INFLUENCE OF CR_2O_3 ON SINTERING OF NUCLEAR FUEL

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ABSTRACT

The aim of this work was to determine the influence of Cr_2O_3 on sinter kinetics of nuclear fuel.

The article can be divided into 2 main parts, where the first one is dealing with the initial stages which are realized before fabrication process. Especially the effect of powder properties on sintering is here analyzed in details.

The second part is focused on the influence of chromium oxide on sintering and properties of pellets after sinter process. The research and evaluation of results were performed in laboratory of nuclear fuel in Erlangen, Germany. The results were also used as a technical documentation for the companies which are specialized on fabrication of nuclear fuel.

1 INTRODUCTION

Reliability of nuclear fuel is one of the most important subject in nuclear power industry. Nowadays, more than 80 percent of world-wide nuclear fuels are produced for light water reactors (LWR), where the uranium is used in ceramic form-UO_2. For reliability and safety of nuclear plants is necessary to ensure that each part of the whole complex will be up to requested standards. Nuclear fuel as one of the most onerous part is still under developing and improving of parameters of fuel, which finally leads not only to better performance but also to increased reliability. This work deals with the sintering of nuclear fuel, which is one of the stages during the fabrication process.

2 EXPERIMENTS

First part of the research was to determine the parameters of uranium dioxide. The measurement was performed with three various powders: AUC, HADU and DC. The meaning of abbreviations is derived from the type of conversion, by which they were produced. The results are summarized in the following table.

Parameter	AUC	DC	HADU
Average particle size	30 μm	51 μm	62 μm
BET surface	4,9 m^2/g	2,5 m^2/g	7,3 m^2/g
Crystallite size	110 nm	210 nm	75 nm
O/U ratio	2,26	2,03	2,27

Tab. 1: *Powder properties*

These powders were further pressed and sintered under H_2 atmosphere by temperature of 1760°C, what is called high-temperature sintering. On the other hand, there is another way of sintering called low-temperature sintering. Next figure demonstrates typical sinter behaviour of UO_2 pellets.

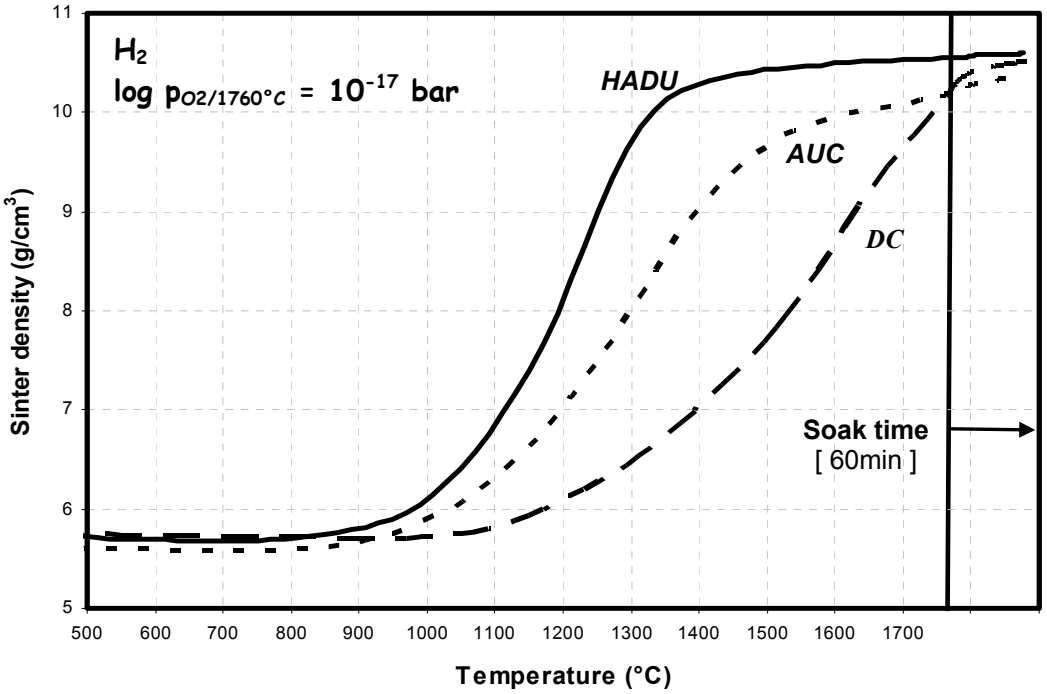

Fig. 1: *High-temperature sintering*

Finally, in this part will be determined the influence of Cr_2O_3 on sinter kinetics and also on the parameters of sinter pellet like grain size, pore size, stochiometry and density of fuel. Each of these parameters mentioned above has a significant effect on operation of nuclear fuel. Stochiometry is responsible for stability of fuel. Porosity is necessary for dynamical properties of fuel. Next, grain size has a big influence on the release of gaseous fission products in first stages of operation of nuclear fuel. Manufacturers are trying to reach the most available values of all these properties. One of the way is the usage of additives. In our tests we used 0,16% Cr_2O_3, which was added in UO_2. We performed several measurements with various temperature profiles by low and high-temperature sintering.

3 CONCLUSION

Generally we can summarize the results as follows:

The effect of Cr_2O_3 by high-temperature sintering:
- increasing of sinter density
- acceleration of sintering
- increasing of grain size
- decreasing of pore size
- no effect on stochiometry

The effect of Cr_2O_3 by low-temperature sintering:
- decreasing of sinter density
- decreasing of grain size
- serious increasing of porosity
- no effect on stochiometry

The obtained results serve like recommendation for French fabrication industries, which are focused on sintering of nuclear fuel.

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