Effect of Poreformer on the UO_2-10wt%CeO_2 Sintered Pellet

Sang Ho Na[a], Yeon Ku Kim[a], Young-Woo Lee[a], Myung June Yoo[b]
a Korea Atomic Energy Research Institute, 150 Dukjin-dong, Yuseung-gu, Daejeon 305-353, Korea, shna@kaeri.re.kr
bKEPCO Nuclear Fuel Company, Ltd., 493 Dukjin-dong, Yuseung-gu, Daejeon 305-353, Korea

1. Introduction

It is known that compositions, sintered density, pore size and its distribution of mixed oxide re dominant factors to maintain a longer cycle operation in the power reactors. The increased content of additive oxide leads a high burn-up. And the sintered density and pore size and its distribution greatly affect the in-reactor behavior of the fuel pellets, that is, densification and swelling[1].

In general, poreformer, such as ADCA(Azodicarbon amide), is used to control the sintered density and pore size and its distribution of sintered pellet[2]. In this work, MOX-simulated (U,Ce)O_2[CeO_2 : 10 wt%] and the poreformer(0~1.0 wt%) are used to investigate the sintered density and pore size and its distribution on the sintered pellet. UO_2-10wt%CeO_2 mixed powder is milled by DM(Dynamic Mill).

2. Methods and Results

Fig. 1 shows a fabrication flow sheet of (U,Ce)O_2 pellet specimens. As shown in this figure, mixed powder is milled by DM for 4 hrs. Poreformer(0.3, 0.7 & 1.0 wt%) is admixed after Dynamic Milling. But in the case of 0.5 wt%, poreformer admixed after-milling and before-milling, respectively. DM jar revolves 25 rpm. Zirconia ball(dia. 8 mm) is loaded 70% of the volume of the jar. Sample size is 50 g of UO_2-CeO_2 powder mixture.

Details are given in Fig. 1. And the case 1 and case 2 are referred as the poreformer admixing before-DM and after-DM, respectively.

2.1 Poreformer Admixing after DM (Case 2)

Fig. 2 shows the percent theoretical density(%T.D.) of UO_2-10wt%CeO_2 sintered pellet according to the various admixed amount of poreformer(0~1.0 wt%) after milling. As shown in this figure, as the admixed amount of poreformer increases, the theoretical density linearly decreases. Its slope is about –3.99, which means the density decrement of 3.99%T.D. per addition of 1 wt% poreformer. Fig. 3 shows the pore distribution of UO_2-10wt%CeO_2 sintered pellet according to the addition amount of poreformer. The mean pore size increases as the addition amount of poreformer increases. And the distribution curve of pore size shifted to the larger pore size with increasing addition amount of poreformer. On the contrary, in the smaller size distribution range(<10 μm), the pore size distribution of the pellet specimen without poreformer is larger than that with addition of poreformer. It is considered that the fine pores disappeared to be combined by large pores, and so larger pores remained in the case of addition of poreformer.

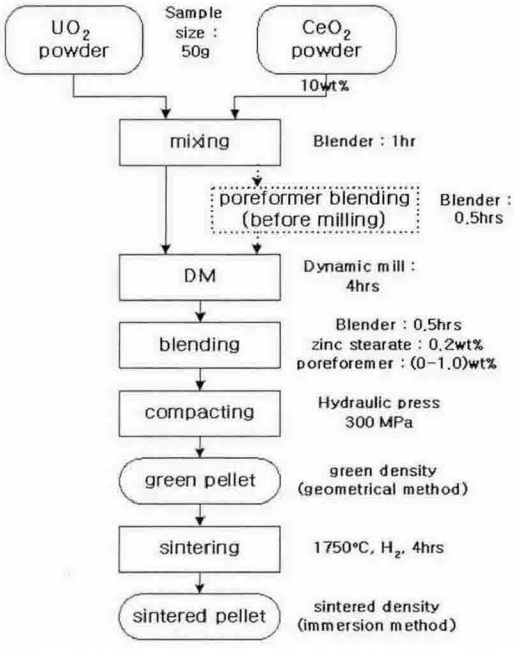

Figure 1. Fabrication flow sheet of (U,Ce)O_2 pellet

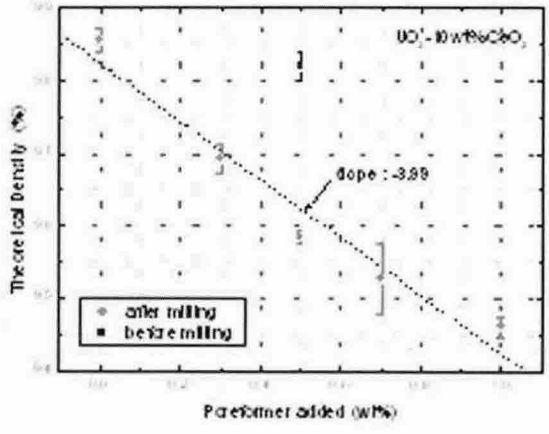

Figure 2. %T.D. of UO_2-10wt%CeO_2 with various addition amount of poreformer

2.2 Comparison between the Case 1 and the Case 2

Fig. 2 also shows the %T.D. of case 1. As shown in this figure, the %T.D. of case 1 is less decreased than

that of case 2. This is attributed the annihilation of fine size of poreformer pulverized by DM during sintering. Fig. 4 shows the pore size distribution of both the case 1 and the case 2 with the same addition amount of poreformer(0.5 wt%). As shown in this figure, the pore size distribution of the case 1 showed a mono-modal type, while the case 2 showed a bi-modal one. And comparing with the case 1, the total porosity of case 2 increased. It is thought that this result led the decrement of sintered density of UO_2-10wt%CeO_2 pellet.

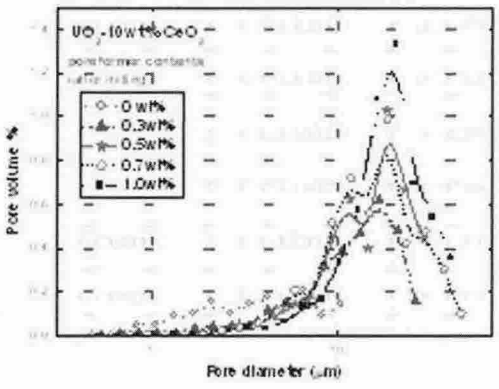

Figure 3. Pore size distribution of UO_2-10wt%CeO_2 pellet with various addition amount of poreformer.

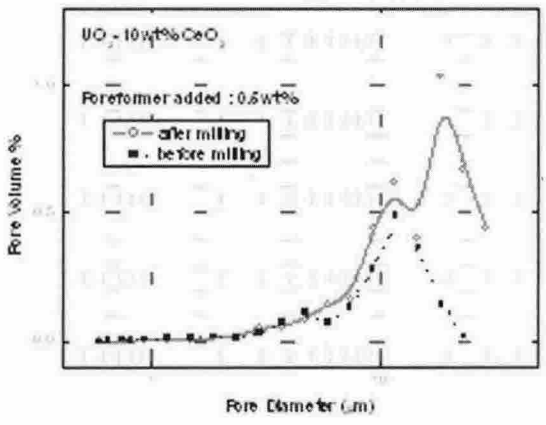

Figure 4. Pore size distribution of UO_2-10wt%CeO_2 pellet with 0.5 wt% addition of poreformer before-milling and after-milling.

2.3 Microstructure of UO_2-10wt%CeO_2 Pelletl

The grain size of UO_2-10wt%CeO_2 sintered pellet is almost the same(about 15~16μm), independently of both the addition amount of poreformer and the admixing method. It is thought that the poreformer has no effect on the grain size of UO_2-10wt%CeO_2 sintered pellet.

3. Conclusion

Effect of the addition amount of poreformer on the sintered density and pore size distribution of UO_2-10wt%CeO_2 pellet is investigated. The results are as follows.

- The sintered density decreases linearly as the addition amount of poreformer increases. The slope is about –3.99
- Comparing with case of before-milling, the case of after-milling shows larger effect on the pore size distribution.

REFERENCES

[1] H. Assmann, W. Doerr and M. Peehs, J. Am. Ceram. Soc., 67 (9) (1984) 631-636
[2] Sang Ho Na et al., Journal of the Korean Nuclear Society, 34, (5) (2002) 433-435

Acknowledgement

This work has been carried out under the Nuclear R & D program by the Ministry of Science and Technology (MOST), Korea.