

DISCUSSION

*H. R. Voorhees*¹—The suggested use of flareless tube fittings appears to offer a simple, economical way to get a firm axial pull on thin tubing. Some of our experience with such fittings in more usual applications may be useful in tension testing as well. To my knowledge, three sources exist for flareless fittings. Although components are not interchangeable between manufacturers, all three designs feature a pair of precision ground ferrules, which press into the outer tube wall and against the inside of the fitting body to grasp the tubing and provide continuous lines of sealing around the tube. Fittings are offered in a variety of alloys and plastics in nominal sizes which are multiples of a $\frac{1}{16}$ -in. tube diameter. Tolerances vary, but a gas-tight seal usually can be made when the actual tube size ranges from 0.005 in. less than to several thousandths of an inch larger than the nominal dimension.

For zirconium alloy tubes tested at 752 F under internal pressure, Type 316 stainless steel provided needed strength and resistance to oxidation. Uniform success was obtained when a close match existed between the tubing and fitting diameters, despite the much lower coefficient of thermal expansion of the tube material. Paxton found a need to tighten his fittings $1\frac{3}{4}$ turns instead of the $1\frac{1}{4}$ turns recommended by the manufacturer. We find that if a gas-tight seal is not obtained at or slightly over the degree of tightening specified by the fitting maker, the leakage seldom can be stopped by further tightening of the nut (When the tubes are slightly undersize, we first tighten the nut until the tube no longer turns freely inside the ferrules under light finger pressure and then apply the recommended number of turns to achieve the seal.).

Some of the tubes tested differed from all stock sizes of fittings, requiring a thin sleeve pressed onto the tube to bring its outside diameter up to the next fitting size. A gas-tight seal could be obtained in fewer than half of our attempts. Even when the initial seal was satisfactory, some sleeves (and, therefore, the fitting) slid off the end of the tube at high internal pressure. Failures of this type were minimized by using a sleeve of annealed material with thermal expansion properties matching those of the tube, and with the final $\frac{1}{4}$ in. or less of the tube filled by a piece of thick walled

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ferritic steel tubing. This will expand the end of the tube slightly when the assembly is heated.

If more than a few tubes of given, nonstandard diameter must be tested, use of custom fittings of special size should result in lower total cost. Some special sizes already are made; for example, one source supplies fittings for tubing 0.425 in. in diameter, a size which has been adopted for certain nuclear power applications. Fittings also can be purchased in some metric sizes.