# Demonstration corner

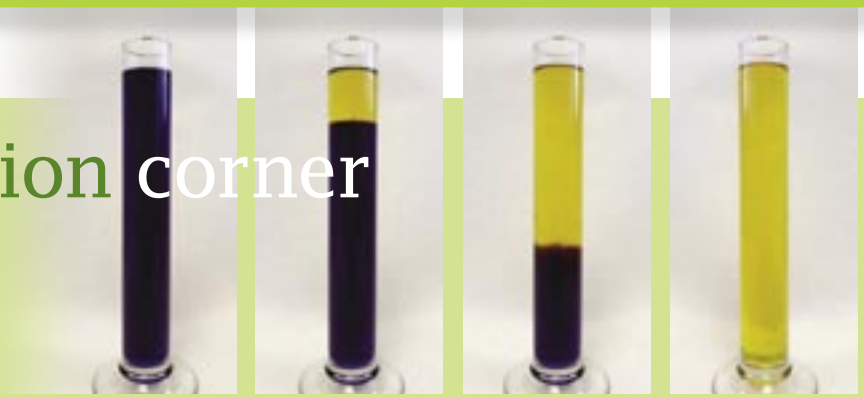

*Figure 1 - The yellow-blue interface moves slowly down the graduated cylinder.*

## AUTOCATALYSIS

Catalysis is a basic principle in chemistry and biochemistry whereby a chemical (the catalyst) facilitates a reaction without being used up in the process.

Some reactions are autocatalytic: a product of the reaction actually catalyses further reactions. One example of this is the reaction between potassium manganate VII and glycerol. This is another attractive demonstration of the process which seems to have its origins in the book: *Chemical Demonstrations: A Sourcebook for Teachers. Volume 1* by Lee R Summerlin and James L Ealy Jr. published by the American Chemical Society in 1965.

A solution, coloured with bromophenol blue, is placed in a measuring cylinder. A small volume of acid is added to the top of the cylinder to initiate the reaction. This forms a yellow layer. Over the next few minutes the yellow layer moves down the column as the autocatalysis effect takes place.

**You will need:**

- 4 g potassium chlorate
- 12.5 g sodium sulfite
- 5 mg bromophenol blue (or a big enough squirt of the solution to give a good colour)
- 5 $cm^3$ concentrated sulfuric acid
- 1 x 100 $cm^3$ measuring cylinder
- 2 x 100 $cm^3$ beakers

### Health & Safety

Concentrated sulfuric acid is highly corrosive. Handle with care when diluting wearing goggles (BS EN 166 3) or a face shield and gloves. The 3 M solution is also corrosive: wear goggles (BS EN 166 3) and gloves.

The reaction produces sulfur dioxide but most of this dissolves in the solution so very little is released to the atmosphere during the actual experiment. Disposal, however, can cause a larger release. (To dispose of the solution, dilute about 10:1 with water and then neutralise with a weak alkali such as sodium carbonate and then wash to waste with plenty of running water).

The reaction is exothermic. The solution will not boil but could get hot enough to be uncomfortable to hold.

### Procedure

1) Place 50 $cm^3$ of water in a beaker and dissolve 4 g of potassium chlorate, followed by 12.5 g of sodium sulfite. Then add the bromophenol blue indicator.
2) Prepare a 3 M solution of sulfuric acid by adding 5 $cm^3$ of concentrated sulfuric acid to 18 $cm^3$ of distilled water.
3) In a second beaker, add 4 $cm^3$ of the 3 M sulfuric acid to 50 $cm^3$ of water with stirring.
4) Slowly, with constant stirring, add the diluted acid from the second beaker to the blue solution in the first beaker. Stir until all solids dissolve. The solution should be blue/violet.
5) Fill a 100 $cm^3$ measuring cylinder with the blue-violet solution.
6) Carefully add 5 $cm^3$ of 3 M sulfuric acid solution to the top of the liquid in the cylinder. (This is best done with a pipette).
7) A yellow colour will appear at the top of the solution, and a yellow/blue interface is formed.
8) Observe for several minutes as the yellow-blue interface moves slowly down the graduated cylinder (Figure 1).

### The chemistry

This is a redox reaction (see Figure 2).

The pH on the reactant side is about 7; the pH on the product side is less than 7. Thus, the reaction proceeds only in an acidic solution. Dropping sulfuric acid on the surface produces acidic products:
$3H^+ + SO_2^{2-} \rightarrow HSO_3^-$

These acid products catalyse further reactants to produce additional acidic products; hence the autocatalytic effect.

Bromophenol blue indicator is yellow in the presence of an acid. Thus, as autoctalysis proceeds, the blue colour of the indicator changes to yellow. The blue solution has a pH between 6.5 and 7.0 due to the buffering effect of the bisulfite/sulfite ions.

$$ClO_3^-{}_{(aq)} + 3HSO_3^-{}_{(aq)} \rightarrow Cl^-{}_{(aq)} + 3\,SO_4^{2-}{}_{(aq)} + 3H^+{}_{(aq)}$$

blue yellow

*Figure 2 - The redox reaction.*

**Reference**

[1] http://www.sserc.org.uk/chemistry-demonstrations/chemistry-demonstrations/3218-hot-stuff.