

**GENERAL CERTIFICATE OF SECONDARY EDUCATION**

**TWENTY FIRST CENTURY SCIENCE**

**ADDITIONAL SCIENCE A**

Unit A154: controlled assessment

**A154**

**CHEMISTRY A**

Unit A174: controlled assessment

**A174**

**Factors that affect how calcium carbonate is dissolved by acid**

**Information for Candidates (2)**

To be issued to candidates **only** on completion of the data collection part of their practical investigation.

**Marks from this specimen task must not be submitted to OCR.**

**These secondary data can be used as part of your practical investigation.**

**You can select the data that are useful for you.**

Hydrochloric acid does remove 'fur' from kettles very quickly, but it also corrodes metals and can be hazardous to use.

Researchers tested the effectiveness of some organic acids in limescale removal. Organic acids are safer to handle, and considered more 'friendly' to the environment.

In one investigation, they immersed a block of marble in different concentrations of each acid for 15 minutes. The mass of the marble was measured and the percentage decrease in mass calculated.

Some of their results are shown below.

% concentration of acid	% decrease in mass of marble after 15 minutes		
	citric acid solution	glycolic acid solution	lactic acid solution
1	0.21		
2	0.30	0.43	0.29
3	0.41	0.40	0.48
4	0.48	0.35	0.80
5	0.55	0.30	0.89
6	0.60	0.30	1.05
7	0.64	0.30	1.17
8	0.69	0.30	1.28
9	0.75	0.29	1.45
10	0.82	0.29	1.58

Research was also carried out at different temperatures, using 10% solutions of each acid.

Some of the results are shown below.

temperature in °C	% decrease in mass of marble after 15 minutes			
	citric acid solution	ethanoic acid solution	glycolic acid solution	lactic acid solution
20	0.8	2.0	0.4	1.8
25	1.2	2.1	0.6	3.0
30	1.5	2.0	0.8	4.3
35	1.7	2.4	1.1	5.5
40	2.0	2.7	1.6	6.6
45	2.1	3.3	2.1	7.3
50	2.4	3.7	2.6	7.9

The research team also investigated the corrosive action of different acids. Pieces of brass were immersed for 72 hours in 10% solutions of each acid.

Their results are shown below.

acid	corrosive action in arbitrary units
citric acid	1.2
ethanoic acid	4.3
lactic acid	1.0
phosphoric acid	2.8
sulfamic acid	2.9

The effectiveness of acids used to remove limescale is dependent on several factors.

Hydrogen ion concentration is very important. The greater the concentration of hydrogen ions in the acid solution, the faster the reaction will be between the acid and the limescale.

As an acid reacts with calcium carbonate, the formation of the calcium salt of the acid is also important. Calcium salts that are insoluble in water may coat the calcium carbonate particles that make up the limescale. The reaction between acid and limescale will then be slowed down.

The solubilities of different calcium salts are shown below.

	solubility in g per 100 g of water at 25°C
calcium citrate	0.10
calcium chloride	75
calcium ethanoate	40
calcium glycolate	1.8
calcium lactate	9
calcium dihydrogen phosphate	2
calcium hydrogen phosphate	0.02
calcium phosphate	0.02

You may be able to extend your investigation by looking for more information. For example, you could look in chemistry books or on the internet for information about:

- the comparative strength of different acids
- ways of preventing limescale from forming in a kettle
- which acids are used in kettle descalers that you can buy in shops.

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