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Methane Pellet Moderator Development

C.A. Foster, D.E. Schechter
CAFI
450 Bacon Springs Lane; Clinton,TN 37716

J.M. Carpenter
Argonne National Laboratory, Argonne, IL

ABSTRACT

A methane pellet moderator assembly consisting of a pelletizer, a helium cooled sub-cooling tunnel, a liquid helium cooled cryogenic pellet storage hopper and a 1.5L moderator cell has been constructed for the purpose demonstrating a system for use in high-power spallation sources.

DESCRIPTION OF THE SYSTEM

The pelletizer, cooled by liquid nitrogen, forms and releases 30,000 2.7mm methane pellets by reverse sublimation in a honeycomb panel in a 50 minute cycle. Figure 1 is a photograph of the 0.15m x 0.9m 3mm cell honeycomb freezing panel ; the circle inset shows the honeycomb matrix magnified. The pelletizer contains two honeycomb panels.

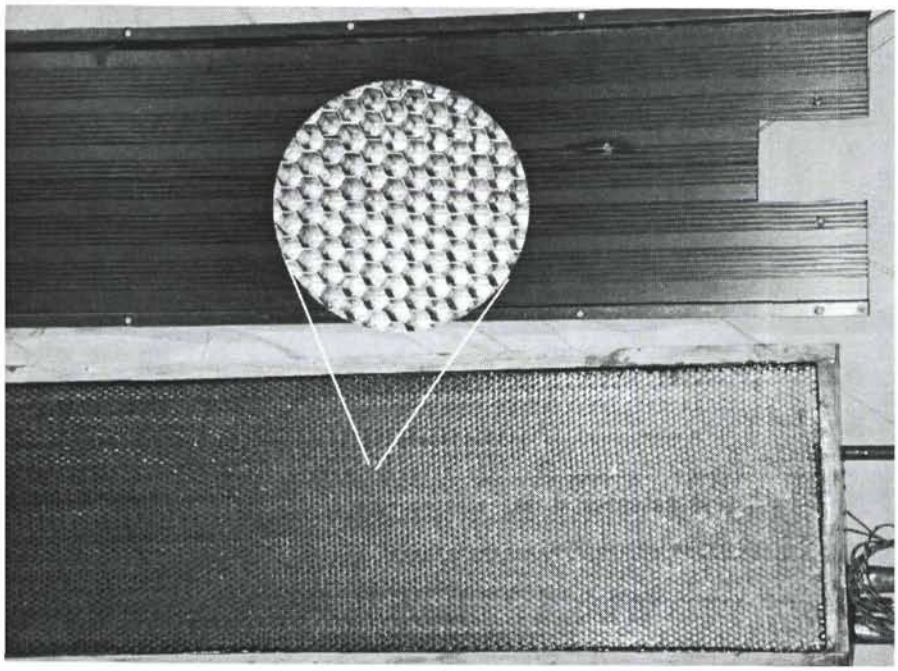

Figure 1. The honeycomb freezing panel; the inset shows the honeycomb matrix in detail.

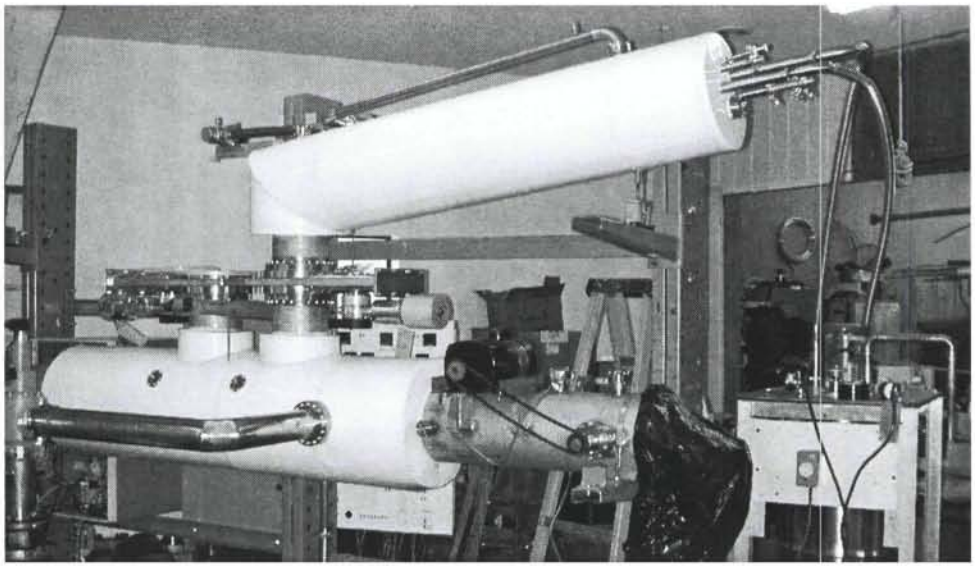

Figure 2. The methane pelletizer, mounted in a foam insulated chamber above the cryogenic conveyor/ sub-cooling tunnel assembly. The liquid nitrogen circulator is to the right. The pellets are conveyed slowly through the tunnel on a metal belt, allowing time to sub-cool.

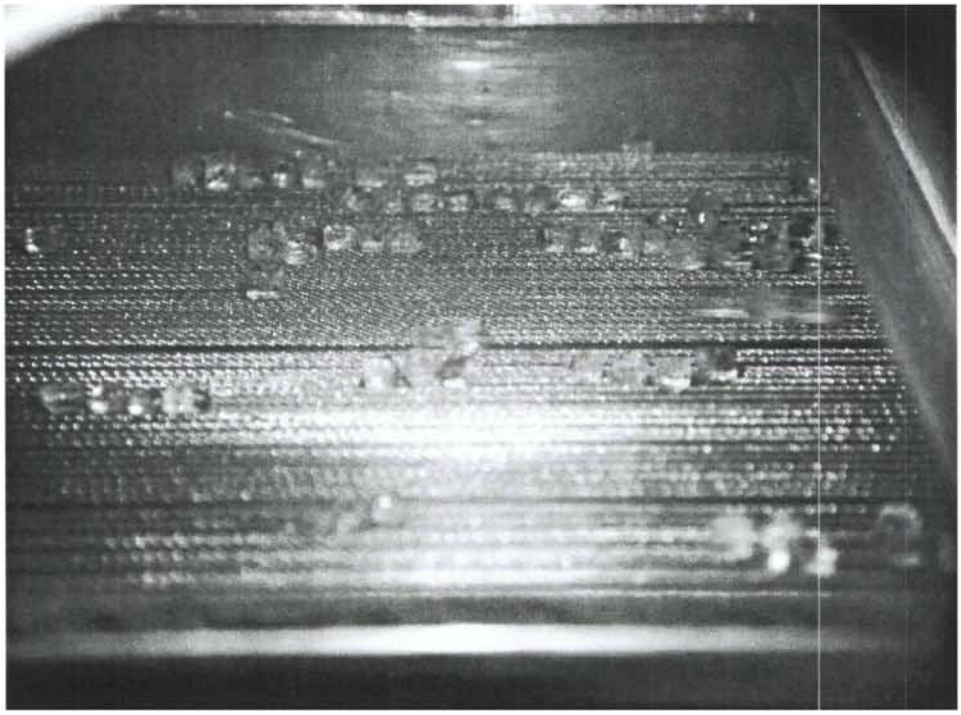

Figure 3. Methane pellets on the conveyor belt entering the sub-cooling tunnel.

After passing through the sub-cooling tunnel, the pellets drop into and are stored in a liquid helium cooled hopper. The photo shows the cryogenic hopper/valve assembly (with the vacuum jacket removed) mounted below the end of the conveyor. The window in the center of the hopper is where photographs of the pellets in the hopper are taken.

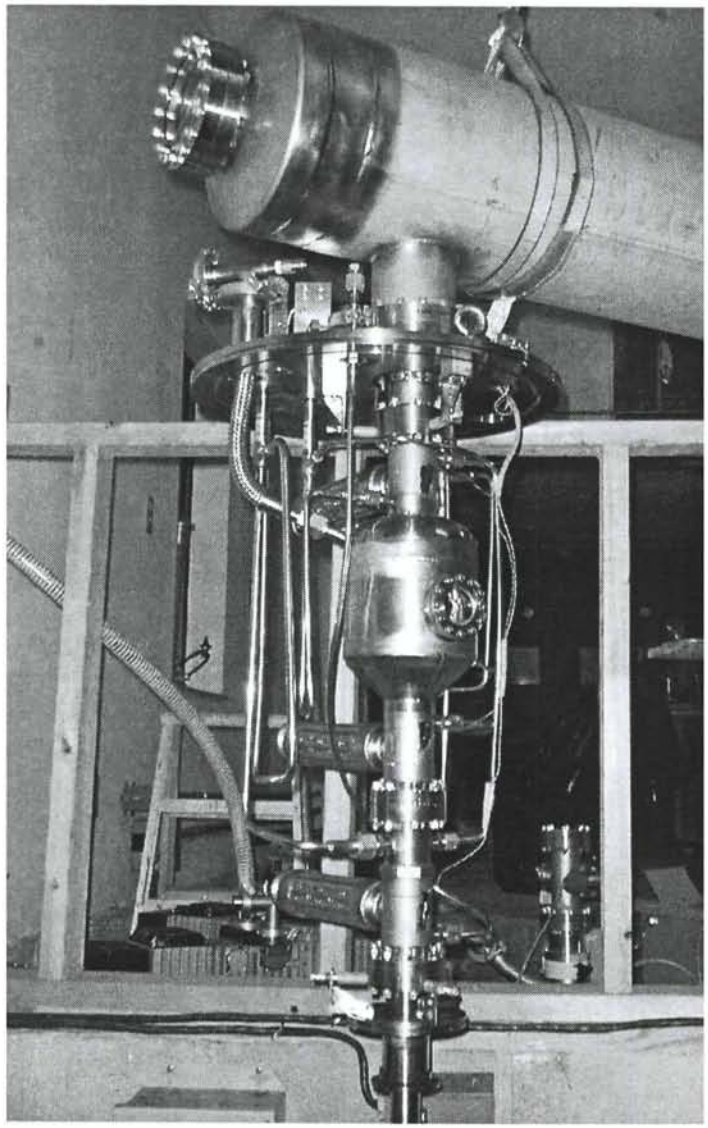

Figure 4. The cryogenic hopper/valve assembly (with the vacuum jacket removed).

Figure 5. The cryogenic hopper filled to the 1.3-liter level with methane pellets.

If progress is made in collecting the pellets at a low enough temperature so that they do not agglomerate in the hopper, the pellets in the hopper will be transferred through the middle and lower ball valves and into the mock moderator cell via a 25mm id transfer line. When required, the moderator cell will be emptied by flash melting the pellets using pressurized methane gas and then blowing the liquid methane from the cell.

PROGRESS

The liquid nitrogen cooled pelletizer works well, growing batches of 30,000 pellets in 25 minutes, followed by a low pressure defrost/release cycle. The conveyer and freezing tunnel function well, however sub-cooling the pellets sufficiently to produce a non-sticky, fluid medium has not yet been fully realized. Pre-cooling the system to 40K followed by a low pressure (5 Torr) defrost has produced the Adriest@ pellets. These pellets were dry enough to flow and fill the hopper with 1.3 liters of pellets (two batches). However, the pellets then agglomerated, so that the hopper could not be emptied into the moderator. A liquid helium-cooled cryopump is being added to the tunnel to further reduce the defrost pressure (~10-2 Torr) which should reduce the temperature of the pellets during the defrost cycle from 70 K to about 50K. It is presumed that the colder pellets will be less likely to stick together.

ACKNOWLEDGEMENT

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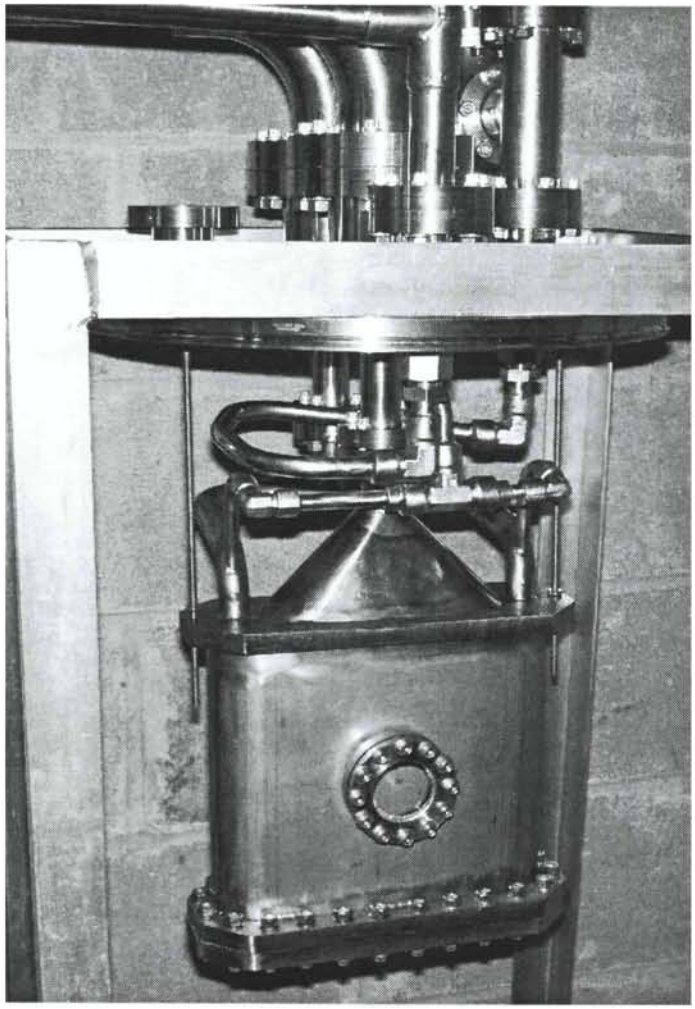

Figure 6. The 1.5 liter Amock moderator@ assembly (with the vacuum jacket removed).