

COMMISSIONER'S DECISION

OBVIOUSNESS Controlling Grain Size in Nuclear Fuel

Particle modification of uranium dioxide where the relative active surface area of the fuel particles are reduced by wet attrition milling while in the green state is shown in the cited art.

Final Action: Affirmed.

This decision deals with the applicant's request for review by the Commissioner of Patents of the Final Action on application 293,717 (Class 31-88) filed December 22, 1977, assigned to Canadian General Electric Company Limited entitled Method of Controlling Grain Size in Nuclear Fuel Compacts. The inventors are Harvey Robert Lee, Adam Krawczyk and Arnold K. Koch. The Examiner in charge issued a Final Action refusing to allow the application on August 18, 1982.

The application relates to the preparation of nuclear fuel where uranium powders originating from a solid and liquid reaction process involving ammonium are prepared by a particle modification step where the relative active surface area of the fuel particles are reduced by wet attrition milling while in the green state.

In the Final Action, the Examiner rejected claims 1 to 7 in view of the following references:

Publication
A.E.C. document, T.I.D.-7546, Book 2, Nov. 18-23, 1957, pp. 416-419, 453-466.

Canadian Patents		
634,890	Jan. 16, 1962	Cope
656,281	Jan. 22, 1963	Moss
856,695	Nov. 24, 1970	Masselot

Masselot relates a process for manufacturing pellets of sintered nuclear fuel comprising the steps of grinding uranium oxide into powder, adding a sintering inhibitor, cold pressing and sintering.

Cope describes a method of making ceramic nuclear fuel comprising the steps of ball-milling a mixture of uranium dioxide powder and gelatinous

plutonium polymer, pressing the mixture to form a green compact and sintering the compact. Moss describes a process of densification of uranium dioxide by ball milling and subsequent tumbling to granulate the material. The publication describes methods for the preparation of uranium dioxide fuel materials.

In the Final Action the Examiner stated (in part):

The rejection of claims 1 to 7 is maintained. The claims lack invention in view of the cited art. The references teach methods of manufacturing ceramic UO_2 nuclear fuel bodies comprising the step of milling the UO_2 powder to obtain the desired grain sizes. Contrary to applicant's arguments the problem of obtaining a controlled and uniform grain size after sintering is fully recognized in the prior art. The publication on page 454, lines 1-4 and 30-36 discusses the effects of ball milling on the sintering characteristics of UO_2 , at line 1 it is stated inter alia that "A more uniform grain structure in the sintered pellet is achieved" and, at line 4, that "it was found that wet milling is more efficient a process than dry milling". Lines 30-36 of the same page also emphasize the importance of UO_2 powder structure in the sintering characteristics of UO_2 , such as uniform grain structure in the sintered material. Further evidence of the recognition in the prior art of the importance of reducing variations in grain size after sintering, can be found in the publication on page 461 lines 5-7, page 463 line 16 and page 466 lines 16-20.

In response to the Final Action the applicant cancelled the claims on file and replaced them with amended claims 1 to 5. That response stated (in part):

The present invention comprises meritorious subject matter, providing an inobvious solution to an existing problem.

In the CANDU^R nuclear reactors which comprise Canada's major contribution to this nuclear age the nuclear fuel is made up of assemblies of fuel pellets encased in a thin zirconium sheath. Under operating conditions of high temperature and high pressure the long residence time of the fuel causes pellet growth to occur against the wrapping constraint of the fuel sheath which is collapsed in tight constraining relation against the pellets.

In the event that atypical crystal growth takes place there is a strong likelihood of pellet failure occurring, which can lead then to rupturing of the sheath and contamination of reactor coolant by radioactive particles. The improved pellets made possible by the present invention go a long way towards reducing this probability. A further advantage of the present invention is the simplified fuel processing made possible, wherein preliminary pelletizing and sintering is avoided, and the wet milling is carried out with powder in the green state. Whilst, subsequent to the wet milling step for reducing the powder in particle size and also in active surface area, the improved powder may be satisfactorily pelletized without the step of pre-compaction that otherwise would be provided.

It appears that the prior teachings cited by the Examiner are defective, when viewed in light of the teachings of the present application, because:

- 1) there is no recognition therein of the significant role played by the reduction of active surfaces, by wet milling, in controlling atypical grain growth;
- 2) the range of grain size obtained in the present process, being about one order smaller than the sizes, where taught, in the prior art (see Responsive letter of Jan. 16, 1981);
- 3) the effective cost reduction made possible in the overall pelleting process, due to avoidance of having to fabricate sintered pellets, prior to crushing and reprocessing the material; and to avoidance of pre-compressing the pellets in the green state, when pelletizing, by relying upon a single compaction, made possible by the improved pouring characteristics of the subject powder.

The consideration before the Board is whether or not the latest amended set of claims are allowable over the art of record. Amended Claim 1 reads:

A process for providing a nuclear fuel green powder of reduced susceptibility to atypical grain growth upon compaction, sintering and prolonged hot soaking, including the step of diminishing the active surface area of the fuel grains by wet milling to achieve a grain size in the range substantially less than 25 micrometres.

Applicant maintains the improved pellet made by the present invention has the advantage of simplified fuel processing wherein preliminary pelletizing and sintering is avoided. Wet milling is carried out with powder in the green state thereby reducing the powder in particle size so that it may be satisfactorily pelletized without the step of pre-compaction previously used. He argues that the cited prior art is defective because there is no recognition of the significant role played by the reduction of active surfaces by wet milling and the range of grain size obtained in the present process being about one order smaller than the sizes in the prior art.

In the Final Action specific portions of the A.E.C. Publication were detailed to show support for the refusal of the claims. Reference was made to page 454 at lines 1 and 4 where studies of ball milling on the sintering characteristics indicate that "a more uniform grain structure in the sintered pellet is achieved" and "it was found that wet milling is more efficient a process than dry milling". Reference is also made to lines 30 to 36 of the same page which emphasize the importance of UO₂ powder structure in the sintering characteristics of UO₂ such as uniform grain structure in the sintered material.

We note from the publication that particle size is detailed in several locations. On page 417 it is stated that powder agglomerates broken up by the action of a high-velocity fluid jet have been employed to prepare UO_2 with particle diameters less than 1μ . At page 454 particle size of less than 3μ are described. Figure 2 on page 416 shows particle sizes of UO_2 powders ranging in size from 1 to 3μ and figure 3 on page 418 shows similar sized particles. Clearly then the range of size obtained by the applicant's process is not smaller than shown in the prior art.

Grain size change associated with sintering is described on pages 454 to 466 inclusive of the A.E.C. Publication. Page 455 states there are "marked differences between the microstructures of compacts sintered from as-received MCW powder and from wet ball milled powder. The former are heterogeneous both with respect to the spatial porosity distribution and grain size, whereas the latter have uniform structures throughout (Figs 7 to 9)". At page 462 grain growth is related to time by a formula utilizing mean grain diameter, a temperature constant and the exponential characteristic of the material. Figure 17 on page 465 shows the rate of grain growth utilizing cold pressed and sintered wet ball milled UO_2 compacts. Page 477 states that the growth of grains will be controlled by the activation energy which controls the disappearance of pores. Therefore we conclude that the publication does recognize the role played by wet milling in controlling grain growth.

The applicant argues that he has a method of preparing a nuclear fuel pellet which reduces the probability of atypical grain growth, and provides an effective cost reduction made possible in the overall process due to avoidance of having to fabricate the sintered pellets material prior to recrushing and reprocessing the material. In response to the Final Action an amended set of claims was submitted but we are unable to find the argued features in these claims. However, we note in the rejected set of claims that refused claims 2, 6 and 7 when combined together would contain the argued features and clear the cited art.

In view of the art of record therefore, we find that the amended claims do not contain patentable subject matter and that the applicant's advance has not been satisfactorily defined in any single claim of the rejected claims.

We recommend that the decision in the Final Action to refuse the claims be affirmed.

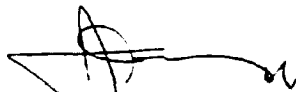


M.G. Brown
Acting Chairman
Patent Appeal Board



S.D. Kot
Member

I have reviewed the prosecution of this application and considered the recommendation of the Patent Appeal Board. I concur with the reasoning and the findings of the Board. Accordingly I refuse to grant a patent containing either the amended claims, or the rejected claims as they presently define the invention. The Applicant has six months within which to appeal my decision under Section 44 of the Patent Act.



J.H.A. Gariépy
Commissioner of Patents

Dated at Hull, Quebec
this 10th day of June 1987

R.A. Eckersley
1420 Dupont Street
Toronto, Ontario
M6H 2B2