BBC Bitesize - Chemistry

Episode 5 – Filtration, evaporation and crystallisation

SUNAYANA: I'm Dr Sunayana Bhargava, a scientist and poet.

TULELA: And I'm Tulela Pea, a science communicator and podcaster.

SUNAYANA: And this is Bitesize Chemistry. This is the fifth episode in an eight-part series on atomic structure and the periodic table. In this episode, we're going to look at the three physical separation processes which are: filtration, evaporation and crystallisation.

TULELA: And when you would use one method over another.

SUNAYANA: As always, it might be handy to write some notes or diagrams along the way so hit pause when you need to. Don't worry, we'll still wait for you to hit play again.

TULELA: Let's begin then with why separating substances in chemistry is so important and where in the real world we use chemistry to do this.

SUNAYANA: It's all about purity. A pure substance in chemistry is one that is only made from one type of element or compound - like pure water which is 100% H20 only, or a pure diamond which is 100% made from carbon.

TULELA: But it's rare that substances are 100% pure – sometimes, they have other substances that we can't see that has been mixed into them. Like, for example, the air which is a mixture of oxygen, carbon dioxide, nitrogen and a few other gases – or sea water which is a mixture of salt and water.

SUNAYANA: Often in chemistry, we want to purify or un-mix a mixture to end up with one or more of the pure substances which made up the mixture. And in order to do so, we have a number of different physical methods which our neural networked intelligent computer knowledge bank – otherwise known as our friendly chatbot NNICK will summarise for us. Hi NNICK, can you give us a summary of physical separation processes in Chemistry?

NNICK: So we're doing physical separation process today are we? Well I suppose so.

The names of all the methods of separation
All extremely helpfully end in '-ation'
As for example filtration, condensation, evaporation
And of course both simple and fractional distillation
But not chromatography
Which doesn't
And hence
Is an aberration

TULELA: Thanks, NNICK. So, a few different processes there. In this episode, we'll look at what methods to use if you want to separate a solid out of a mixture with a liquid. So grab that pen and paper to make notes.

SUNAYANA: There are two different processes that we have in our chemistry tool box, filtration and crystallisation. Both are examples of physical separation processes which don't involve a chemical reactions and where no new substances are made. Let's look at how they work and when you would use one or the other. First, if you have an insoluble solid that that you want to separate from a liquid.

TULELA: Insoluble means that the solid doesn't dissolve, it is still solid – so, for example, a mixture of sand and water, and for this we use filtration to separate the sand out of the mixture.

SUNAYANA: You may have seen this in the classroom or lab, it's a nice simple experiment where you fold a sheet of filter pater into a cone shape, pop it into a filter funnel and pour the sand-water mixture through it.

TULELA: The filter paper has tiny holes – or pores – which allows the water to pass though as these molecules are way smaller than the holes, but the sand can't pass through the holes and is trapped. We call what passes through the filter paper the filtrate.

SUNAYANA: In this case, that would be the water.

TULELA: Right – and what's left in the filter paper – the residue.

SUNAYANA: In this case, the sand.

TULELA: And we're left with the water and sand and nothing else. No new substances. Sunayana, can you think of some other every day uses of filtration?

SUNAYANA: Well, how about when you make put a tea bag into boiling water. The tea bag is like the filter paper and allows the water to pass through, but doesn't let the solid tea leaves escape. The solid tea bags are filtered out using boiling water, but the tea flavour which dissolved in the water can pass through into the cup.

That's filtration, useful if you want to separate an insoluble solid from a liquid. What about if you have a soluble solid and liquid mixture, otherwise known as a solution?

TULELA: Soluble means that the solid has dissolved in the liquid, like salt in water. And because it's dissolved we can't use filtration to separate the salt out but we can use…evaporation and crystallisation.

SUNAYANA: Here's how you would crystalise salt water to separate the salt out.

TULELA: Pour the mixture – in this case, salty water – into an evaporating dish and begin to warm the dish with a Bunsen burner. As the solution warms up, some of the water - also known as the

solvent - evaporates away and so the mixture becomes more concentrated with the salt and the solid particles of salt begin to form in the dish.

SUNAYANA: At some time, we'll begin to see crystals of salt form – this is called the point of crystallisation. And once most of the water – the solvent – has evaporated away, we can remove the heat source. The rest of the solvent will evaporate away and the dish will cool, allowing the crystals of salt to form. And as before we're left with just what was in the mixture – nothing new has been produced.

TULELA: That's so cool, Sunayana. I really love this experiment as you can see the crystals of the salt begin to appear before your eyes as if by magic out of the salty water mixture.

SUNAYANA: But it's not magic, Tulela. Maybe we should say 'as if by chemistry'. So, I gave you some real world examples of filtration. Your turn for crystallisation.

TULELA: Well, that salty water example is a really good one. In a much more scaled-up version, we can extract table salt from salty sea water or lake water. Another example is how we can separate sugar from honey – and, every time it snows, that's another example of a crystallisation process because that's how snowflakes are formed.

SUNAYANA: Hands up which of you lovely podcast listening friends wants a quiz? OK. Here's three questions, five seconds each to get the correct answer – or hit pause, look it up on the BBC Bitesize webpages and no one will ever know.

TULELA: Question 1. What process can you use to separate a insoluble solid, such as sand from water?

SUNAYANA: By filtration – filter paper, funnel – sorted.

TULELA: Question 2. Once the mixture has passed through the filter paper, what is the insoluble solid which is left in the paper called?

SUNAYANA: It's the residue.

TULELA: And Question 3. What new substances have been made when we use crystallisation to separate salt from water?

SUNAYANA: None. Remember that in physical separation there are no new substances made.

TULELA: Time for a separation summary from this episode.

SUNAYANA: There are several processes we can use in chemistry to separate – or purify – a mixture.

TULELA: We've looked at two to use where we have a mixture of a solid and liquid.

SUNAYANA: Filtration for an insoluble solid from a liquid.

TULELA: The remaining solid is the residue, and the liquid is the filtrate.

SUNAYANA: And use crystallisation to separate a soluble solid from a liquid.

TULELA: And watch those crystals grow as if by chemistry.

SUNAYANA: Both filtration and crystallisation are examples of physical processes which do not involve chemical reactions and no new substances are made.

TULELA: In the next episode, we'll look at two further methods of separating mixtures which are distillation and chromatography.

SUNAYANA: I'm Dr Sunayana Bhargava.

TULELA: And I'm Tulela Pea.

SUNAYANA: To hear more, search Bitesize Chemistry on BBC Sounds. Thanks for listening.

TULELA: Bye everyone.