Influence of pH on Crystallization point of Liquid Aluminium Sulphate 8% w/w (as Al_2O_3)

Liquid Aluminium Sulphate, 8% w/w (as Al_2O_3) is an inorganic, acidic chemical. It is used primarily as a coagulant for the treatment of water. The alumina content is directly related to the ability of the chemical to remove organics, colour and other contaminants from the raw water.

The Quality Control methodology relating to this product is governed by standard IS EN 1302:1999. This standard describes how the Aluminium and Alumina content should be analysed. When analysing liquid aluminium sulphate the two most important parameters are actual Aluminium & Alumina content and actual Acidity content. Analysis of both of these parameters are covered in IS EN 1302:1999. Both methods are wet chemistry based. In the case of Aluminium analysis the method principle is that full aluminium complexation with an excess of EDTA occurs and direct aluminium content is measured by titration of the excess EDTA with a standard solution of zinc.

The main reason that IS EN 1302:1999 requires this method to be used is that normal atomic absorption measurement of % w/w aluminium content incurs too many margins of error. These include errors due to the massive dilutions required and also possible interferences.

Chemifloc scientific staff after many years of analysis have come to realise that this analysis cannot be routinely carried out where staff may not have the time nor infrastructure readily available and instead leads to plants having to outsource analysis usually carried out by inappropriate methodology as outlined above.

In order to make life easier and cost effective Chemifloc, through analysis, recognised the relationship between pH and Acidity content. Also the relationship between Specific Gravity and Alumina content (as Al_2O_3) at known Acidities. Attached are a series of Calibration Charts. These Calibration Charts allow Plant Staff to quickly determine the Alumina content of any sample.

Free Acidity

The degree of Acidity (Sulphuric Acid excess) has an impact on the pH of the product. As the degree of Acidity increases the pH decreases. The effect that Acidity has on Liquid Aluminium Sulphate is demonstrated in the Calibration Charts attached.

Calibration Charts

Charts 1, 2 and 3 illustrates the relationship between Specific Gravity and Alumina Content at different levels of Acidity.

Chart 1 is derived using 0% w/w Acidity Liquid Aluminium Sulphate (pH 1.4 to 2.2) From this chart you can see that Neutral Acidity Liquid Aluminium Sulphate at a density of 1.320 g/l @ 20^{o}C has an Alumina content (Al_2O_3) of 8% w/w.

Chart 2 is derived using <1.0% w/w Free Acidity Liquid Aluminium Sulphate (pH 0.6 to 1.4) From this chart you can see that this Liquid Aluminium Sulphate at a density of 1.320 g/l @ 20^{o}C has an Alumina content (Al_2O_3) of 7.88% w/w as Al_2O_3.

Chart 3 is derived using 1.0 – 2.0% w/w Free Acidity Liquid Aluminium Sulphate (pH 0.2 to 0.6) From this chart you can see that this Liquid Aluminium Sulphate at a density of 1.320 g/l @ 20^{o}C has an Alumina content (Al_2O_3) of 7.68% w/w as Al_2O_3.

NOTE

Just because your Liquid Aluminium Sulphate has an specific gravity of 1.320 g/l @ 20^{o}C or higher, that doesn't always guarantee that its 8% w/w as Al_2O_3.

Chart 1

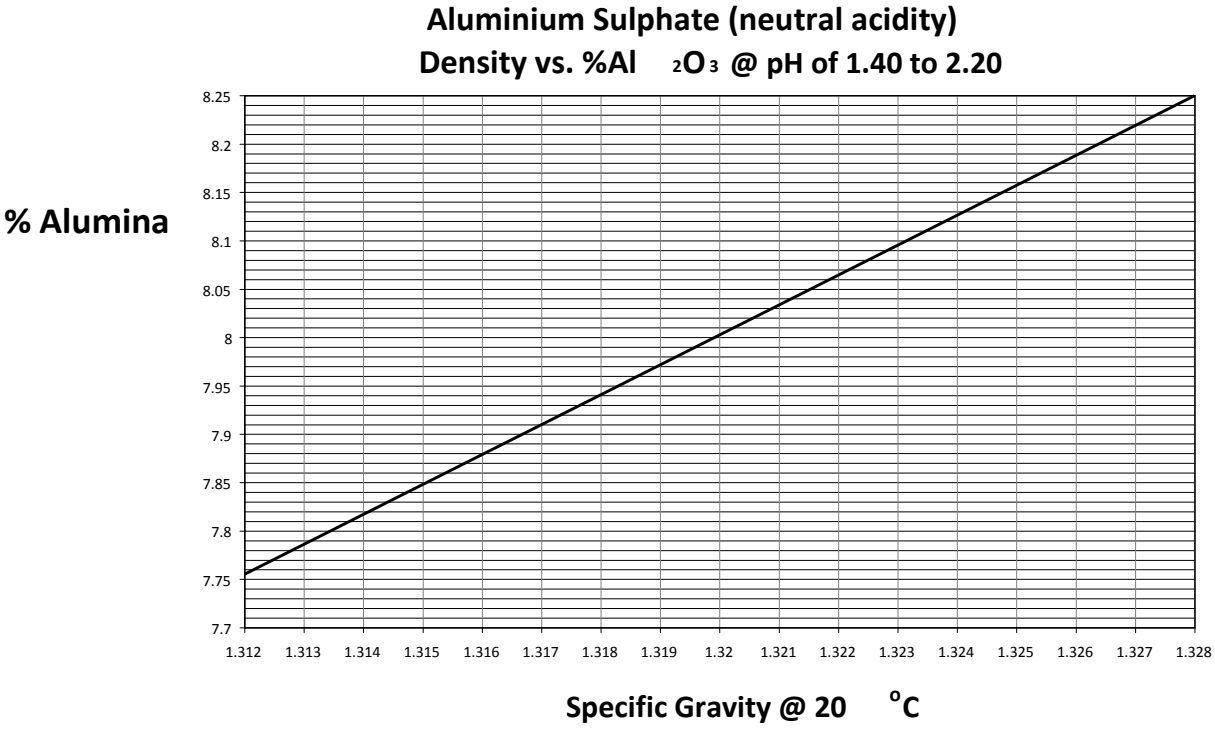


Chart 2

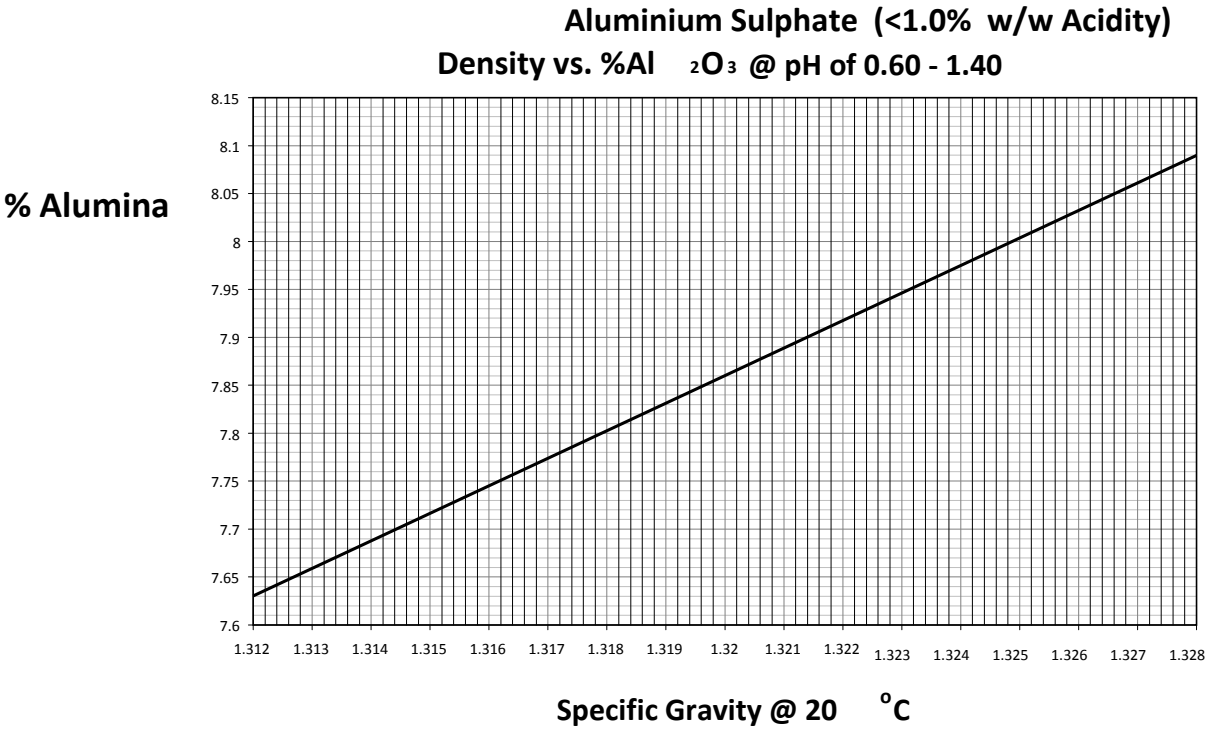


Chart 3

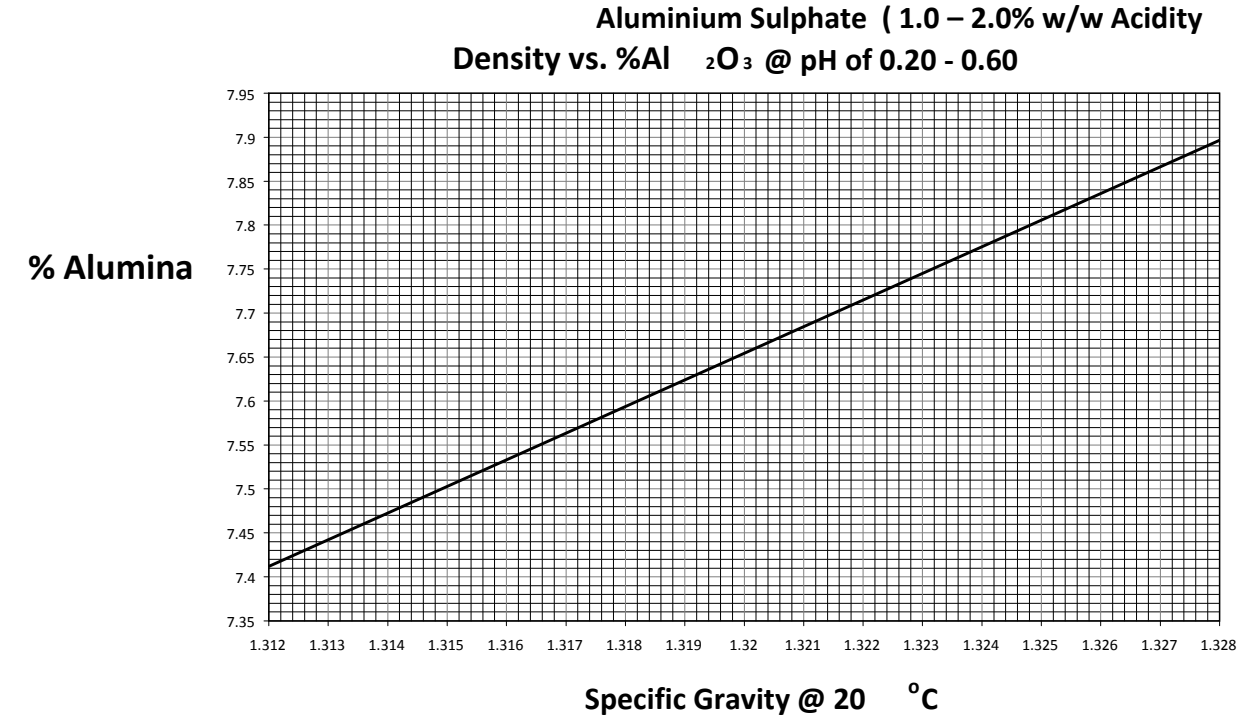
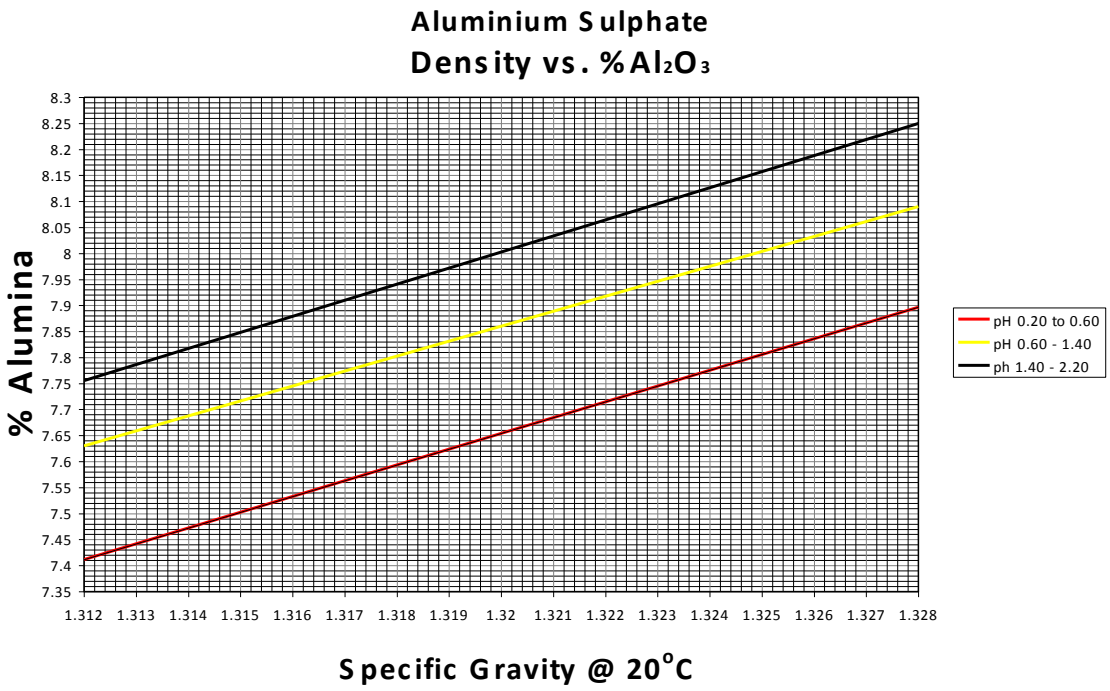


Chart 4 is a reference chart suitable as a working tool to allow determination of Alumina content (Al_2O_3) for any Liquid Aluminium Sulphate sample at varying Free Acidity concentrations.

Chart 4



Free Sulphuric acid excess in aluminium sulphate tends to change many of the chacteristics of aluminium sulphate. Below are the main characteristic changes;

1) Alumina content

As demonstrated in Chart 1, neutral acidic aluminium sulphate with a density of 1.320 g/l @ 20°C would have a concentration of 8% w/w (as Al_2O_3). ***As the degree of acidity increases (the pH decreases) the alumina concentration at any particular density would be lower than the alumina concentration at the same density of neutral acidic liquid alum.*** This is largely due to the fact that sulphuric acid itself has a density of 1.84 (ie 1 litre of sulphuric acid = 1,840 g). So any increase in acidity would increase the density while decreasing the concentration of the Alumina. This is the main reason that when measuring Specific Gravity of Liquid Alum it is essential to simultaneously measure the acidity. If an acidity measurement is unavailable then at a minimum a pH should be measured. From both the density and the pH a much more accurate Alumina measurement can be obtained as outlined above.

2) Crystallization Point

There are many factors that contribute to give Liquid Aluminium Sulphate its Crystallization Point. The two most important are;

a) Concentration of Alumina
b) Concentration of Acidity

A general rule of thumb is that the higher the concentration of either or both Alumina & Acidity then the higher the crystallization point in degrees celcius.

A solution of 8% w/w (as Al_2O_3) Liquid Aluminium Sulphate with neutral acidity has a crystallization point of < 7^oC. **The more acidic the solution the higher the crystallization point becomes ie; becomes closer to 0^oC.** This matter is of great relevance to water treatment plants in Ireland especially as we have become accustomed to subzero winter temperatures of the last few years. IS EN 878:2004 stipulates that Liquid Aluminium Sulphate should have a crystallization point of not less - 7^oC. The lower the % w/w Acidty of the Liquid Alum the greater the protection against crystallization.

We must emphasize that this quick check analytical method is not a replacement for the wet chemistry analysis outlined in IS EN 1302:1999 but the charts have been derived from analysis carried out by the methods outlined in the standard and therefore give an accurate approximation for fast, cost effective and regular confirmation of product supplied.