The green, green chemistry of home

The concept of 'green chemistry' appeared on the scene in the mid to late 1990s. The name certainly gives an indication but it is an approach to chemistry which aims to minimise the use and generation of hazardous substances. Green chemistry focuses on the environmental impact of chemistry, including technological approaches to preventing pollution and reducing consumption of non-renewable resources [2].

Figure 1 - Green chemistry [1].

Of the 12 principles of Green Chemistry, most are quite understandably focussed on the chemical industry and relate to reducing the damage of industrial processes. There are some, however, that have wider relevance, particularly:

- **Prevention.** Preventing waste is better than treating or cleaning up waste after it is created.
- **Inherently safer chemistry for accident prevention.** Whenever possible, the substances in a process, and the forms of those substances, should be chosen to minimise risks such as explosions, fires, and accidental release.

School chemistry has never been as big an offender as industry for two main reasons: it takes place on a much smaller scale and schools are, quite reasonably, averse to using many of the more harmful substances. There are still many areas of school chemistry though where a greener approach would be beneficial. The environmental benefit is obvious but there are also safety advantages and significant cost savings to be had by reducing the amount of waste that has to be disposed of by costly contractors.

There are various things schools can do to develop a greener approach to their chemistry. In a series of upcoming articles, we will offer a few approaches to deal with particular issues. In the meantime, here are a few more general ideas.

1) Reduce the scale

For example, the making of a precipitate of lead iodide is still quite a common activity in many schools. We are the first to admit that this is a gorgeous, yellow precipitate but it does involve the preparation and use of lead nitrate solution as well as the production of the solid lead iodide itself. Lead compounds are reproductive toxins as well as being damaging to the environment and so, like all lead compounds, these must be disposed of as special waste. If the sole objective is to demonstrate precipitation, there are plenty of alternatives that are not harmful to the environment.

If there is a particular desire to show lead iodide then your pupils can use a microscale approach (see the activity 'Diffusing Precipitates' [3]) where they will literally only use a grain or two of lead nitrate. The amount of lead used and produced is so small that the waste from the experiment can simply be wiped up on a paper towel and put in the bin.

Another way of reducing scale is to carry out an experiment as a demonstration – the students could experiment with less harmful precipitates and the teacher could show one example of the lead iodide precipitate.

2) Reuse and recycle

A common school practical is the preparation of copper sulphate crystals. Assuming that it really is desirable to make the attractive blue crystals, then there is little alternative to using copper oxide >>

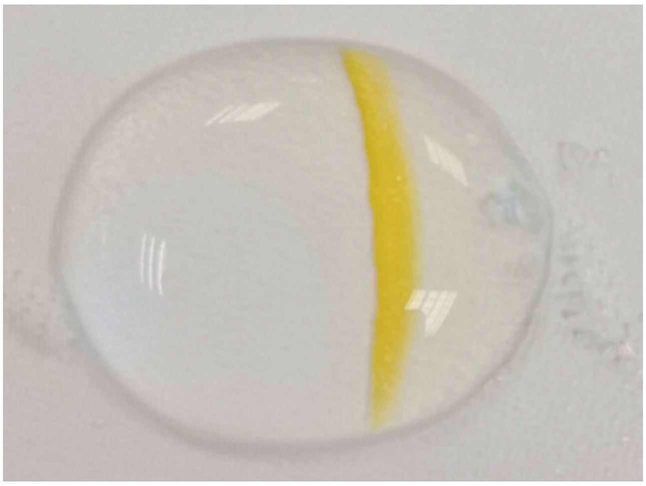

Figure 2 - A microscale precipitate of lead iodide.

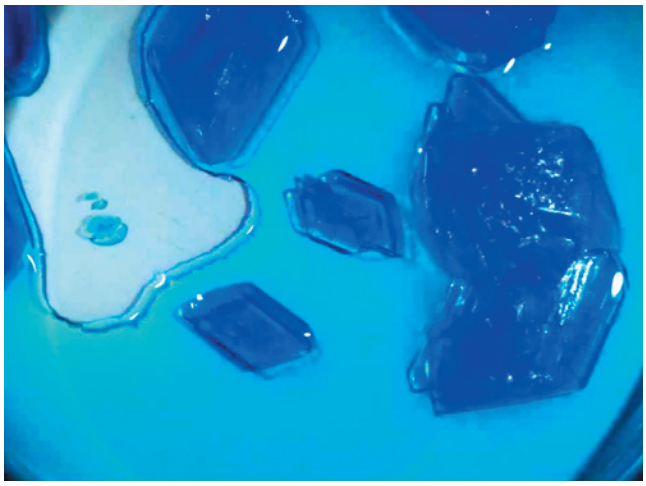

Figure 3 - Copper sulphate crystals.

meaning you can end up with an awful lot of copper sulphate solution. This is often just stored for disposal but why? Rather than paying for disposal and then buying in more copper sulphate to make up solutions, the sensible thing to do is simply to keep what has been made and to use it instead. The purity may not be perfect but unless it is needed for an advanced higher project then it is unlikely to make much, if any, difference. It will certainly be quite suitable for use for displacement reactions, exothermic reaction with zinc, analysis of water of hydration, producing precipitates of insoluble salts, complex formation and much more.

Similarly, many solutions of zinc and silver in particular can be treated and re-used.

3) Use something less environmentally harmful

We are all now quite wary of using lead and mercury compounds in part at least due to their environmental harm. But there are other elements that are deeply problematic for the environment.

Copper we have already touched on. In many cases iron salts can be used as a substitute and these are much less harmful.

Cobalt and nickel - these compounds are carcinogenic as well as being damaging for the environment. Where possible an alternative should be found.

Zinc - rather like copper, due to the fact that zinc compounds are so widely used we tend to overlook the environmental damage they can do. It is far from insignificant, however, and so where possible zinc compounds should be avoided.

Chromium VI compounds - these are dangerous for the environment and also are carcinogenic, toxic and have numerous other health hazards. In short, they are best avoided. Two common uses for these compounds are oxidation tests for alcohols and as indicators in silver nitrate titrations of chlorides. These two procedures are addressed in the second part of this article.

Please note
SSERC is definitely **not** suggesting that these substances are banned (or are likely to be in the near future). We are merely suggesting a responsible approach. Where there is no suitable alternative, by all means go ahead and use dichromates or nickel compounds but do what you can to reduce the impact: have a demonstration rather than a class practical, use a microscale approach etc.

References

[1] Image from Flavio~ on Flickr https://www.flickr.com/photos/37873897@N06/8277000022/.
[2] https://en.wikipedia.org/wiki/Green_chemistry.
[3] https://www.sserc.org.uk/subject-areas/chemistry/chemistry-resources/microscale-chemistry/diffusing-precipitates-microscale/.