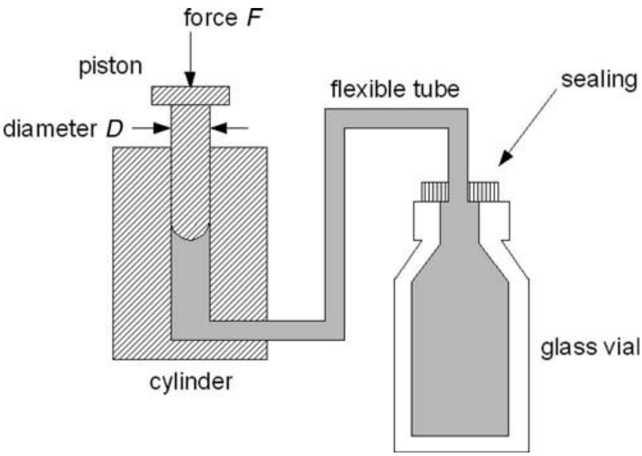

FIGURE 3 Scheme of burst-pressure testing experimental setup.

Methods”). It is recommended as an iterative improvement cycle in the development phase of a new glass-container product to continue strength testing and improving until the container is highly reliable and robust.

Burst-Pressure Testing

Burst-pressure testing is one of the most common methods to investigate the strength of glass containers used for pharmaceutical applications. A liquid medium (water) is used to apply a mechanical load in a single vial via a hydrostatic pressure (Fig. 3).

In most cases the hydrostatic pressure is generated with a constant load rate (e.g., 2 bar/sec) until breakage of the sample. The strength of a vial can then be calculated from the value of the hydrostatic pressure p_{hyd} at failure:

$$p_{\mathrm{hyd}} = \frac{4F}{\pi D^2} \tag{4}$$

where F is the force at failure and D is the diameter of the piston to apply the hydrostatic pressure (Fig. 3). The hydrostatic pressure p_{hyd} induces different kinds of mechanical stresses in the glass of a vial (Fig. 4):

- Radial compression stresses σ_{rad} perpendicular to the inner walls
- Circumferential tensile stresses σ_{tan} tangential to the surface(s)
- Longitudinal stresses σ_{ax} parallel to the axis of the vial

The value of the radial compression stresses σ_{rad} equals the hydrostatic pressure p_{hyd} and is present everywhere where the vial is in contact with water:

$$\sigma_{\mathrm{rad}} = p_{\mathrm{hyd}} \tag{5}$$

As σ_{rad} are compression stresses, they have no influence on the fracture behavior of the vial (in a realistic assumption brittle materials do not fail under compression loads). Nevertheless, whenever radial stresses are present there is also a component of tangential stresses perpendicular to the walls of the vial