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Development of simplified fuel fabrication technologies for fast reactors

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A high-density annular MOX fuel pellet fabrication technology has been developed for producing a low O/M ratio of less than 1.97 for fast reactors. The low O/M ratio sintered pellets aim to suppress the fuel-cladding chemical interaction (FCCI) at high burnup, and a simplified MOX pellet fabrication process (Short process) is a new production technology for this MOX fuel. The short process is a technology for producing pellets by tumbling granulation, die wall lubrication pressing, sintering, and O/M ratio adjustment using a raw MOX powder obtained by the microwave heating direct denitration method. Compared with the conventional process, the short process can reduce the number of processes from 23 to 8, which makes it possible to improve economic efficiency. In this report, the development situation of the short process was reviewed, and the test results of die wall lubrication pressing and O/M ratio adjustment technologies were extended for scale-up of the fabrication technology.

In the development of the die wall lubrication pressing technology, it is necessary to find the optimum operating conditions because a tumbling-granulated MOX powder is directly pressed without a mixing process with additional lubricant to fabricate annular pellets. The MOX granulated powder was fed by a feeder to a die, and was pressed with 8 cycles/min punch at about 510 MPa. The green pellets of about 55.3 %T.D. were sintered at 2023 K for 4 hours to obtain sintered pellets of 95 %T.D. or higher. The quality of the green annular pellets can be improved by optimizing the operating conditions of the die wall lubrication pressing.

Regarding the O/M ratio adjustment, as results of scaled-up tests by increasing the loading amount from 1.0 to 2.0 kgMOX/batch, and 5%H₂+95%Ar mixed gas flow rate from 5.0 to 10.0 l/min/kgMOX, the average O/M ratio increased from less than 1.97 to slightly higher than 1.97. As a result of the thermo-fluid dynamics simulation, it was revealed that a large part of gas did not pass through the mesh plate and leaked through the clearance between the mesh plate and the gas inlet. Further simulations indicate that the gas flow path can be improved by lengthening the lower end of the outer frame of the tiered mesh plates and installing a rod with an ejection hole in the center of each mesh plate. It is expected that these methods can reduce the O/M ratio to less than 1.97.

Country/Int. organization

Japan

Speaker's email address

segawa.tomoomi@jaea.go.jp

Speaker's title

Mr

Affiliation/Organization

Japan Atomic Energy Agency

Primary author: Dr SEGAWA, Tomoomi (Japan Atomic Energy Agency)

Co-authors: Dr ISHII, Katsunori (Japan Atomic Energy Agency); Mr NISHINA, Masahiro (Japan Atomic Energy Agency); Mr NAKAMICHI, Sinya (Japan Atomic Energy Agency); Mr KAWAGUCHI, Koichi (Japan Atomic Energy

Agency)

Presenter: Dr SEGAWA, Tomoomi (Japan Atomic Energy Agency)

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