on. For example, it can be shown that the nominal residual hoop stress at the liner bore at Point X in Figure 3 would be 1/2 the value normally achieved entirely under the shrink-ring. (An analysis of this is given in Reference (2)). This is assumed to apply to the type of shrink rings shown in Figure 2 as well. Thus, it is concluded that a side-bore container with such "partial" shring-rings, compared to a straight-bore container with the same number but "whole" shrink-rings, will have a pressure capability less than that given by Equation (11).

To avoid difficulties associated with shrink-rings on a side-bore liner, an autofrettaged monoblock design of a side-bore container is considered. If the wall ratio could be made sufficiently large, and an autofrettage residual stress of sufficient magnitude could be achieved, then Equation (11) may apply for p = pressure capability of an autofrettaged straight cylinder. For example, pressures, p, up to 290,000 psi have been applied many times to a monoblock autofretteged cylinder of 285,000 psi ultimate tensile strength as reported by Thomas, Turner, and Wall[2]. The cylinder had an overall wall ratio of K = 7.2.

Before autofrettage can be recommended with confidence for side-bore cylinders, experiments should be conducted to determine if the same benefit is achieved as achieved in straight-bore cylinders. It is well to point out here that autofrettaged cylinders are weaker in fatigue than are shrink-fitted cylinders[2] but an autofrettaged monoblock may be easier to replace than a liner of a shrink-fitted container.

Clearly, there are many unknowns in the design of side-bore containers. Even in the design of straight-bore containers much remains to be learned about such factors as fatigue properties of high-strength steel cylinders under cyclic internal pressures and the autofrettaging capabilities of high-strength steels. However, because relatively low fluid pressures of about 150,000 psi will be required for the HYDRAW of titanium tubing, the use of a side-bore container is a distinct possibility and would be eminently desirable from a materials handling standpoint. Consequently, studies are soon to be conducted on geometrically similar plastic models to determine the stress-concentration factor at the critical tee-intersection. This will be done by measuring the strains under pressure indicated by suitably positioned strain gauges. Pressures of only a few hundred psi would be required. The variation of stress-concentration factor with wall ratio will be investigated. The model will be designed with an optimum side-bore to through-bore diameter ratio of one, and with a tee-intersection-radius to bore-radius ratio of one.

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