Chemical separations at home
Age range: 11-18 years

CHEMICAL SEPARATIONS AT HOME

OBJECTIVES

- Learn some simple chemical separation techniques
- Understand how these transfer to an industrial setting

MATERIALS NEEDED

- Sieving: sieve, rice, flour
- Filtration: coffee filter, sand, water
- Distillation: salt, water, wide/flat dish
- Chromatography: paper towel/filter paper, ink, water
- Phase separation: tall glass, water, at least two from: honey, pancake syrup, washing up liquid, vegetable oil, rubbing alcohol, lamp oil

BACKGROUND INFORMATION

Please see the webpage and biobased economy lesson plans for more information about the importance of chemical separations in creating viable products

- Separations and processes that simplify complex mixtures into manageable chunks allow us to work with pure chemicals. Pure chemicals give us high-quality products that are fit for use by consumers. The more effective the separation technique is, the more we can do with a feedstock, like crude oil or biomass.
- Many of the techniques outlined in this practical have a corresponding industrial process that will look a bit different, but they largely operate using the same scientific principles

STEP-BY-STEP INSTRUCTIONS

SIEVING:

A really simple way of separating two things is sieving. This separates two solids of different sizes, for example rice and flour. You can try this at home by mixing a handful of rice into flour, and then pouring the mixture through a sieve. Rice will be caught in the sieve while flour will pass through.

FILTRATION:

If you have a fine solid mixed in a liquid, sieving will result in both parts of the mixture passing through. Filtration uses a material that allows liquids to pass through, but not solids. At home you may have used coffee filters as an example of this. You could try using this method to separate sand from water. Filtration is used extensively in chemical research. We usually make chemicals in a liquid mixture, as this allows us to mix all the chemicals needed for a reaction to happen. Filtration then allows us to collect a solid chemical from this mixture once it has been made.

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DISTILLATION:

Water turns to steam at 100 ^{o}C. Water also evaporates slowly at lower temperatures, leaving behind anything that's dissolved in it. This is how we get salt from seawater, for example. You can try this yourself with a homemade saltwater solution left out in the sun, the shallower the dish the faster the process will be. This process is distillation. We can also get clean water from saltwater using this method, although we need a way of capturing the water. The Royal Society of Chemistry offers excellent resources detailing how to do this and other separation practical activities at home.[1] In industry we use this to remove liquids from other chemicals. Often the chemicals won't evaporate easily, and so liquids like water or organic solvents can be boiled off to give a pure chemical. We can also separate different liquids like this, for example, this is how we refine crude oil into its components.

CHROMATOGRAPHY:

This technique separates chemicals based on their affinity for a solvent (like water) or a solid phase. For example, if you dip a paper towel into water and the water runs up the towel, the chemicals dissolved in the water will travel different distances up the towel depending on how attracted to the towel and/or the water they are. This can be visualised by spotting black ink at the bottom of filter paper and leaving the end dipped into shallow water. The ink will run up the paper with the water, but different components of the ink will move at different speeds, eventually separating the ink into its constituent colours. In chemical industries we use this to separate mixtures of chemicals that cannot be filtered or distilled. Many examples of how to conduct a chromatography experiment at home exist online, for example at BBC Bitesize.[2]

PHASE SEPARATION:

This is separation based upon density differences. If you mix oil and water, you'll notice that the oil sits on top of the water and may form blobs on the surface. In industry we exploit this to separate chemicals. Our target chemical might be soluble in oily substances (lipophilic) while the impurities might prefer to be dissolved in water. We can mix an oily solvent and water with our impure chemical to get the mixture to dissolve, and then selectively take the solvent. This will only contain our target chemical and leave behind the impurities in the water. You can see these phases in action by making a density column with home ingredients. In a tall glass you'll want to add the following liquids in the order that they're listed: honey, pancake syrup, washing up liquid, water, vegetable oil, rubbing alcohol, and lamp oil.

Don't worry if you don't have them all, this just means your density column will have fewer layers. When adding layers, leave enough room in your container for the rest of the layers you want to add.

Add your first liquid without letting it touch the sides of the container, and then add the remaining liquids on top. When you pour in these other liquids, ensure you do it gently without disturbing the surface of the layer below – pour it slowly onto the end of a spoon just above the surface, or slowly trickle it down the side of the container. By the end, you should be able to see the distinct layers. ThoughtCo have a guide to this.[3]

ADDITIONAL ACTIVITY:

Using the techniques above, try to separate a mixture of rice, salt, and flour. If you use water, try to get dry ingredients back at the end.

[1] https://edu.rsc.org/resources/separating-mixtures/1803.article
[2] https://www.bbc.co.uk/bitesize/guides/zqqtrwx/revision/4
[3] https://www.thoughtco.com/make-a-density-column-604162