



Adhesive Technologies

ANOBRITE 139 CHEMICAL BRIGHTENER FOR ALUMINIUM ALLOYS

1. DESCRIPTION

ANOBRITE 139 is a liquid aluminium brightener. It consists of a blend of mineral acids and other minor ingredients, the proportions of which have been optimised so that **ANOBRITE 139** can be used on a wide variety of aluminium alloys (except high silicon content die-casting alloys), to obtain very satisfactory results.

ANOBRITE 139 has excellent brightening and smoothing properties. It can be used on super-purity and commercial aluminium which has not been mechanically polished. It removes heavy scratches and other imperfections from the metal.

Continuous operation with **ANOBRITE 139** is possible without having to totally renew a bath of the brightener. As brightening continues the aluminium content of the bath increases and so does the viscosity of the solution. Drag out losses, therefore, increase as aluminium content improves and eventually by drag out and the aluminium content becomes stabilised. Baths of **ANOBRITE 139** can be operated continuously with equilibrium aluminium contents of 50 g/L without sludging.

Control of working baths of **ANOBRITE 139** can be performed very simply by adopting a standard daily operating procedure. Once a schedule of control procedures has been established these should be maintained. However, if any of the physical operating conditions changes e.g. Time of immersion, temperature, agitation etc. then it might be necessary to change the control procedure to maintain the bath in balance. A simple method of establishing what the operating conditions for optimum performance are, for any given situation are given.

The **ANOBRITE 139** brightening and polishing system has distinct advantages over other methods in cheapness and simplicity of operation. It is very suitable for a very wide variety of domestic equipment made from aluminium. Such applications would be for items, which because of their intricate shape, could not be readily polished mechanically. Other categories in the domestic field are trays, shelves, trim on washing machines etc. Further applications of this product would be for the polishing of decorative trim which is replacing chromium plated brass and steel in many industries.

2. DEFINITION OF TERMS

Brightening, smoothing and polishing are three terms that are often used. It is important to understand the meaning of these terms and how they relate. Before this is done two further terms will be defined, namely total and specular reflectivity.

The total reflectivity of a surface is related to the amount of light reflected from that surface, expressed as a ratio to the amount of light incident on its surface, but in this case it will be predominantly in one direction, which will be related to the angle of incidence of the beam of light shining onto it. This is illustrated below:



When a surface is brightened the total reflectivity of the metal surface will be increased without the removal of a significant amount of base metal. This is associated with the smoothing of small surface irregularities and is defined as micropolishing.

Smoothing refers to the process whereby significant amounts of metal, particularly from high spots, are removed so that smoother surfaces are produced. Smoothing results from the leveling of coarse projections and is usually defined as macropolishing.

When micro and macropolishing take place together then polishing takes place. This has been defined as "The dissolution of metal so that a smooth, bright surface is obtained without the formation of etch patterns".

A polished surface will have a high specular reflectivity. As **ANOBRITE 139** both brightens and smoothes then it can be called more precisely "A Chemical Polish For Aluminium Alloys".

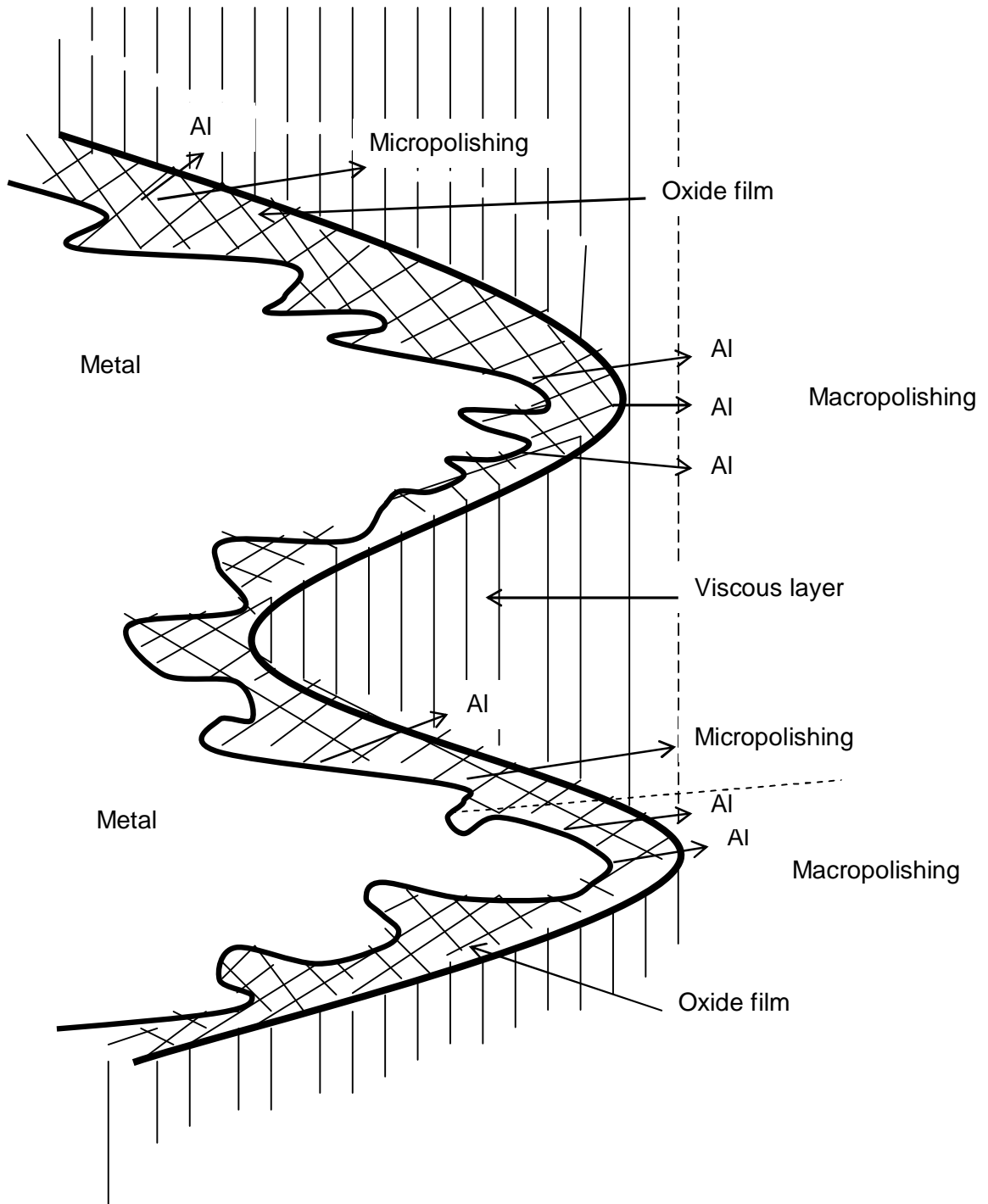
3. THE CHEMICAL BRIGHTENING PROCESS

For a chemical brightener to work effectively it must contain an acid which can react with aluminium and therefore cause its dissolution, an oxidising agent which will be reduced by its reaction with the metal and a substance capable of removing the oxide film formed on the metal.

When the aluminium is initially placed in the brightener solution, the metal reacts to form a thin, semi-permeable oxide film and hydrogen is evolved. An equilibrium is set up whereby the oxide film thickness reaches a maximum when the film disintegrates as fast as it is being formed. This oxide film is structured such that the aluminium passes into random vacant sites in the film and eventually the metal passes into solution as the oxide film is dissolved away. This random removal of metal prevents the formation of etch patterns. A viscous layer of reaction products is also formed which covers the oxide film. This layer is thinner on the peaks than the troughs results in the high spots of the aluminium being smoother in preference to the troughs in the surface.

This mechanism is called macropolishing and operates for irregularities of 0.15 mm depth and upwards. Similarly micropolishing occurs within the oxide film by the more rapid diffusion of aluminium at the small peaks in the surface. Micropolishing proceeds in the absence of the viscous layer associated with macropolishing and is effective for discontinuities smaller in dimension than the oxide film, i.e. less than 0.15 in depth.

These mechanisms are illustrated below.



ANOBRITE 139 contains additives which help the mechanism for brightening to proceed more effectively.

4. OPERATION

As a bath of **ANOBRITE 139** is operated, the composition of the bath changes. The nitric acid content of **ANOBRITE 139** is reduced by reaction and boils off. The water content is reduced by evaporation. The aluminium content increases due to the dissolution of aluminium from the brightening material and total solution is lost by drag out on the brightened substrate. To maintain optimum performance of the bath, addition of nitric acid, **ANOBRITE 139** and possibly water have to be made to maintain the physical and chemical characteristics of the bath within certain defined limits. The method for doing this is given in Section 5.

Processing Sequence

The following sequence should be used when operating **ANOBRITE 139**

- a) Degrease work.
- b) Rinse in water.
- c) Immerse in the polishing tank of **ANOBRITE 139**
- d) Rinse in water. (This is facilitated if the water temperature is 50°C or above).
- e) Desmut.
- f) Rinse in cold water prior to anodising.

Temperature

ANOBRITE 139 is normally used at temperatures between 90°C and 110°C.

The exact temperature employed depends on the aluminium alloy being brightened and the level of dissolved aluminium in the brightener. As the dissolved aluminium level increases in the brightener it may be necessary to increase the temperature of operation to maintain the degree of polishing that is required.

Immersion Time

The time for immersion of work to be brightened depends on the type of aluminium alloy brightened, the temperature of the bath and aluminium content. Normally 1 to 5 minutes immersion will be required. During polishing, it is necessary to agitate the work to prevent the chance of gas streaking. This can be done mechanically, or air agitation could be used.

Equipment

Stainless steel of EN 58J (316) quality must be used for the tank to contain **ANOBRITE 139** and related equipment which comes into contact with this product. Heating is required, as is fume extraction.

5. CONTROL

The basis for establishing operating conditions for optimum performance depends on maintaining the specific gravity and nitric acid content of **ANOBRITE 139** within specified limits for any given aluminium content of the bath. This is done by making additions of nitric acid, **ANOBRITE 139**, and if necessary, water, according to a regular schedule.

Three parameters have to be measured to do this: S.G., Nitric Acid Content and Total acidity (or Aluminium Content). The methods for determining these parameters are given in section 4.

The aluminium content can be calculated from the total acidity value, S.G. and nitric acid content using the nomogram in Fig. 1. An illustration of the use of the nomogram is given as a foot note to the figure.

Nitric Acid Addition

The limits for 70% nitric acid content expressed as percent v/v for any aluminium content are given in Fig. 2. The percentage volume difference between the actual and required nitric acid content to bring the level back to a good operating range should be added on a regular schedule. Normally, additions of nitric acid are made several times per day, depending on operating conditions. The optimum level of nitric acid for any aluminium level is just above the lower limit as shown in Fig. 2.

ANOBRITE 139 and Water Additions

For any given aluminium content, the specific gravity of the bath should be maintained within the limits shown in Fig. 3. This can be done by making an addition of **ANOBRITE 139** and / or water as appropriate. During operation, the S.G. will tend to rise above the upper limit rather than drop below the lower limit for any particular aluminium level. Therefore, the additions of **ANOBRITE 139** and / or water will be added to decrease the S.G. to an optimum operating level and to improve the drag out losses.

6. ANALYTICAL METHODS

Sampling Procedure

Obtain approximately a 200 mL sample of the brightener from the working tank. It is important to ensure that the tank is thoroughly agitated so that a representative sample is obtained and that the sample is taken from under the surface to avoid contamination by impurities floating on the surface. If additions have been recently made, allow enough time for thorough mixing.

The sample obtained is allowed to cool to 20°C. Allow to stand long enough so that all air bubbles have escaped from the sample.

ANALYTICAL METHODS (continued)**Nitric Acid Content**

Apparatus Required (available from laboratory suppliers)

250 mL beaker.
25 or 50 mL burette
100 mL and 1 Litre flasks
hot plate or gas burner
100 mL measuring cylinder
5 mL and 10 mL pipette
pipette bulb
thermometer

Reagents Required

- ❖ Ferrous Sulphate $7\text{H}_2\text{O}$ (A.R.)
- ❖ Nitric Acid (70% w.w.) S.G. 1.40 (as used for additions)
- ❖ Phosphoric Acid 85%
- ❖ Sulphuric Acid 98% w.w.

Available from laboratory suppliers

Preparation of Ferrous Sulphate Solution

Add 50 mL concentrated sulphuric acid to 700 mL distilled water and dissolve in 265g. $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ (A.R.). Cool and make up to 1 Litre.

Standardise every week and keep in a well stoppered bottle. (see section "Procedure")

Preparation of Nitric Acid Standard

Pipette 10 mL of 70% HNO_3 into a 100 mL volumetric flask and make up with the concentrated phosphoric acid.

Procedure

Take 5 mL of the nitric acid standard by pipette and put into a dry 250 mL beaker (a conical flask should not be used for this titration). Add 80 mL of concentrated phosphoric acid. Stir and warm to $40^\circ\text{C} - 45^\circ\text{C}$. Titrate with Ferrous Sulphate Solution until the first permanent golden-brown colour is formed. Towards the end of the titration there will be numerous gas bubbles dispersed throughout the solution and reddish-brown fumes are evolved. At the end point no fumes are evolved.

Let S be the number of mL of Ferrous Sulphate used. (see section "Preparation of Ferrous Sulphate Solution"). Take 5 mL of the brightener solution by pipette and repeat the above procedure.

Let T be the number of mL of Ferrous Sulphate used.

Then % (v/v) 70% HNO₃ = $\frac{T}{S} \times 10$

ANALYTICAL METHODS (continued)

Total Acidity

Apparatus Required

50 mL burette
250 mL conical flask
25 mL pipette
Pipette Bulb
250 mL volumetric flask

Reagents Required

1N Sodium Hydroxide

Procedure

Pipette 25 mL of brightener into a 250 ml volumetric flask and make up with distilled water. Take 25 mL of this solution and put into a 250 mL conical flask. Titrate with 1N NaOH to a faint permanent turbidity.

Total acidity is expressed as number of mL of 1N NaOH required to neutralise the brightener.

Use the nomogram in Figure 1 to calculate the aluminium level in the solution.

It will then only be necessary to carry out checks on S.G., nitric acid contents etc. only occasionally, to ensure that operating parameters are being maintained in the optimum range. If any operating condition changes e.g. temperature, type of work etc. then checks should be made daily until a new schedule of additions has been established.

7. DEFECTS APPEARING ON BRIGHTENED ANODISED ALUMINIUM

Their Recognition, Origin and Rectification:

Type of Defect	Origin	Rectification
Pitting	Too high an operating temperature (most common). Too high Nitric Acid content	Reduce bath Temperature. Reduce Nitric Acid Level.
	Poor degreasing; by not removing all buffing compounds.	Improve cleaning stage.
	Generally: by not operating at recommended composition and temperature.	Good bath control and adequate degreasing.
Non-Uniform Appearance Barnacling. (white deposit on metal surface)	Deposition of aluminium orthophosphate from the bath onto the aluminium surface.	Reduce the S.G. of the bath.
Dull Finish	Bad extrusion practice caused by cooling too slowly on run out table and the precipitation of Mg_2Si .	Improve extrusion practice.
White Filming	Too low nitric acid.	Increase nitric acid content.
	Incomplete desmutting.	Improve desmutting stage.
	Too thick anodic film.	Reduce film thickness.
Streaking	Gas evolution in the brightening bath.	Improve agitation in the bath.
	Drain time too long.	Shorten drain time.

8. BATH SLUDGING AND ITS RECTIFICATION

If a bath has been run at a high S.G. for some considerable time then some sludging might occur. This sludging is the precipitation of aluminium phosphate. It may be possible to cure this by reducing the S.G. to a good operating range. If, however, this is not possible because the aluminium content of the bath is too high, then the solution should be allowed to cool when the aluminium will crystallise out. The clear supernatant solution should then be taken out and the tank cleaned, after which the solution can be replaced, together with fresh **ANOBRITE 139**, to bring up to a working level.

9. OPERATING FEATURES OF ANOBRITE 139

Specular Reflectivity

The affect of aluminium content in a brightener bath on the specular reflectivity obtained on aluminium pieces is shown in Figure 4.

It can be seen that the aluminium content of the bath reduces the specular reflectivity that can be obtained at any given temperature.

It can also be seen that by increasing the temperature bath, greater specular reflectivity can be obtained and by increasing the temperature of the operation this can go some way towards offsetting the effect of higher aluminium contents in the bath.

Increasing the time of immersion will result in greater smoothing and brightening. The effect that time of immersion has on the brightening obtained varies depending on the aluminium concentration, as shown below for an average bath temperature of 100°C.

<u>Aluminium Content:</u> (g/L)	<u>Specular Reflectivity</u>	
	1 min	3 mins
10	68%	84%
50	68%	70%

Rate of Metal Removal:

The rate of which metal is removed when brightening takes place, depends on the temperature of operation and aluminium content of the bath. This is shown below:

Temperature (°C)	Aluminium Content (g/L)	
	10	50
95	11.20 g/sq. m./min.	3.1 g/sq. m./min.
105	12.70	4.4

OPERATING FEATURES OF ANOBRITE 139 (continued)Drag Out Losses:

As the aluminium content of the brightener increases so the viscosity increases and therefore the amount of brightener dragged out on the work.

Varying the temperature of the operation does not have any significant effect on drag out losses between 95°C and 105°C. These drag out losses were obtained after a 10 second drain time.

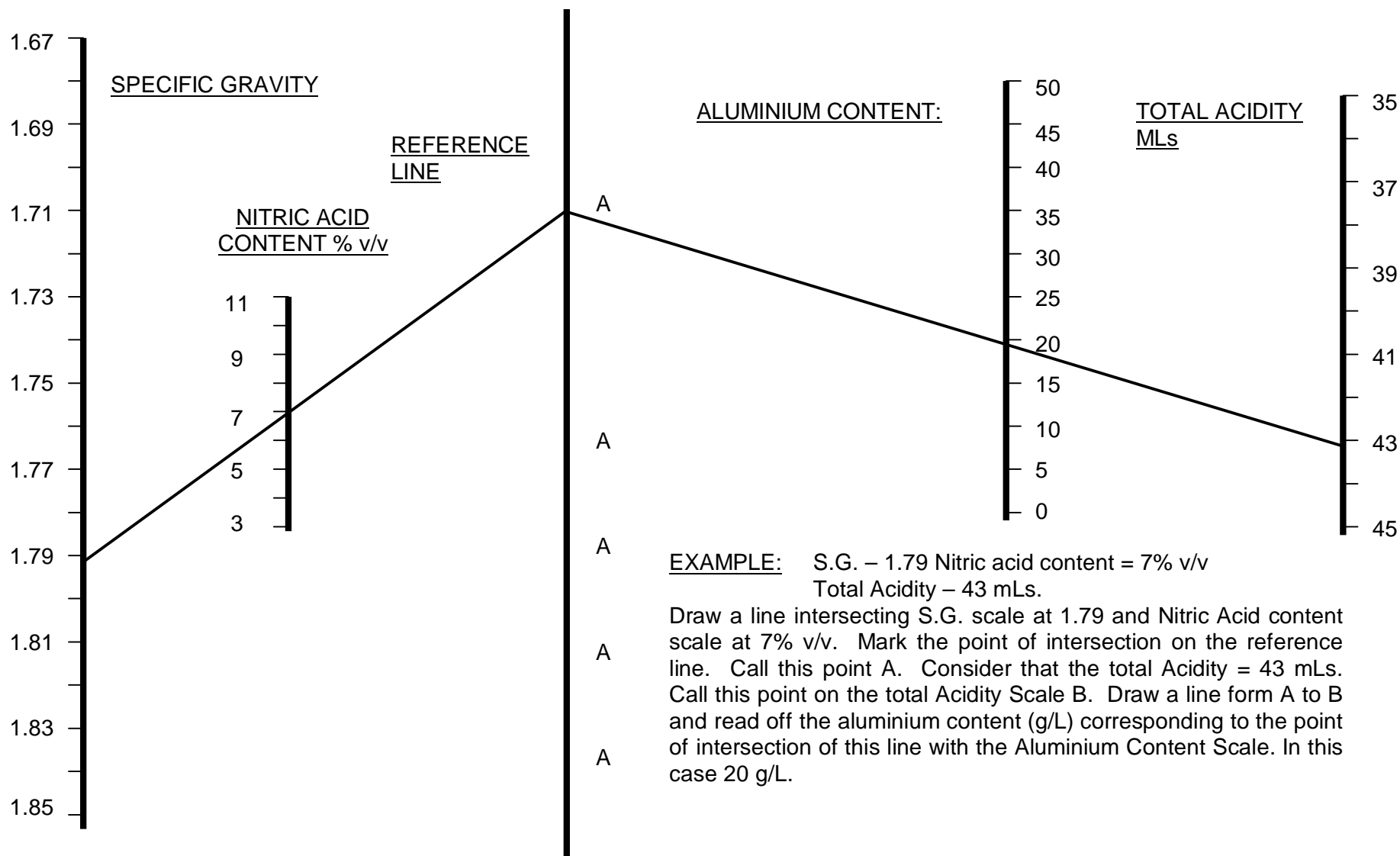
Aluminium Content (g/l)	10	50
Drag out loss mL/m ² .	700	1300

It is advisable not to have a longer drain time than ten seconds otherwise streaking can occur.

DISCLAIMER

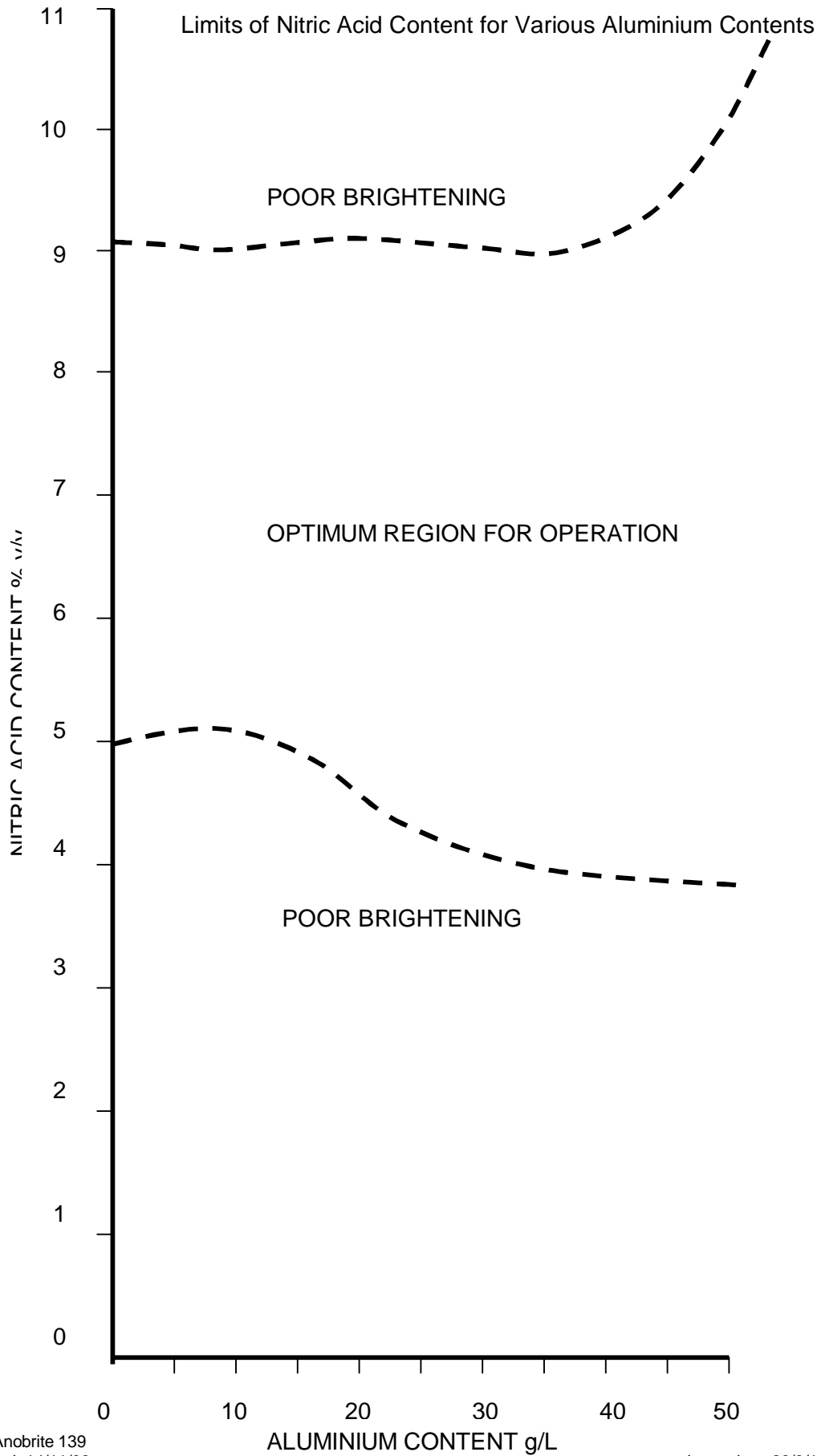
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ALUMINIUM CONTENT NOMOGRAM

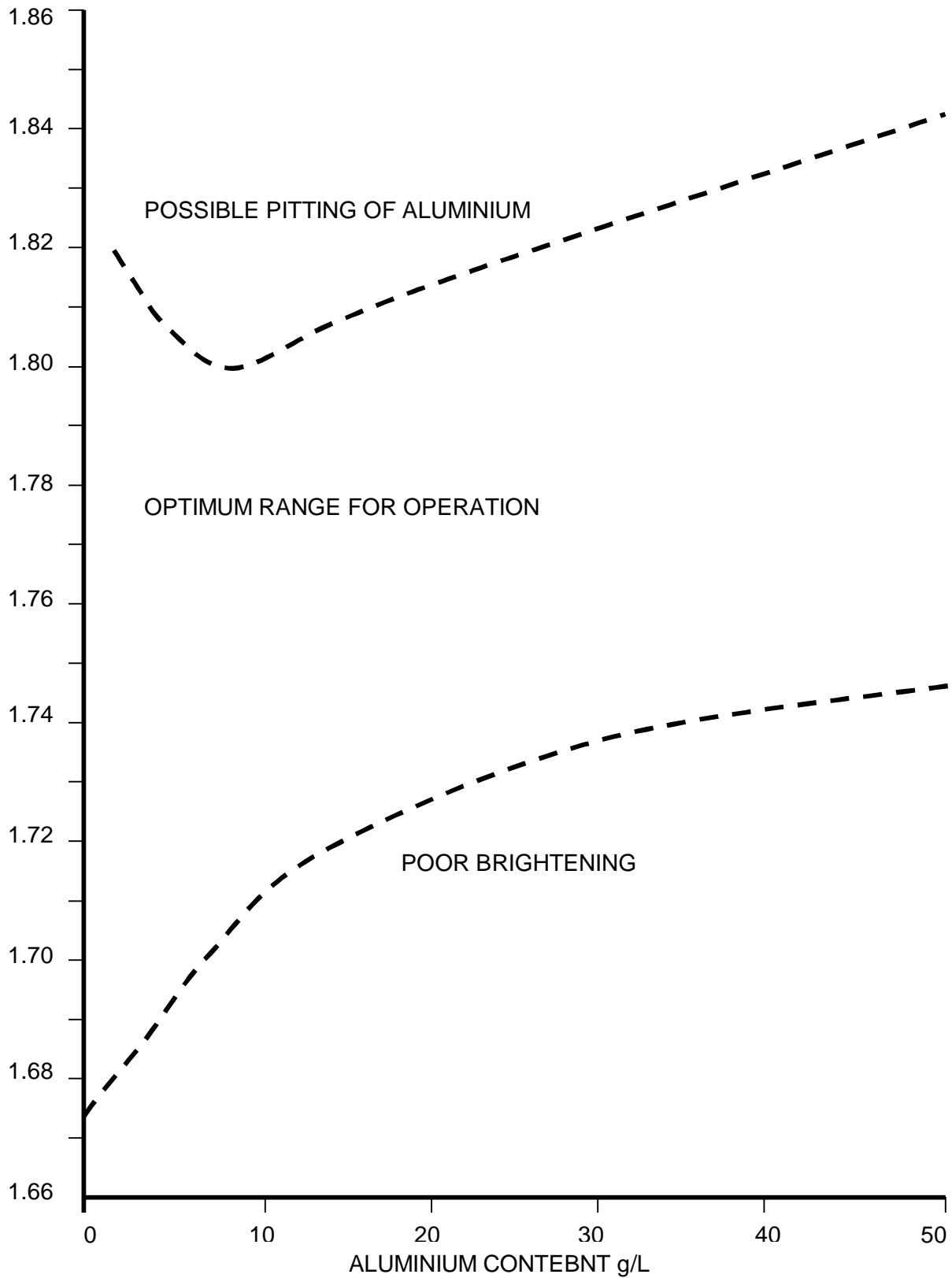


EXAMPLE: S.G. – 1.79 Nitric acid content = 7% v/v
 Total Acidity – 43 mLs.

Draw a line intersecting S.G. scale at 1.79 and Nitric Acid content scale at 7% v/v. Mark the point of intersection on the reference line. Call this point A. Consider that the total Acidity = 43 mLs. Call this point on the total Acidity Scale B. Draw a line from A to B and read off the aluminium content (g/L) corresponding to the point of intersection of this line with the Aluminium Content Scale. In this case 20 g/L.



Specific Gravity Operating Range for Various Aluminium Contents



RELATIONSHIP OF PERCENTAGE SPECULAR REFLECTANCE
WITH ALUMINIUM CONTENT OF THE BATH

