MECHANICAL PROBLEMS OF A PEBBLE BED REACTOR CORE

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The development of the pebble bed reactor did require very detailed knowledge of the behaviour of the pebble bed and the influence of different parameters. In a large number of model experiments the behaviour of pebble bed had been studied. The paper will give a survey of the questions and problems and also of the status of knowledge which we have today. The main problems are the following:

blockage of the outlet tube, velocity distribution of the spheres during recycling of the bed, problems of systematic orientation near the container wall due to the small tolerances of the spheres, forces on the reflector wall and core-bottom, forces caused by the adsorber rods which are pushed directly into the pebble bed, forces on the adsorber rods during recirculation of the bed.

The most important parameters which are influencing all these effects are:

the geometry, i.e. the ratio of the diameters of the outlet tube and the pebble bed to the sphere diameter, ratio of diameter to height of the bed, form, inclination and number of hoppers, tolerances of the spheres. Furthermore the material data of the spheres which are used such as density strength and elasticity, in case of the reactor for graphite in case of the models in addition for ceramic and glass. An important parameter is the friction coefficient because the friction coefficient of graphite increases by about a factor of 4 under very pure inert-gas-conditions like they occur during reactor operation in contrary to normal atmospheric conditions.

As it is not possible to simulate the reactor operation conditions in model experiments referring to all important parameters in one single experiment, a large number of model experiments with parameter variations had to be done to get enough information to extrapolate to reactor conditions with reasonable accuracy. The comparison of the results of the model experiments with reality could be done with the operational results with the only pebble bed reactor under operation, the AVR reactor. It could be shown that it is possible to predict the mechanical behaviour of a pebble bed reactor core with sufficient accuracy. But this comparison did also demonstrate the limits of accuracy of the model experiments because the AVR reactor is a very difficult example with regard to its very complex geometry.

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DISCUSSION

Q

P. W. P. H. LUDWIG, The Netherlands

Why do the control rods do not come from the bottom of the tank as I think that this would reduce the forces.

A

C. B. v. d. DECKEN, Germany

The forces you need to push a sphere in a pebble bed in upward direction are nearly the same as to push it in the other direction, there is nearly an isotropic distribution of forces. In the case of pushing the rod from the bottom, you would start with high forces at the beginning. As the rods in many cases have to be pushed in only to a small depth this would have only disadvantages. Furthermore the hot end of the reactor is the bottom. You would have to operate the rods under high temperature.

Q

R. D. VAUGHAN, U. K.

What is the main reason for taking steps to minimize the crystallization effect ?

A

C. B. v. d. DECKEN, Germany

For a very long time of operation of the reactor the velocity distribution would change. It would take too much time to reach a steady state condition. Furthermore, if the crystallization effect takes place the velocity profile becomes very uneven.

Q

H. G. SCHAFSTALL, Germany

Ändern sich die hier vorgetragenen Ergebnisse der Parameter-Studien wenn Kugeln mit unterschiedlichen Durchmessern verwendet werden oder der Kugeldurchmesser geändert wird ?

A

C. B. v. d. DECKEN, Germany

Verwendet man Kugeln mit grossen Durchmesser-Unterschieden, dann geht das Leervolumen der Schüttung zurück, damit wird der Kugelhaufen steifer. Kleine Unterschiede der verschiedenen verwendeten Kugeln in einer Mischung bringen keinen Unterschied. Experimente mit Kugeln verschiedener Fertigungstoleranzen haben dies gezeigt.