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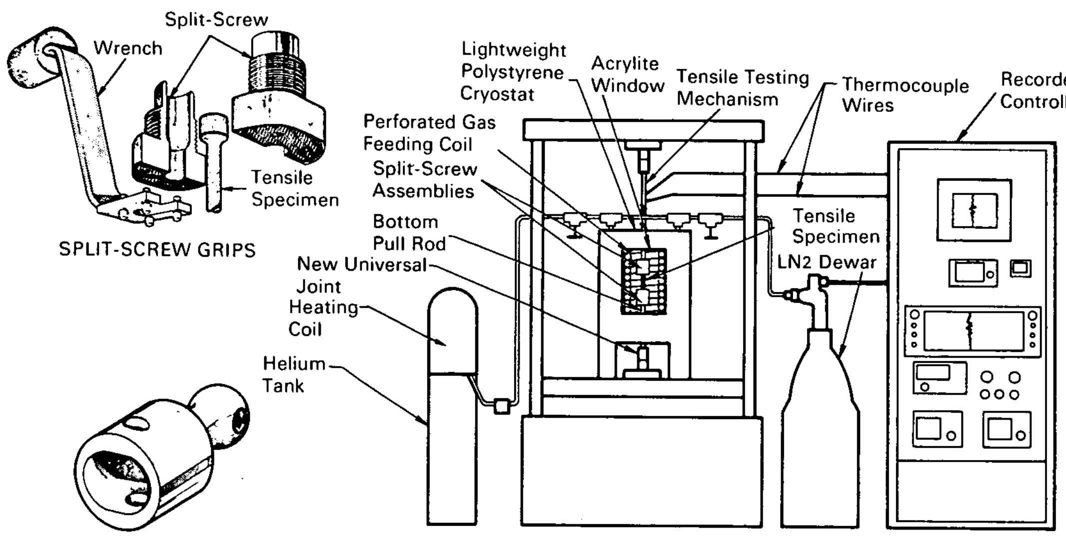
AEC-NASA TECH BRIEF

Test System Accurately Determines Tensile Properties of Irradiated Metals at Cryogenic Temperatures



NEW UNIVERSAL JOINT

The problem:

Previous radiation-effects tensile testing of brittle-type metals indicated losses in strength and ductility after irradiation at 140°R in liquid nitrogen (LN_2). The measured properties appeared to be affected by premature failure caused by eccentricity of the loading system of the tensile testing equipment. A need was also apparent for fast, accurate control of specimen temperature during testing at intermediate temperatures (from 190°R, up) to determine annealing effects.

The solution:

A standard tensile testing system modified by the incorporation of (1) a lightweight cryostat, (2) split-screw grips, (3) a universal joint, and (4) a special temperature control system.

How it's done:

The cryostat is made of a lightweight material (expanded polystyrene with a density of 1 lb/ft^3), which reduces misalignment effects formerly caused by the greater weight of conventional metal cryostats. It contains two acrylite windows, which facilitate viewing the split-screw grips and loading the specimen under LN_2. This system was developed for testing metal specimens irradiated at 140°R. The specimen must be kept under LN_2 during irradiation and thereafter until the LN_2 is drained from the cryostat at the appropriate stage in the test procedure. The cryostat is attached directly to the bottom pull rod by a special seal, eliminating the need for complicated dynamic seals.

(continued overleaf)

The split-screw grips are precision machined to the contour of the test specimen shoulders to reduce misalignment effects due to uneven loading. Unlike conventional split-screw grips, which are threaded to the end of the unit, the new grips are made with a guide and beveled edge to facilitate rapid and accurate seating under LN_2. Also, the heads contain precision-located holes that match precision-located pins in a specially designed wrench; this permits rapid assembly of the split-screw grips around the specimen and assembly into the main grip body under LN_2 without jamming.

To further reduce misalignment effects, a universal joint with limited side travel is inserted in the socket located on the movable crosshead and is connected with the bottom pull rod. Semielliptical design of the universal-joint head and the socket seal limits side travel to minimize any random stresses or spillage of LN_2 that might be caused by "flopping" of the universal joint before slack in the system is taken up.

In the temperature control system, the specimen is surrounded by a coil containing specially sized and specially located holes through which either cold gaseous nitrogen or preheated gaseous helium may be injected through lines leading into the coil from an LN_2 dewar or a helium tank. Temperature is determined from a calibrated thermocouple at a control point near the specimen and is maintained at the desired set point (after the LN_2 has been drained from the cryostat) by a controller which actuates solenoid valves as required.

Notes:

1. By using this improved test system, misalignments may be reduced to less than 5%, and specimen temperature can be controlled within $\pm 2°$R at temperatures as low as 190°R.
2. The system was developed for use in determining the radiation effects on cryogenic tensile properties of beryllium. It should be easily applicable to the determination of tensile properties of other materials at cryogenic temperatures where misalignment of the testing system is a factor and close temperature control is desirable.
3. Inquiries concerning this innovation may be directed to:

   Technology Utilization Officer
   AEC–NASA Space Nuclear Propulsion Office
   U.S. Atomic Energy Commission
   Washington, D.C. 20545
   Reference: B67-10617

Patent status:

No patent action is contemplated by AEC or NASA.

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