

Recycling of Materials

Recycling of Hydrogen Pressure Vessels

- Hydrogen storage system is typically > 5% of vehicle weight.
- The End-of-life vehicle directive requires 95% recycling and recovery from vehicles disposed of >2015.
- Pressure vessels comprise metallic components (pipes, valves, cylinder liner...), thermoplastic components (some liners) and carbon fibre composite (vessel structure).
- To facilitate economic recycling the components should be designed to be easy to separate and recycle.
- Carbon fibre composite typically makes up a third of the weight of the hydrogen storage system.

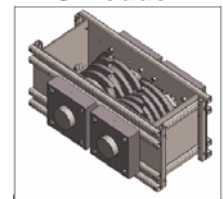
Preparation of Hydrogen Pressure Vessels

- Cutting the pressure vessel longitudinally allows the liner and other components to be removed easily.
- The composite can then be fed into a shredder to reduce it in size to pieces < ~25mm.
- The metallic components and thermoplastic liner can then be recycled using conventional processes.

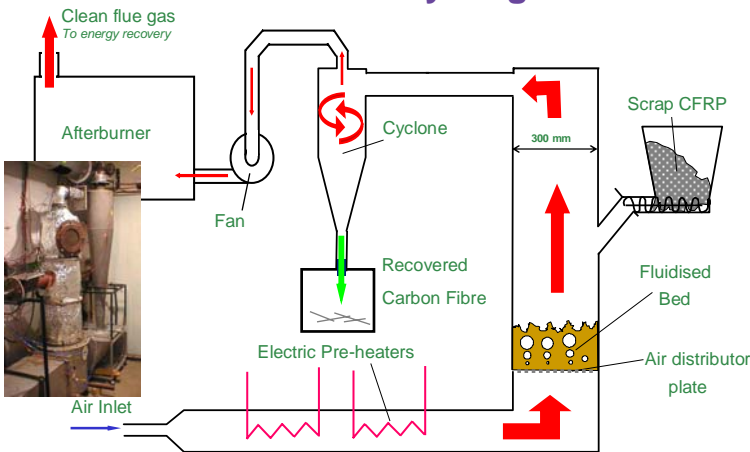
Shredded composite



Shredder



Fluidised Bed Recycling Process



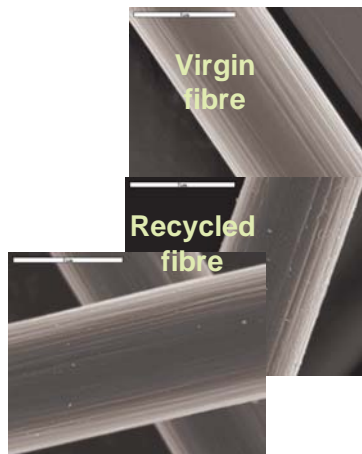
Fluidised Bed Recycling Process for Carbon Fibre Composites

- The shredded composite is fed into a fluidised bed.
- In the fluidised bed, the heat (550°C) volatilises the polymer from the fibres and clean carbon fibres are carried off in the gas stream.
- The fibres are separated in a cyclone and the gases, containing polymer products, pass into an afterburner for full oxidation followed by energy recovery.

Recycled Carbon Fibre

Fibre properties:

- Strength of about 3GPa.
- Modulus of over 200 GPa.
- No change in fibre diameter.
- Clean fibre surface.
- Fibre length typically 10-15mm depending on size of shredded composite feed.



Applications for Recycled Carbon Fibre

- Recycled carbon fibre is clean and bonds well to epoxy resin. It is suitable for processing into applications such as thermoset or thermoplastic moulding compounds these can be used in applications to give enhanced mechanical properties or for electrically conductive plastics.