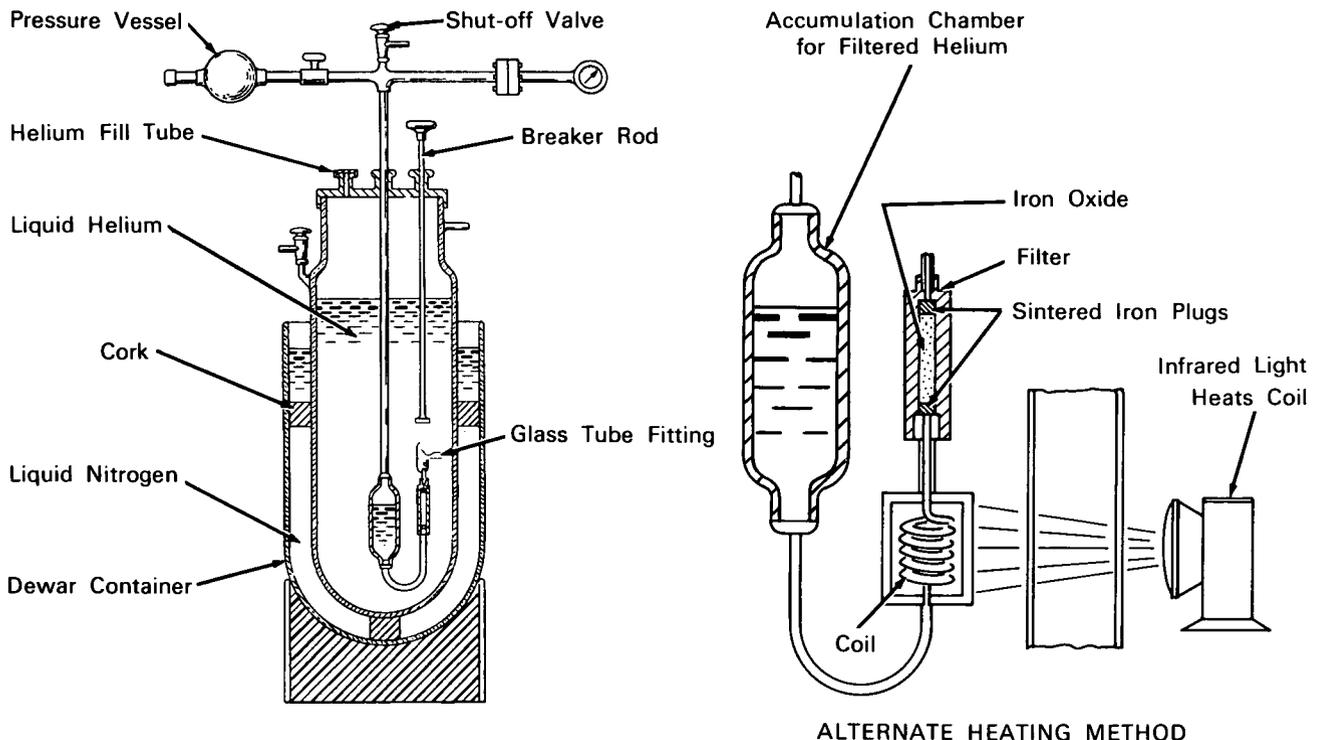


NASA TECH BRIEF



This NASA Tech Brief is issued by the Technology Utilization Division to acquaint industry with the technical content of an innovation derived from the NASA space program.

Cryogenic Filter Method Produces Super-Pure Helium and Helium Isotopes



The problem: Purification of helium to produce super-pure helium gas for experimental use and to separate the various isotopes of helium.

The solution: Cool helium to a temperature below 2.19 degrees K in a low-pressure environment, so that part of the helium becomes super-fluid, then filter through a material with extremely fine pores.

How it's done: Liquid helium is filtered, while in the lambda II state (super-fluid, a state of practically zero viscosity) through iron oxide particles such as

jewelers' rouge. Normal liquid helium cannot pass through this filter. The filtering equipment consists of an iron oxide filter with sintered iron plugs at each end. One end is connected by a tube to an accumulation or storage chamber; the other end is connected to a liquid helium intake in a thick-walled vessel. A glass tube closes the filter (helium) intake.

The equipment is lifted out of the thick-walled vessel, thoroughly cleaned to remove impurities, heated to 300 degrees C to drive out moisture, and

(continued overleaf)

then lowered into the thick-walled vessel containing liquid helium in a Dewar system cooled by liquid nitrogen.

Liquid helium is next brought to the lambda II state (the point at which super-fluid helium begins to form) by placing it in a low pressure environment (below 30 mm). A breaker rod is depressed to break the glass tube. This allows the super-fluid, liquid helium to enter the filter, flow through the sintered iron plug and into the accumulation chamber. Since only super-fluid helium can pass through the filter, all impurities are stopped. When the accumulation chamber is filled with pure liquid helium, the entire helium bath and equipment is heated above the lambda II point so that no super-fluid remains. Heating prevents helium from flowing backward since normal liquid helium cannot pass through the iron oxide.

The process of filling the accumulation chamber can be speeded up by using an infrared light source. A coil with a heat-absorbing surface is connected between the filter and the accumulation chamber. An infrared source, placed outside the Dewar system, emits light, heats the coil, and causes the super-fluid liquid helium to become normal. When super-fluid liquid helium is in the coil, it diffuses out of the coil through the filter as well as from the filter into the coil.

Heating causes liquid helium in the coil to become normal liquid helium, which is unable to flow out through the filter. The process of diffusion will

force liquid helium into the coil and from there into the accumulation chamber. The final step is to open the shut-off valve on the accumulation chamber and allow the purified liquid helium to heat up to a gas and to fill the pressure vessel.

Notes:

1. This process is also useful in separating isotopes of helium. Helium 3, which exists in minute amounts together with the most common isotope, helium 4, may be separated out. Although helium 3 remains liquid at low temperatures and does not stick to iron oxide particles, it does not become super-fluid like helium 4. Therefore, helium 3 experiences considerable resistance in passing through the minute pores of the filter and diffuses through the filter more slowly than helium 4.
2. Use of this method is suggested for research laboratories and chemical processing where ultra-high purity helium, or its isotopes, are required.

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