

Kinetics - Lab 4

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L4 - Chemistry (OME BEng Sem2) (ACDB4011)

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Introduction

The aim of this experiment is to determine the effect of a number of factors on the rate of a reaction, in this case magnesium with Hydrochloric acid (HCl). the factors being tested are:

- Concentration of the HCl
- Temperature at which the reaction takes place
- The surface area of the magnesium

Based on previous experience and knowledge the Hypothesis is the the increase in each of the factors will increase the rate of reaction and do so considerably more when factors are combined, eg 10°C increase in temp and powdered magnesium.

The reason for this is to do with the collisions of the reactants as with more heat the particles have more energy so move faster and thereby collide more often, with surface area a larger area to collide with causes more collisions and with concentration there are more particles to collide which thereby results in more collisions. [1]

The way this relates to OME is the rate at which an explosive compound reacts is important in its performance eg with black powder very finely ground powder burns quicker and more violently than coarser powder. Thus you can control and tailor the characteristics of your explosive to exactly meet you needs another example fo a factor would be a catalyst which is a reason aluminium powder is sometimes added to explosives.

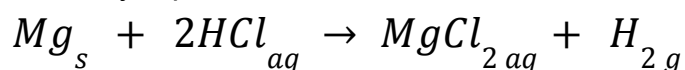
The variables in this experiment are

Independent - temperature, concentration of HCl and surface area of magnesium

Dependant - rate of reaction

Control - volume of HCl and approximate mass of Magnesium

The only equation used is:



Data and calculations

Concentration:

1 M HCl/volume vs 1 M HCl/time

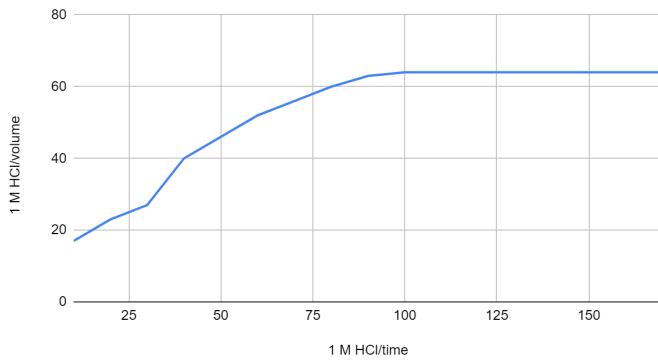


Figure 1

1 M HCl		1.5 M HCl		2 M HCl	
time	volume	time	volume	time	volume
10	17	10	25	10	32
20	23	20	43	20	54
30	27	30	52	30	61
40	40	40	58	40	65
50	46	50	59	50	73
60	52	60	60	60	76
70	56	70	63	70	79
80	60	80	66	80	80
90	63	90	71	90	80
100	64	100	75	100	80
110	64	110	79	110	80
120	64	120	81	120	80
130	64	130	84	130	80
140	64	140	84	140	80
150	64	150	87	150	80
160	64	160	87	160	80
170	64	170	87	170	80

1.5 M HCl/volume vs 1.5 M HCl/time

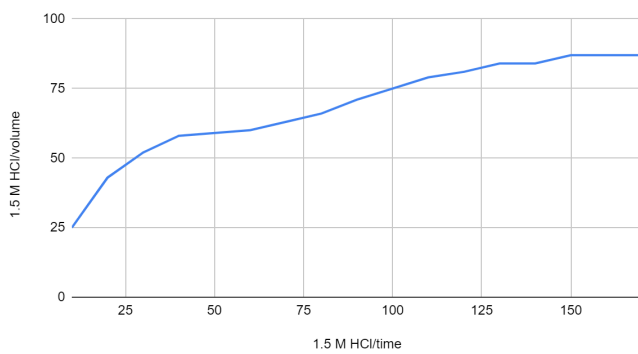


Figure 2

2 M HCl/volume vs 2 M HCl/time

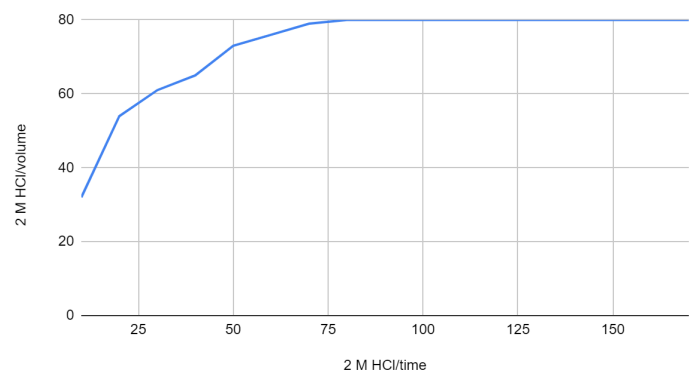


Figure 3

Temperature:

25 C/volume vs 25 C/time

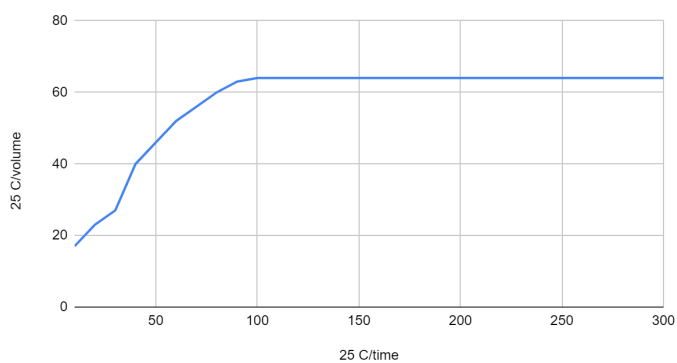


Figure 4

45 C/volume vs 45 C/time

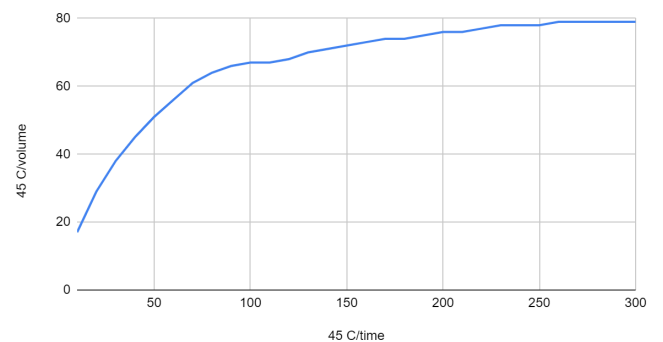


Figure 5

25 C		45 C		55 C	
time	volume	time	volume	time	volume
10	17	10	17	10	23
20	23	20	29	20	37
30	27	30	38	30	47
40	40	40	45	40	52
50	46	50	51	50	57
60	52	60	56	60	61
70	56	70	61	70	64
80	60	80	64	80	64
90	63	90	66	90	64
100	64	100	67	100	64
110	64	110	67	110	65
120	64	120	68	120	67
130	64	130	70	130	69
140	64	140	71	140	70
150	64	150	72	150	71
160	64	160	73	160	72
170	64	170	74	170	73
180	64	180	74	180	74
190	64	190	75	190	75
200	64	200	76	200	75
210	64	210	76	210	76
220	64	220	77	220	77
230	64	230	78	230	78
240	64	240	78	240	79
250	64	250	78	250	79
260	64	260	79	260	79
270	64	270	79	270	79
280	64	280	79	280	79
290	64	290	79	290	79
300	64	300	79	300	79

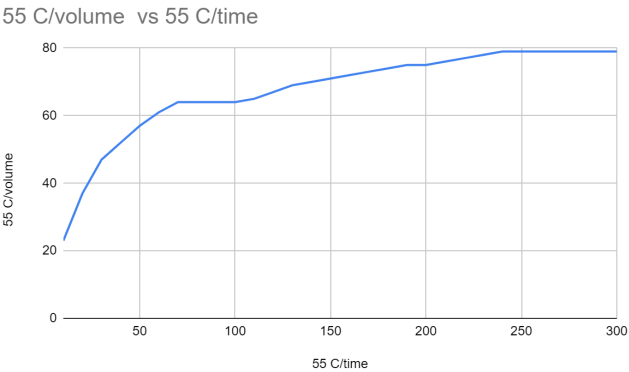


Figure 6

Surface area

strip		turnings	
time	volume	time	volume
10	17	10	9
20	23	20	16
30	27	30	24
40	40	40	29
50	46	50	35
60	52	60	41
70	56	70	45
80	60	80	49
90	63	90	52
100	64	100	55
110	64	110	57
120	64	120	60
130	64	130	62
140	64	140	63
150	64	150	65
160	64	160	66
170	64	170	67
180	64	180	68
190	64	190	68
200	64	200	69
210	64	210	69
220	64	220	70
230	64	230	70
240	64	240	70
250	64	250	70
260	64	260	70
270	64	270	70

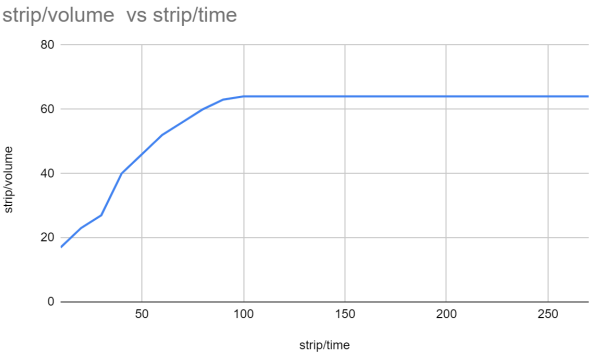


Figure 7

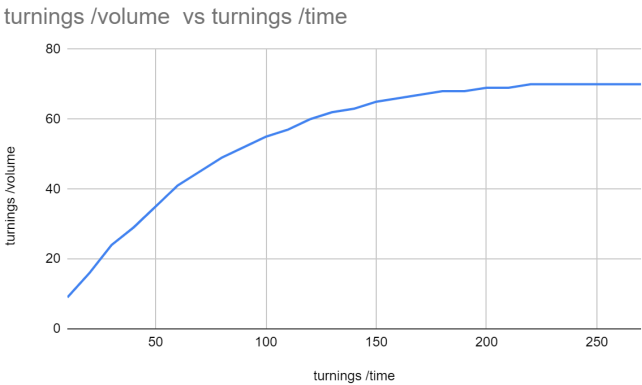


Figure 8

Results

Concentration:

In terms of concentration the experiment results showed what was expected with a higher slope on the graph and thereby rate of reaction as the concentration increases. In graph 2 this may not be clear as the first graph has a slightly different scale but when consulting the raw data it can be seen that at every time point the 1.5 M is producing more hydrogen.

Temperature:

A similar result can be seen with the temperature as a variable as the temperature increases the rate of reaction increases as seen by the slightly steeper graphs.

Surface area:

This did not perform as expected and instead of a steeper curve and earlier plateau a more gentle curve with a more consistent rate of reaction across the entire thing this may be caused by some of the filing not fulling being submerged in the acid and instead floating on the surface of the acid reducing its reaction potential.

Conclusions

The experiment went rough as expected with each factor increasing the rate of reaction, a further study could be done into how combining these factors has an impact and what the most efficient combo is e.g. increase in temp and concentration has more effect than surface area and temp. The hypothesis that was set out at the start of the experiment was met and thus the experiment was a success

References

- [1] R. King, (2015) "aqa as/alevel yr 1 chemistry" [Online], Available:
<https://www.taleem360.com/aqa-asa-level-year-1-chemistry-pdf-by-rob-king-70l>
- [2] Yin Liu, Hu Wen, Jun Guo, Yongfei Jin, Shixing Fan, Guobin Cai, Renfei Liu,
"Correlation between oxygen concentration and reaction rate of
low-temperature coal oxidation: A case study of long-flame coal" "Energy" vol. 275,
15 July 2023

Appendices

Materials and Equipment:

- Hydrochloric acid (HCl) of concentration 1 M and 2 M
- Magnesium strips and turnings
- Deionised water (DI water)
- Test tube
- Bung with gas delivery tube
- Gas syringe
- Measuring cylinders
- 2 clamp stands and claps
- Thermometer
- Timer
- Bunsen burner
- Bunsen burner stand
- Clay triangle

Method

1. Set up the equipment so that the syringe is horizontal and dry so it can move unobstructed
2. Initially mix a 1.5 M HCl mix by adding 25% of the total volume as DI water eg 20ml of 1.5 M would have 5ml would be DI and 15ml of HCl

Sub methods:

Concentration

1. Place 20ml of 1 M HCL into the test tube then weigh a 4 cm strip of magnesium and then record this weight
2. Drop the strip in and then quickly ad the bung and start the timer, record the gas created at given periods eg every 10 secs then continue till all the magnesium has reacted
3. Repeat this with the 1.5 M and 2 M solutions and then compare the results

Temperature

1. As the first result of the 1 M solution was already room temp heat the HCl up to the desired temperature eg 60°C
2. Then add a 4 cm magnesium strip and quickly ad the bung and start the timer, record the gas created at given periods eg every 10 secs then continue till all the magnesium has reacted
3. Then repeat this for another temperature

Surface area

1. Obtain magnesium turnings to the exact weight of the first strip then add it to 1 M HCl and record how fast it reacts as with both previous comparisions