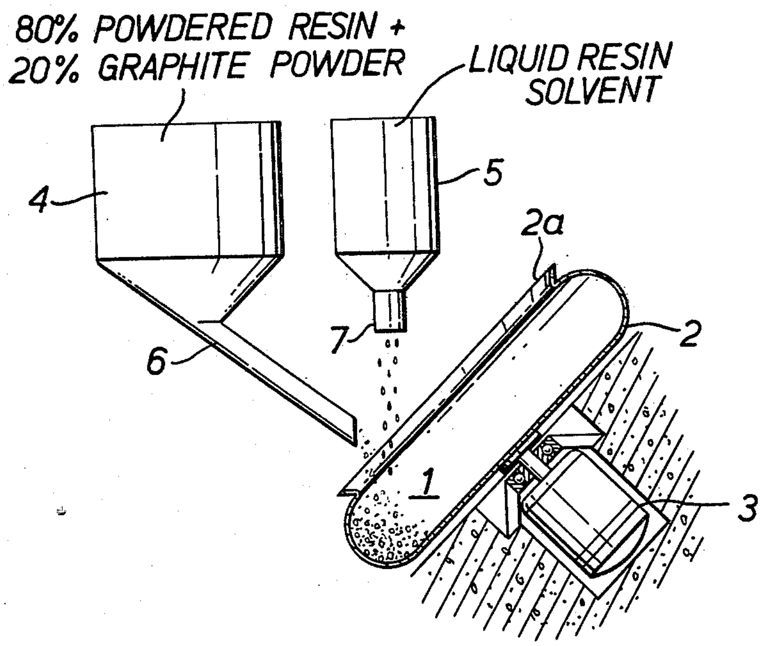
METHOD OF PREPARING NUCLEAR FUEL ELEMENTS INCORPORATING
FISSION PRODUCT RETAINING FUEL PARTICLES

Filed April 12, 1967



United States Patent Office

3,492,379
Patented Jan. 27, 1970

3,492,379

METHOD OF PREPARING NUCLEAR FUEL ELEMENTS INCORPORATING FISSION PRODUCT RETAINING FUEL PARTICLES

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Filed Apr. 12, 1967, Ser. No. 630,408
Claims priority, application Great Britain, Apr. 28, 1966, 18,767/66
Int. Cl. G21c *21/00*
U.S. Cl. 264—.5 8 Claims

ABSTRACT OF THE DISCLOSURE

Particles of nuclear fuel which have been coated with a fission product retentive layer are formed into an agglomeration by applying a thermosetting synthetic resin to the outer surface of the coating, pouring into a cavity, and heating to set the resin. The resin is applied as a thin layer by tumbling the particles with a resin powder which is softened by contact with a resin solvent. Powdered graphite is mixed with the resin powder to make the mixed powders flowable without difficulty.

BACKGROUND OF INVENTION

This invention relates to the preparation of nuclear fuel elements incorporating fuel particles coated with an outer layer of fission product retaining material.

It has been proposed that coated fuel particles be incorporated into fuel elements by mixing the particles with powdered graphite and a bonding agent and then hot pressing the mixture in a suitable die to form an artefact. It has also been proposed to overcoat the particles with a layer of resin treated graphite powder and then to press a batch of these overcoated particles to shape. It has further been suggested that preformed graphite bodies be drilled with blind holes into which loose coated particles are poured and retained in the hole by a closure member. Of these methods the first two can produce a fuelled body having an even dispersion of fuel in graphite which is considered generally desirable but as both require the addition of graphite to the fuel bearing artefact, when the time comes for reprocessing these artefacts, a large bulk of non-nuclear material has to be processed. The third method does not possess this disadvantage, but nevertheless it introduces a safety hazard in that should a container crack, then the loose particles within it may escape and enter the coolant circuit. It is thought, therefore, that such a construction would not easily satisfy the safety requirements for reactor operation.

SUMMARY OF THE INVENTION

According to the invention there is provided a method of preparing a nuclear fuel element incorporating fission product retaining fuel particles which resides in applying a thin layer of a thermosetting synthetic resin to the outer surface of the particles, arranging the particles so coated in intimate contact with one another in their operative position and heating the particles in situ to cure the resin and fix the particles in position. Preferably the fission product retaining particles are coated with a layer of phenoformaldehyde resin e.g. of a thickness of 10 microns, and then the particles are poured into holes formed in a carrier member after which they are heated so as to adhere to one another and to the walls of the hole on curing. By this means a high packing density of the particles can be achieved. Moreover a coherent body may be formed without filter material and hence a high fuel density is achieved.

DESCRIPTION OF THE DRAWING

The drawing shows a diagrammatic representation of the process steps.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In one process embodying the invention a batch **1** weighing 500 grams of nuclear fuel particles, each about 800 microns diameter and pre-coated with pyrolytic carbon as a fission product retaining layer, was placed in a rotary drum **2** mounted for rotation on an axis, which is inclined at a small angle to the horizontal, by motor **3**. The drum 2 has one open end **2***a* for the introduction of the process materials. The drum was rotated on its axis at a speed of about 30 r.p.m.

A supply **4** of powdered phenoformaldehyde resin in admixture with powdered carbonaceous material such as with graphite powder (20 percent by weight of the resin) and a supply **5** of resin solvent (methylated spirit) were mounted above the drum. The powdered carbonaceous material had the remarkable effect of making the mixed powders flowable without difficulty. Suitable feed pipes **6**, **7** were arranged to communicate the supply of mixed resin and graphite powders and solvent with the interior of the drum, the pipes terminating above the open end of the drum at adjacent positions so that the powders and the solvent contacted one another after these materials had left their respective feed pipes and before they entered the drum. The quantity of resin used was about 10 percent by weight of that of the particles i.e. 50 grams of resin. The supply of resin and solvent was then stopped.

As the solvent made contact with the resin grains, the latter softened and became tacky so that the resin tended to stick to the surfaces of the tumbling fuel particles. After 30 minutes, each of the particles in the drum had acquired a thin coating of the powder, mainly resin, which had hardened by evaporation of the solvent. By proper adjustment of the mixed powder feed and solvent feed a substantially even distribution of resin amongst the charge of particles was achieved resulting in a substantially uniform coating of powder, mainly resin, on each particle of about 10 microns in thickness.

The particles were then removed from the drum and were found to be free flowing particles and hence easily handlable without sticking together. They could then be poured into any cavity and heated to about 180° C., in situ, to cure the resin and so form a coherent agglomeration of nuclear fuel particles.

In a particular case the particles were incorporated in a fuel element by firstly forming a tube of graphite, about 6 inches long, 1½ inch external diameter, ½ inch internal diameter. An annular row of holes each ⅓ inch diameter spaced on a pitch circle of 1⅕ inch diameter were then drilled axially in the tube wall parallel with the tube axis. Each of the holes was filled in turn with a predetermined quantity of the resin coated particles. A packing density of 50 percent was achieved. The element was then placed in an oven and heated to 180° C. to cure the resin. The element was then allowed to cool and the integral fuel element formed was easily handlable in any attitude without fear of fuel particles becoming detached. If desired the particles may be vibro compacted before heating.

I claim:

1. A method of forming a nuclear fuel element incorporating nuclear fuel particles which have been adapted to retain fission products by the application thereto of an outer coating including the step of applying to the outer surface of such particles a further coating comprising a thin layer primarily of thermosetting synthetic resin, disposing these particles in substantially unpressed, free, intimate contact with one another, and then heating the particles in that condition to cure the resin and fix the particles in position.

2. A method of forming a nuclear fuel element as claimed in claim **1** in which after the particles have been given said further coating they are poured into a blind hole in a body of neutron moderating material and heated in situ to cure the resin and fix the particles in position.

3. A method of preparing a nuclear fuel element incorporating nuclear fuel particles bearing a fission product retaining layer comprising tumbling the particles in a mixture of powdered thermosetting resin and powdered carbonaceous material, the resin powder having been softened by contact with resin solvent, until the particles acquire a thin layer of the mixed powders, allowing the solvent to evaporate so as to produce substantially free flowing resin coated particles, pouring the particles into a container, and heating them to form a coherent agglomeration of fuel particles.

4. A method as claimed in claim **3** wherein the quantity of resin by weight is about 10% of the weight of the nuclear fuel particles.

5. A method as claimed in claim **4** wherein the quantity by weight of the resin is substantially greater than the powdered carbonaceous material.

6. A method as claimed in claim **5** wherein the mixture of resin and carbonaceous material consists essentially of 80% by weight resin and 20% by weight carbonaceous material.

7. A method as claimed in claim **3** wherein the resin coating on each particle is about 10 microns in thickness.

8. A method as claimed in claim **3** wherein the powdered resin and powdered carbonaceous material are premixed before the tumbling so that the powdered carbonaceous material makes the mixed powders flowable without difficulty.

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U.S. Cl. X.R.

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