

A Head-End Process for the Reprocessing of Reactor Core Materials

Description

This invention relates to the fragmentation of coated nuclear fuel particles and fuel elements comprising coated fuel particles embedded in a ceramic matrix material such as graphite. The reprocessing of coated particle fuel e.g. from high temperature gas-cooled reactors is useful to maximise the use of the fuel and is even mandatory when envisaging closed fuel cycles such as the U-Pu or Th-U fuel cycle, or waste transmutation in this type of reactor. Recycling of rejected fresh fuel batches from the production process is also required to recycle the fissile material. These coated fuel particles feature high resistance against mechanical impact and chemical attack. To make the fuel accessible to classical aqueous reprocessing a head-end process was developed which isolates the coated particles from the matrix material and then fragments the coatings so as to make the fuel in these particles accessible to chemical dissolution. Disadvantages of other methods are high energy consumption, low efficiency, production of toxic and explosive dust, high level of noise and vibration or high capital and operating cost.

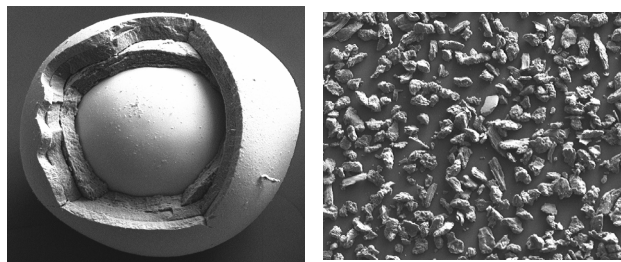
For fragmentation, the fuel elements are placed in a suitably dimensioned container filled with water. Electrodes on top and bottom of the container allow the formation of multiple pulsed high voltage sparks across the water. Direct action of these sparks and/or pressure spikes from cavitation causes the fuel elements to disintegrate progressively. Coated particles and matrix material can be separated before submitting both to a second treatment to obtain the desired fragment sizes in sub-millimetre dimensions. The fuel can then be dissolved in nitric acid which is the first step of classical aqueous reprocessing while the matrix powder (in general graphite) can be decontaminated and recycled. The method is suitable for hot cell environments, requires little energy and is suitable for relevant material streams.

Innovative aspects and main advantages

- High efficiency
- Low-energy consumption
- Safe and reliable operation
- Applicable in hot cell environment
- Suitable for relevant material streams

Areas of application

- Disintegration and separation of nuclear fuel elements comprising ceramic matrix material and coated fuel particles to reduce waste volume.
- Reprocessing of coated fuel particles e.g. from high temperature gas cooled nuclear reactors.
- Recycling of contaminated matrix graphite.
- Recovery of fissile material from rejected fresh fuel elements and particles from production with recovery of intact fuel kernels.



Cracked dummy fuel particle (diam. 0.9 mm) and fully fragmented coating shells

Stages of development

Patent Priority date 16/02/2005 US
Patent granted LU 91158&60
Patent pending US 60653400
EP

ForschungsZentrum Karlsruhe is co-inventor
Pilot tests performed and positive

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Reference: file n°2741