Transactions of the Korean Nuclear Society Spring Meeting
Gwangju, Korea, May 30-31, 2013

The Effect of U_3O_8 Additon on the Sinterability of CANDU-Type UO_2 Pellet

G.D. Jung [a], C.M. Yang [a], M.J. Yoo [a], D.H. Cho [a] and S.H. Na [b]
[a] *KEPCO Nuclear Fuel Company, Ltd., 989beon-gil 242, Deodeok-daero, Yuseong-gu, Daejeon 305-353, Korea*
[b] *Korea Atomic Energy Research Institute, 150 Deokjin-dong, Yuseong-gu, Daejeon 305-353, Korea,*
gdjung@knfc.co.kr, cmyang@knfc.co.kr, mjryu@knfc.co.kr, dhcho@knfc.co.kr, shna@kaeri.or.kr

1. Introduction

A UO_2 scrap rate, in general, is approximately 5% in the manufacturing process of CANDU UO_2 pellets. The scrap is oxidized into U_3O_8 powder under an air atmosphere at constant temperature for recycling.

If pellets, which consist of UO_2 and U_3O_8, are sintered in a H_2 atmosphere, the component U_3O_8 acts as the pore, and the sintered density of the pellet decreases. In other words, U_3O_8 is a density controller as well as a pore-former.

In this study, the effects of an additional amount of U_3O_8 powder, formed according to the oxidation temperatures, on the sinterability of CANDU-type UO_2 pellet were investigated.

2. Methods and Results

CANDU-type pellets (97%TD, ~8um) were oxidized with 3 different temperature conditions (350, 450 and 550℃) for 4 hours under an air atmosphere in a product-scale oxidation furnace. The results of XRD analysis showed that all oxidized powders formed according to the oxidation temperature were confirmed as U_3O_8. (Fig. 1)

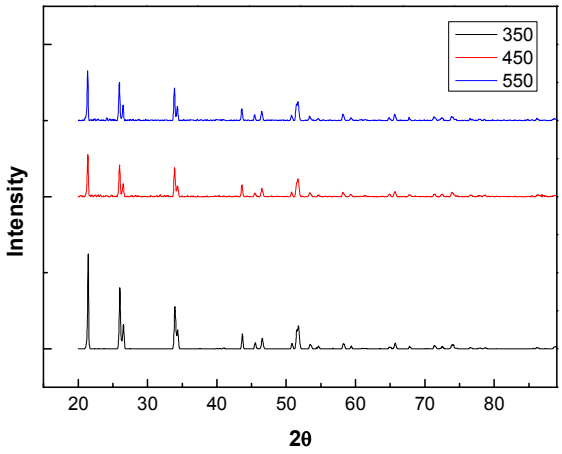

Fig. 1. XRD pattern according to the oxidation temperature

Fig. 2 shows the specific surface area(m^2/g) of U_3O_8 powder formed according the oxidation temperature. As shown in Fig. 2, the specific surface area of U_3O_8 powder decreases as the oxidation temperature increases. If the oxidation temperature is increasing, the strength of grain boundary of UO_2 scrap pellet is weaker than that of the grain. Accordingly, the oxygen diffuses rapidly along the grain boundary. The 2-3 crystal grains become one particle during high oxidation temperature. Therefore, the oxidation temperature increases, the particle size of the U_3O_8 powder increases. The specific surface area of the powder then decreases. [1]

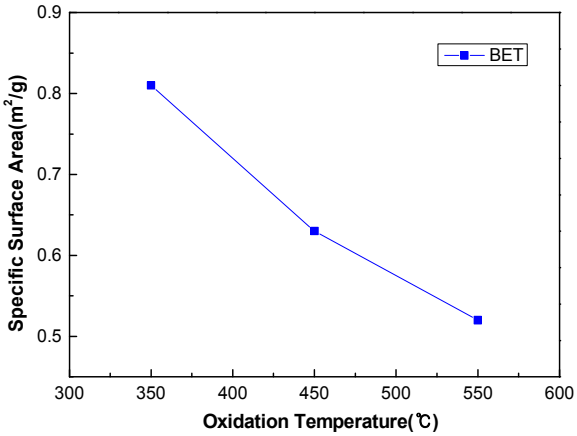

Fig. 2. Specific surface area of U_3O_8 powder according to the oxidation temperature

U_3O_8 powder, which is formed at each oxidation temperature, was added to ex-ADU natural UO_2 powder as 5 conditions (0, 2.5, 5, 7.5 and 10wt%). Next, these powders were mixed for 30 min. in a tubular mixer with 0.19wt% Acrawax for a lubricant.

The mixed powders were compacted with the density of 5.67g/cc, such as a density of product-scale. The green pellets were sintered at 1610℃ for 6 hours in a H_2 atmosphere. The sintered density of the pellet was measured by an immersion method.

Fig. 3 shows the sintered density according to an addition amount of U_3O_8 powder that formed at the each oxidation temperature.

As shown in Fig. 3, the sintered density of UO_2 pellet decreases with increase in the additional amount of U_3O_8 powder. However, U_3O_8 powder formed at the lower oxidation temperature is added into the UO_2 powder under the same addition, the drop width of the sintered density of the pellets appeared to be small.

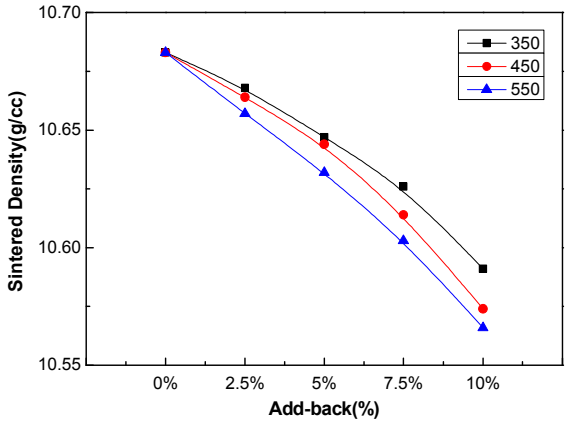

Fig. 3. Sintered density according to addition amount of U_3O_8

Fig. 4 shows the relationship between specific surface area of U_3O_8 powder and sintered density drop with a 1wt% addition of U_3O_8 powder.

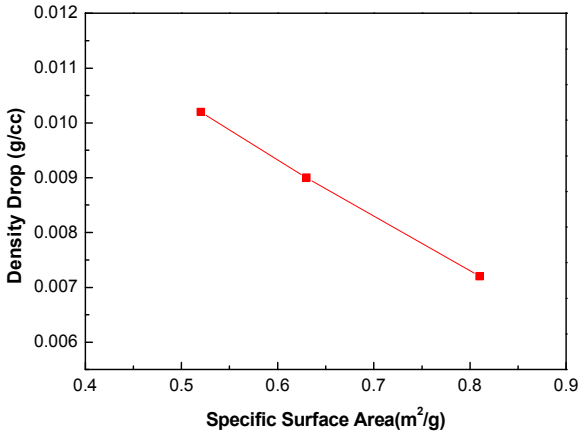

Fig. 4. Density drop according to the specific surface area of U_3O_8 powder

As shown in Fig. 4, the density drop decreases with an increase in the specific surface area of U_3O_8 powder.

It is thought that the specific surface area of U_3O_8 is an important factor to control the sintered density of the pellet for recycle of the UO_2 scrap. [2]

3. Conclusion

- The result of XRD analysis showed that oxidized powder that was oxidized at 350, 450 and 550℃, was confirmed as U_3O_8.
- Increasing of the additional amount of U_3O_8 powder causes decreasing of the sintered density of UO_2 pellet.
- Decreasing of the oxidation temperature of U_3O_8 powder causes increasing of specific surface area of U_3O_8 powder and decreasing of the density drop of UO_2 pellet.

References

[1] S.H. Na et al., Proc. of the Korean Radioactive Waste Society, Autumn 2011, Jeju, 9(2) 2011, pp.163-164
[2] C.M. Yang et al., Transactions of the Korean Nuclear Society Spring Meetiog, Jeju, Korea, May 17-18, 2012