (alumina). The foundation of the aluminium age was complete. The Bayer & Hall-Heroult processes unchained the world’s most plentiful and versatile structural element for the use of man.

Almost simultaneously, a 22-year-old American, Charles Martin Hall, worked out the fundamental electrolytic process still in use today. Hall had begun his experiments while still a student at Oberlin College, Ohio. He achieved his success, after graduation, with home-made equipment in the family wood shed. He separated aluminium from the oxygen with which it is chemically combined in nature by passing an electric current through a solution of cryolite and alumina.

WHAT ALUMINIUM IS

Aluminium is a metallic element that comes from the ore bauxite. Aluminium is one of about 100 basic elements out of which the physical universe is built. It was created billions of years ago when the whirling clouds of hydrogen under constant pressure with electro-magnetic forces collided to form new elements. When Earth’s mass cooled, aluminium mixed with water and oxygen to form the original material from which bauxite is made. It is called bauxite after Les Baux, France, where it was discovered in 1821.

Aluminium is a light metal and can be given great strength by alloying. It resists corrosion, conducts heat and electricity and reflects light and radiant energy. Aluminium is non-toxic, non-magnetic and can be formed by all known metal working processes. Because of these advantages it is used in hundreds of ways.

HOW ALUMINIUM IS MADE

The bauxite is mined by various processes, once mined it is crushed into very small particles before refining to recover alumina from which aluminium is made.

The separation of the alumina from bauxite is a complicated process. This involves the use of a caustic soda solution heated under pressure to dissolve the alumina. Impurities are filtered out of the solution in the form of a mud-like material. The filtered solution is cooled and alumina is recovered by precipitation in a hydrate form.

The resulting fine crystals are then heated in long revolving kilns to drive off the water of crystallisation. The product is alumina in a white powder form.

Aluminium metal is produced in large steel shells lined with carbon. These shells are as "pots" and are arranged in long rows called "pot lines". Alumina is mixed with cryolite in the pots and large quantities of electricity are introduced to reduce the alumina into aluminium and oxygen. The process is continuous and molten metal is siphoned from the pots at regular intervals.

HOW ALUMINIUM IS TURNED INTO PRODUCTS

Once aluminium is produced it can be made into forms ready for manufacturers to convert into finished products. Industries requiring aluminium may specify from a range of alloys and their metal can be supplied in the form of ingots, extruded shapes, rod, tube, bar, sheet, plate and foil.

When aluminium is passed between rolls under pressure it becomes longer and thinner in the direction in which the plate or sheet is moving. The process starts with special alloy rolling ingots. These are pre-heated to rolling temperatures, and then are fed into a hot mill with the ingot passed back and forth through the mill. One of the best known forms of aluminium is sheet, which has many uses.

One of the most remarkable of all these forms is foil, which is aluminium metal that has been rolled very thin so that it is pliable yet strong. Aluminium foil is widely used in kitchens and food packaging.

Aluminium extrusions have been used commercially for 40 years; a heated billet is pushed under tremendous pressures through a die, the metal taking the shape of the holes in the die. Extrusions are mostly used to reduce the weight or number of parts in an assembly, or to achieve shapes that cannot be produced satisfactorily any other way.

- internal partitioning
- window frames
- rainwater gutters and downspouts
- roofs
- walls
- insulation
- sliding doors
- garage doors
- fly wire screens
- venetian blinds
- awnings
- kitchen utensils
- refrigerators
- air conditioners
- tubular furniture
- electric fittings and appliances
- radio and TV sets
- handrails
- car engines and trim
- trains and freight wagons
- ships and boats
- caravans
- outboard motors
- motor mowers
- wrapping foil
- cans
- closures
- sports equipment
- water and chemical piping
- tanks
- tubing
- armature windings
- food containers
- electric wire and cable

Handling and Storing Aluminium

HANDLING AND STORING

Aluminium is an easy material to keep in good condition. It has a high natural resistance to corrosive conditions encountered during shipment and storage, and a little care will maintain its original appearance for a long time. The main things to guard against are conditions that might cause water stains or surface abrasions.

Aluminate makes every effort to pack aluminium so that traffic marks or rub marks do not occur during shipment and so that it remains dry. All incoming shipments should be inspected punctually, however, and any damage will be inspected and normally replaced by Aluminate.

TRAFFIC MARKS

To avoid traffic marks Aluminate packs the metal so that it is not subjected to undue flexing or twisting and so that the aluminium within a package does not rub. Aluminium that is subject to damage by flexing or bending is usually packed on skids or in timber boxes. Cardboard is used where necessary for packing thin or soft metal. Strapping is used to reinforce packets and boxes and to bind wrapped bundles.

Traffic marks may appear as surface abrasions, scratches or a condition resembling cinders embedded in the metal. These result from mechanical abrasion and subsequent oxidation of the abraded areas. The main disadvantage lies in their unsightliness and their effect on the finished product.

WATER STAINS

These are non-metallic in appearance and, while usually whitish, may appear sparkling depending upon the alloy or degree of oxidation. They are caused by the entrapment of moisture between the neighboring surfaces of closely-packed aluminium. The purer aluminium alloys are more resistant to water stain, while the condition seems most noticeable on those alloys having a high magnesium content. Water staining is a superficial condition and the mechanical properties of the aluminium having such stains are not affected. If a shipment of aluminium arrives in wet condition, it should be thoroughly dried before use. This may be done by evaporation by air or by means of a heater. When the moisture is removed in this way within a short period after the metal becomes wet, no stain will result. If staining has occurred, and the moist condition causing it is removed, the stain will not develop further. Once safely dry, the aluminium should not be stored near such water sources as water and steam pipes, and it should also be kept away from open doors and windows.

CONDENSATION

Condensation is perhaps the most common cause of water stains on aluminium. Condensation may also cause surface deterioration which may only become visible if the aluminium is subsequently etched and anodised. It may be prevented by avoiding conditions where the moisture of the air increases enough to carry the dew point above the metal temperature. It is therefore important to ensure that an increase in humidity or a sudden fall in temperature does not take place during storage.

Aluminium packed in original boxes should never be left in the open, because the greater variations in temperature and humidity outdoors increase the likelihood of condensation. Even if the package is wrapped with 'waterproof' paper, the impossibility of obtaining a perfect seal makes outdoor storage highly undesirable. These waterproof packages are designed only for the protection of the aluminium during shipment and are not designed to withstand any prolonged exposure to weather.

Where water stains have occurred, the degree of staining may be judged accurately by the relative roughness of the stained area. If the surface is reasonably smooth, the stain is only superficial, and its appearance can be improved by chemical or mechanical treatments. Using steel wool or scratch-brushing and oil may be useful for trying to remove water staining. If a chemical dip without undue etching is preferred, a solution containing 10 per cent by volume of sulphuric acid and 3 per cent by weight of chromic acid at about 10°C may be used.

Cold metal should be placed in a dry storage place until its temperature has increased substantially before it is brought into a heated room with a higher humidity. This may be accomplished by placing a new shipment in temporary storage where its temperature is raised slowly to that of the final position.

STORING ALUMINIUM

It is desirable to avoid contact between aluminium and other metals as this sometimes results in scratches or other marks. The use of wood-faced shelving racks and bins is suggested. It is also good practice to keep aluminium away from caustics, nitrates, phosphates, and some acids.

In the continuous use of large quantities of metal, the oldest stock should be used first. Occasional checking of the stock on hand will help to prevent any severe corrosion.

Cleaning Aluminium

Aluminium has a natural attractiveness and lustre. Its surface can be treated in various ways to produce different results, and in the hands of the skilled architect it lends itself to some superb effects and variations and contrasts with other materials.

For this reason and because aluminium is so well proven in service, it is now by far the most common material for exterior work such as windows, curtain walls, doors, and shop fronts.

The surface finish of aluminium can be spoiled by in-correct care and the purpose of this information is to detail the methods of looking after aluminium after proper erection on site. Usually this involves no more than periodic cleaning, on the same basis which the glass in the windows is cleaned, and it is often only lack of appreciation of this factor which can spoil the effects so proudly installed in the first place.

Anodising considerably enhances aluminum's appearance and renders the surface more resistant to most forms of attack and enables cleaning and maintenance.

The Architectural Aluminium Fabricators' Association of New Zealand has published a good guide to Design and Specification and this deals with all aspects of design and use, care and maintenance. The aim here, rather briefly, is to highlight the cleaning feature since it applies to so many users of architectural aluminium products.

Grime which causes deterioration cannot be prevented from settling on exposed surfaces. If cleaned frequently then the lightest methods of washing will produce satisfactory results. There are many ways to clean aluminium, from using harsh abrasives to plain water. The type of cleaning that should be used depends on the finish, level of soiling, and the shape, size and location of the surface to be cleaned.

The mildest method possible should be used, particularly for aluminium which has been anodised.

The following cleaning materials and procedures are listed in ascending order of harshness. The mildest treatment should be tried on a small area and if not satisfactory only then should the next be tried.

- Plain water
- Mild soap or detergent
- Solvent cleaning, e.g. kerosene, turpentine, white spirit
- Non-etching chemical cleaner
- Wax-base polish cleaner
- Abrasive wax
- Abrasive cleaner

Cleaning Aluminium continued

After applying the cleaner, aluminium should be washed down and dried with a clean cloth to prevent streaks.

There should be no build-up of the cleaner at the bottom edges of the aluminium.

If using proprietary cleaners the maker's recommendation should be obtained and followed.

If abrasives are used then the appearance of the aluminium finish may be affected. If there is a grain in the finish then cleaning should always follow this grain.

Aluminate has fine sanding pads available to remove any unsightly marks from anodised aluminium.

Once the condition of the surface requires the use of abrasive or etching materials Aluminate recommends consulting cleaning specialists.

When all other methods fail it may be necessary to resort to heavy-duty cleaning. This involves the use of cleaners containing strong etching chemicals or coarse abrasives.

Regular cleaning of the surface with the correct materials will ensure a perpetual finish to all aluminium products.

Anodising Aluminium

The capacity of aluminium to respond to anodising, the most familiar of finishes, make aluminium a most important metal in a quite original way. Aluminium can take on this attractive, durable and tough-wearing finish making it possible to exploit its strength and lightness in a large number of applications, particularly in the construction industry.

Anodising is basically an induced thickening of the natural protective oxide film on the metal's surface. It is a conversion of the parent metal and thus is not a 'coating' in the usual sense.

Unless severely malformed or strained by excessive thermal movement, the anodic film will not peel, chip or crack. With conventional sulphuric acid anodising, the alloys usually anodised produce a clear, hard, and extremely corrosion-resistant film capable and can be coloured if required.

The functional and decorative potential this confers on the metal is widely used in applications ranging from domestic cookware to building components.

Variations of the conventional electrolyte composition and process variations produce anodic coatings of unique functional properties. Therefore, very hard anodic films are developed to provide abrasion resistant surfaces on bearings, gears, pistons and similar components.

Anodic films are coloured by a variety of methods. Conventional sulphuric acid films are microscopically porous, and organic or inorganic dyes and pigments may be included and sealed in the film.

Whether clear or coloured, it is important that designers understand the essential nature of anodising. Expected changes to the anodic film reproduce the physical nature of the original metal surface. This means that any mechanical finish applied previously to the surface will be clearly evident, and the characteristics of different metal forms will remain.

The more durable coloured films necessary in exposed environments are more usually produced integrally with the evolution of the anodic layer and are everlasting.

Thus, an extruded section and a sheet element, if colour anodised to the same specification and placed together, will show an noticeable colour difference due solely to minor but distinguishing differences in surface profile peculiar to the mill process which produced them.

Basic anodising consists of a suitable chemical pre-cleaning dip, then etching in a caustic soda base solution, anodising electrolytically in a sulphuric acid or other solution, and to end with sealing to reduce porosity.

The anodised surface is inert, and therefore a protective film of aluminium oxide.

The thickness of the aluminium oxide 'anodised' coating can be varied by processing time.

The depth of anodised coating can be varied according to application.

25 MICRON: Recommended for heavy duty external permanent architectural applications where little deterioration can be tolerated.

15 MICRON: Recommended for the majority of ordinary architectural requirements.

10 MICRON: This is suitable for internal applications and outdoor applications where cleaning is very common, for example, caravan trim.

When specified these figures are minimums, and film thickness is checked on a batch basis by electronic means.

Colour finishes are checked for colour against standards, and tested for leaching by being placed in a boiling 0.1 per cent borax solution.

Cleaning is advantageous if the fine finish of anodised aluminium is to be preserved. Weakening of the anodic film occurs mainly as a result of grime deposition and attack by impure moisture, which in a coastal environment contains chlorides and in an industrial or city environment contains sulphur compounds.

Deposited grime absorbs impure moisture much like a sponge and holds it against the anodised surface; this allows the attack to proceed thereby damaging the film, which cannot be brought back without removal.

Regular cleaning is recommended, the frequency depending on accessibility and the harshness of the environment. In a rural atmosphere where grime deposits and pollution of the atmosphere are at a minimum, cleaning should not be needed more frequently than every six months in order to remove deposits and reinstate the appearance.

In industrial and marine environments more frequent cleaning, e.g. monthly, is necessary and the upper limit between cleanings should never be more than 12 weeks.

When an anodised surface has been uncared for, it is sometimes possible to effect restoration by the use of solvents such as kerosene or mineral turpentine along with a mild household abrasive using a soft cloth. The use of harsh abrasives will damage the film beyond repair.

Under the harshest conditions involving grime deposition and atmospheric pollution by both sulphur compounds and chlorides, more frequent cleaning is prudent if deterioration of the anodic film is to be prevented.

It could be assumed that with outdoor applications anodised components should be cleaned with the same occurrence as windows, using the same materials and techniques.

Aluminate has fine sanding pads available to remove any unsightly marks from anodised aluminium.

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