

## Reaction vessel

Reaction vessels are at the heart of a chemical plant. They are where the chemical changes and reactions take place. The capacity of reaction vessels can range from 50 litres to 250,000 litres and they are generally made from stainless steel, glass lined steel, glass or ceramics.

The ingredients for the chemical reaction are called the reactants. These raw materials can be loaded into the reaction vessel in a variety of ways. Measured amounts of reactants may be pumped into the vessel through pipes attached to inlet valves. Powders or liquids may be poured into reaction vessels using large funnels, called hoppers, connected to the top of the vessel.

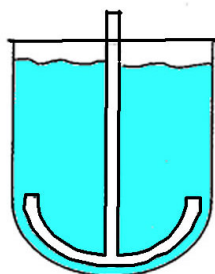
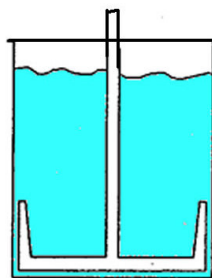
The conditions inside a reaction vessel are controlled to give the fastest possible chemical reaction. This can include:

- Heating the vessel to speed up a chemical reaction. This is achieved by having steam-filled pipes inside the vessel or in a "jacket" surrounding it. Temperatures of several hundred degrees centigrade may be required.
- Cooling the reaction vessel may be required if the chemical reaction produces heat. A cold water jacket cools the vessel and prevents the build up of dangerously high pressures. Cooling water flows constantly through the jacket and removes heat from the reaction vessel. This water is passed through a heat exchanger, to cool it down, before being returned to continue the cooling of the reaction vessel.
- Stirring the contents of the reaction vessel mixes them thoroughly. This makes sure that the reaction goes as quickly as possible and that all of the reactants are involved in the reaction. A variety of paddles can be used with speeds of rotation that range from 30-40 revolutions, to several thousand revolutions per minute. The diagrams below show a variety of paddles used to stir reaction mixtures.
- Increasing the pressure inside the vessel. Some reactor vessels may be kept at a high pressure to improve the amount of product made or speed up the reaction.

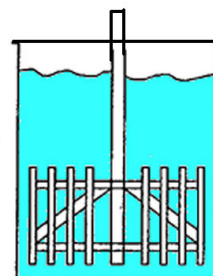
Sensors monitor these conditions and operators, or automatic systems, make the necessary adjustments to maintain the best conditions for the chemical reaction.

## Types of stirring paddles

Blades fit shape of vessel to ensure good mixing.



Anchor paddle



Gate paddle

## Classroom contexts

These questions may provoke some discussion, or suggest further activities, within the classroom. Scroll down below the curriculum links for some suggested answers.

- What things, that are used every day, are made in a chemical factory?
- What vessels are used to mix and react materials in the house?
- Think of a way to investigate which is the best design for a mixing paddle.
- What kind of vessels are used in schools for chemical reactions?

## Links to the Primary Science National Curriculum

### Key stage 2

Sc3 - 2a  
(Materials)

Describe changes that occur when materials are mixed.

Sc3 - 2f  
(Materials)

That non-reversible changes result in the formation of new materials that may be useful.

### ***What things, that are used every day, are made in a chemical factory.***

The list could almost be endless. Common "chemicals" are things like bleach, cleaning fluids, petrol, pesticides and medicines. Less obvious will be cosmetics, flavourings, colourings, paints, inks and products such as plastics and synthetic fibres.

### ***What vessels are used to mix and react materials in the house?***

Mixing in the kitchen could involve the use of bowls and possibly a food processor. Making a cup of coffee shows mixing when instant coffee, water, milk and sugar are all

mixed with and stirred with a spoon. A mixing palette can be used to create different colours by combining paints.

***Think of a way to investigate which is the best design for a mixing paddle.***

The shape of a paddle, and its speed of rotation, will influence how well it acts to mix the ingredients in the reaction vessel. Different types of stirrers, spoons and paddles could be investigated. For example, do thin stirrers work better than broad ones? Try stirring a mixture of sand and water to see which is the best.

***What kind of vessels are used in schools for chemical reactions?***

Reaction vessels may include test tubes, beakers, flasks and disposable paper cups.