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## Cleaning metals with acid cleaners

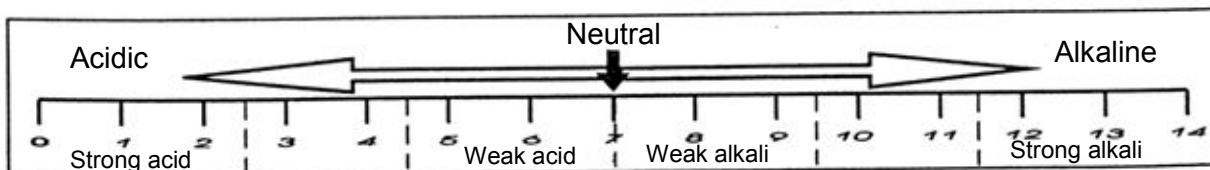
As mentioned in previous Technical Bulletins, acid cleaners are primarily used to remove inorganic deposits such as lime scale, rust, etc. Acid cleaning agents are also used to pickle stainless steel. The type of acid chosen to clean the metal depends on the substrate and the type of contamination. This Technical Bulletin contains more details of the theory of the various acid cleaning agents in the Vecom Group's product range.

### The acidity, or pH

A special molecule is water (H<sub>2</sub>O). In fact, it would be preferable to write the chemical formula as H-OH. A water molecule is actually comprised of two electrically-charged parts (ions): H<sup>+</sup> and OH<sup>-</sup>. The positive part (the H<sup>+</sup> ion) is the acidic part; the negative part (the OH<sup>-</sup> ion) is the alkaline or basic part. Pure water contains an absolutely identical number of both parts; consequently pure water is electrically neutral.

The pH is defined as *the negative logarithm of the concentration of H<sup>+</sup> ions*.

In pure water just one of every 10,000,000 molecules will decompose into ions, i.e. a concentration of 0.0000001 (10<sup>-7</sup>). Consequently pure water has a pH of 7, whilst the concentration of H<sup>+</sup> ions in an acid with a pH of 3 will amount to 10<sup>-3</sup> – or, in other words, there will be one H<sup>+</sup> ion for every 1,000 water molecules.



### The pH of a number of well-known materials:

Battery acid	0	Milk	6.5
Gastric acid	1	Pure water	7.0
Citric acid	2	Blood	7.4
Vinegar	2.5	Seawater	8.5
Cola	3.6	Soda solution	8.7
Wine	3.9	Hair shampoo	9.8
Tomato juice	4	Household ammonia	11
Black coffee	5	Liquid bleach	12.5

### Choice of the type of acid

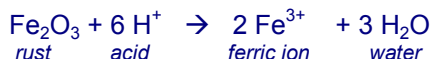
The choice of the type of acid and any additives used, depends on the substrate and the nature and extent of the contamination. In general, strong acids such as hydrochloric acid (HCl), nitric acid (HNO<sub>3</sub>), sulphuric acid (H<sub>2</sub>SO<sub>4</sub>) and phosphoric acid (H<sub>3</sub>PO<sub>4</sub>) are unsuitable for use with light metals such as aluminium, zinc, copper and nickel. This is because these metals undergo a fairly violent reaction in a strong acidic environment; they dissolve, and generate hydrogen gas. This can form an explosive mixture with oxygen (in the air!). In such situations the addition of rust inhibitors, often complex organic amines, can offer the answer. In general, strong acids are generally used for industrial cleaning.



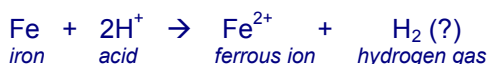
Weak acids such as citric acid, formic acid and sulphamic acid are suitable for use with metals such as aluminium, zinc, copper and nickel. Although these metals will be affected by these acids, this will be much less severe. Moreover these acids are more pleasant in use. For this reason weak acids are used, in particular, for cleaning in the institutional sector.

### Some reactions between metals and acids

The properties possessed by acids can be used to remove specific deposits such as rust (iron oxides). This reaction results in the conversion of iron oxide into a soluble ferric ion and water.

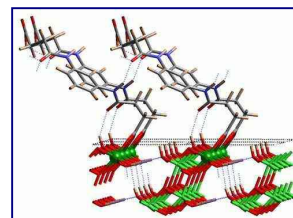


However the disadvantage is that in addition to the above reaction the acid also reacts with the actual metal. This reaction affects the metal surface (corrosion). This reaction between an acid and a metal results in the formation of hydrogen, with the visible evolution of gas bubbles on the surface. The hydrogen may also react with the metal. This process is referred to as 'hydrogen embrittlement'.



The detrimental side-reaction between an acid and metal can be greatly reduced by the addition of inhibitors to the acid solution. Inhibitors are often comprised of organic nitrogen and/or sulphur compounds together with surfactants. Surfactants ensure that the surface is thoroughly wetted with the solution, which in turn results in a more uniform surface reaction and prevents localized corrosion.

The inhibitor counters corrosion by forming a thin film on the surface of the metal. The surface of the metal is slightly charged, as a result of which polar organic compounds (inhibitors) are drawn to the surface and form the protective layer. Unfortunately each type of acid requires a specific inhibitor; moreover not all inhibitors are capable of protecting every type of metal. For this reason it is important to use the appropriate inhibitor for the specific acid.



### Summary of acid cleaning agents.

Vecom has formulated a range of products on the basis of a variety of acids and inhibitors. The following table lists guidelines for the metals for which each product is suitable.

	Steel	SS	Al	Zinc	Inhibitor	Degreasing	Application
<b>Cetemax San</b>	+	+	+	+/-	+	+	Sanitary cleaner for day-to-day maintenance
<b>Cetemax San Plus</b>	+	+	+	-	+	+	Sanitary cleaner for periodic maintenance
<b>Descalant F / BA-S</b>	+	+	-	-	+	-	Powder for cleaning cooling systems
<b>Descalant HD / BA-30</b>	+	-	-	-	+	-	Severe contamination (steam boilers)
<b>Descalant F / BA-S</b>	+	+	+	+	+	-	Powder for cleaning light-metal cooling systems
<b>Descalant NF-Liquid / BA-70</b>	+	+	+	+	+	-	Mild, acidic liquid descaling agent. Safe on aluminium
<b>Descalant Tankclean</b>	+	+	-	-	-	+	Removal of cement deposits. Safe on aluminium
<b>Vecosan Brightner GTM</b>	+	+	±	-	-	++	Cleaning weathered aluminium
<b>Vecosan Plus</b>	+	+	+	-	-	+++	Degreasing of aluminium before painting
<b>Vecosan Rustcleaner</b>	+	+	+	-	-	+/-	Removal of rust and lime scale
<b>Vecosan Metal Cleaner</b>	+	+	+	-	-	++	Cleaning aluminium, (stainless) steel, and copper. Contains no HF
<b>Vecosan Super</b>	+	+	±	-	-	+	Cleaning aluminium and (stainless) steel
<b>Vecosan Tankbrightner</b>	-	+	+	-	-	+	Imparting a shine to aluminium
<b>Vecosan TTC-101</b>	+	+	±	-	-	++	Removal of stubborn atmospheric contamination
<b>Vecosan TTC-204</b>	+	+	±	-	-	+	Removal of rust smears. Contains no HF
<b>Vecosan TTC-Foam</b>	+	+	±	-	-	++	As Vecosan TTC-101, no hindrance from acid fumes
<b>Vecosan TTC-Foam</b>	+	+	±	-	-	+	Especially in combination with alkaline cleaners
<b>Vecosan Vlakenbeits</b>	+	+	+	-	-	+++	Finishing agent for stainless steel