

Separating caffeine

Education in Chemistry

May 2021

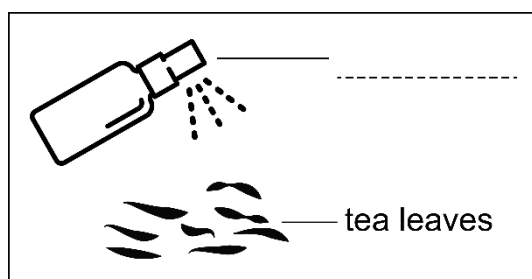
<https://rsc.li/2QLDAXU>

An excellent way to improve your understanding when reading an extended piece of text is to convert the key processes into a series of labelled diagrams or a graphic.

In this activity you will develop this skill by looking at each of the three options for decaffeination in turn and completing graphics of the steps involved in each process.

1. Extracting caffeine with organic solvents

- Add labels to each of the diagrams used to illustrate the step described.
- Add in an explanation of why that step is needed. The explanation has been added to Step 1 for you as an example.

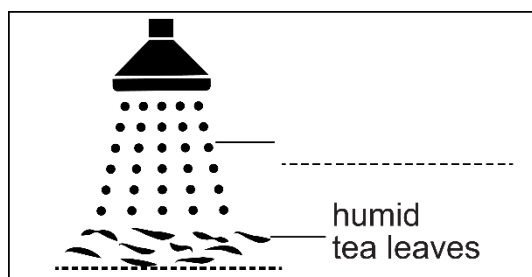


Step 1

Spray the tea leaves with water.

Explanation

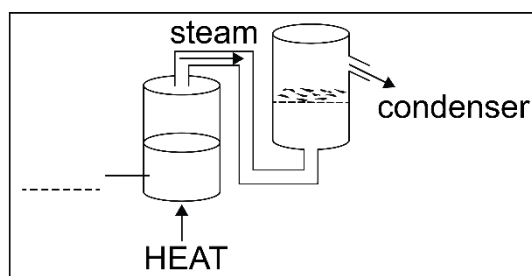
To swell the leaves and open their pores to enable the organic solvent to penetrate them.



Step 2

Shower the humid tea leaves for 1.5–2.5 hours with dichloromethane.

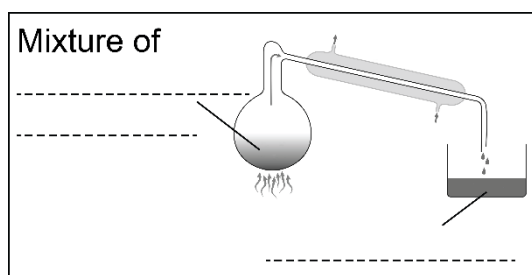
Explanation



Step 3

The caffeine-laden dichloromethane is driven off the leaves using steam before they are dried to reinstate their original humidity levels.

Explanation



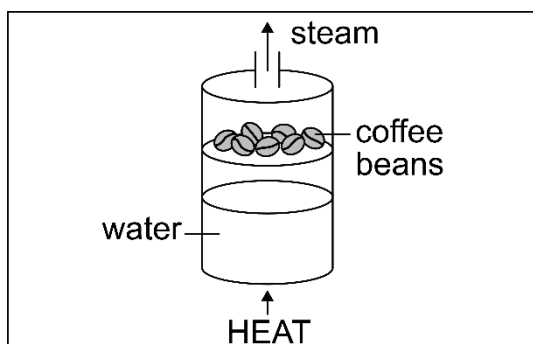
Step 4

Caffeine is removed from the solvent by distillation.

Explanation

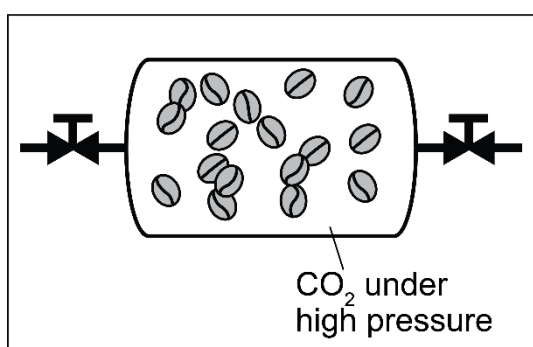
2. Extracting caffeine with supercritical carbon dioxide, CO₂

For this extraction option, describe the step illustrated by the diagram and add an explanation of why that step is required.



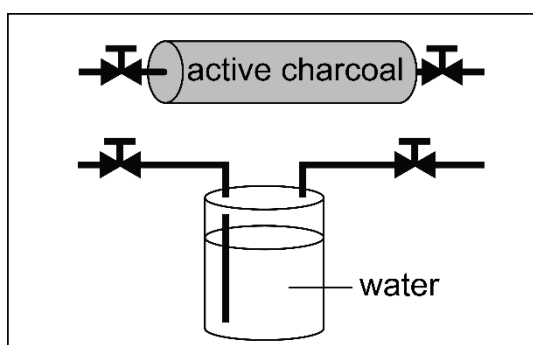
Step 1

Explanation



Step 2

Explanation



Step 3

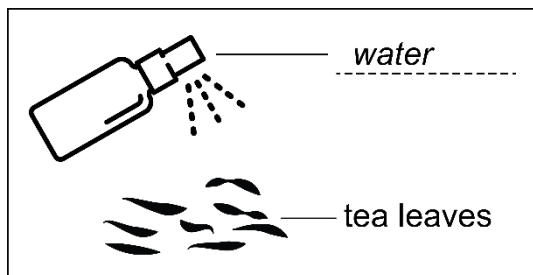
Explanation

3. Extracting caffeine with water

Using the graphics given above as examples, draw your own graphic to illustrate the steps involved in extracting caffeine from coffee using water.

Answers

1. Extracting caffeine with organic solvents

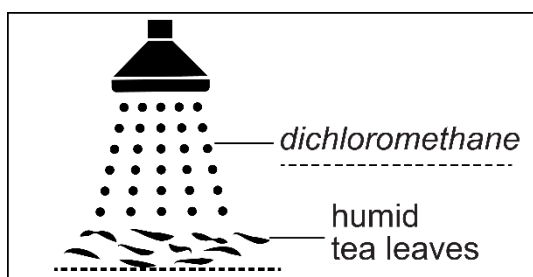


Step 1

Spray the tea leaves with water.

Explanation

To swell the leaves and open their pores to enable the organic solvent to penetrate them.

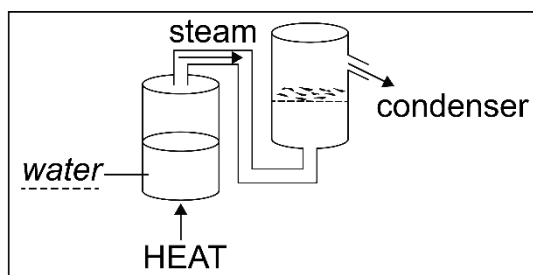


Step 2

Shower the humid tea leaves for 1.5–2.5 hours with dichloromethane.

Explanation

To extract the caffeine.

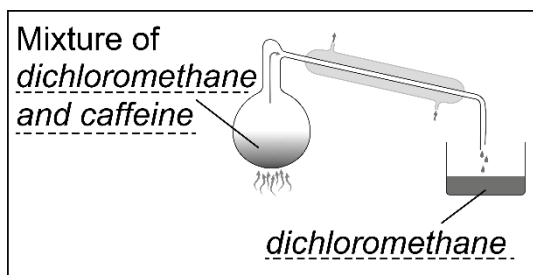


Step 3

The caffeine-laden dichloromethane is driven off the leaves using steam before they are dried to reinstate their original humidity levels.

Explanation

To ensure the tea is free of solvent and caffeine and ready to drink.



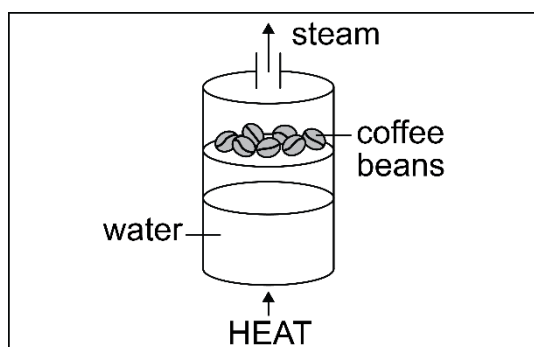
Step 4

Caffeine is removed from the solvent by distillation.

Explanation

Separating the caffeine from the dichloromethane means that the dichloromethane can be reused and the caffeine can be purified for use as natural food-grade caffeine.

2. Extracting caffeine with supercritical carbon dioxide, CO₂

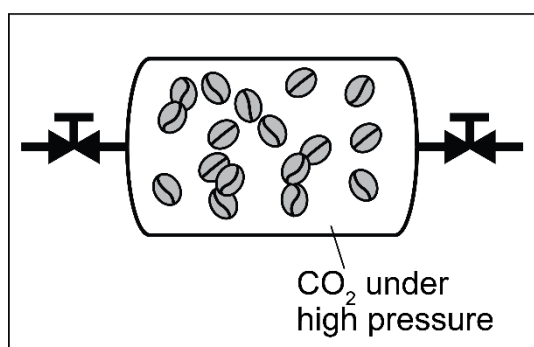


Step 1

Swell the coffee beans or tea leaves with steam.

Reason

To enable the solvent to penetrate the beans or leaves.

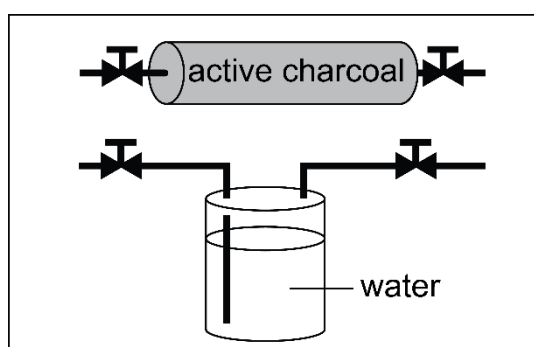


Step 2

Place the coffee beans or tea leaves in a high-pressure vessel with CO₂ and pressurise for a few hours.

Reason

To selectively extract the caffeine.



Step 3

Pass the carbon dioxide through active charcoal or into distilled water.

Reason

To remove the caffeine from the CO₂ to allow both to be reused.

3. Extracting caffeine with water

Possible steps that could be illustrated include:

Step 1 Soak the green coffee beans for 8–10 hours in water that has been pre-saturated with all the soluble solids found in coffee beans apart from caffeine.

Step 2 Dry the beans.

Step 3 Pass the water through a carbon filter to recover both the caffeine and the aqueous extract for reuse.