

## Application Guide for Discharge Bottle Supports

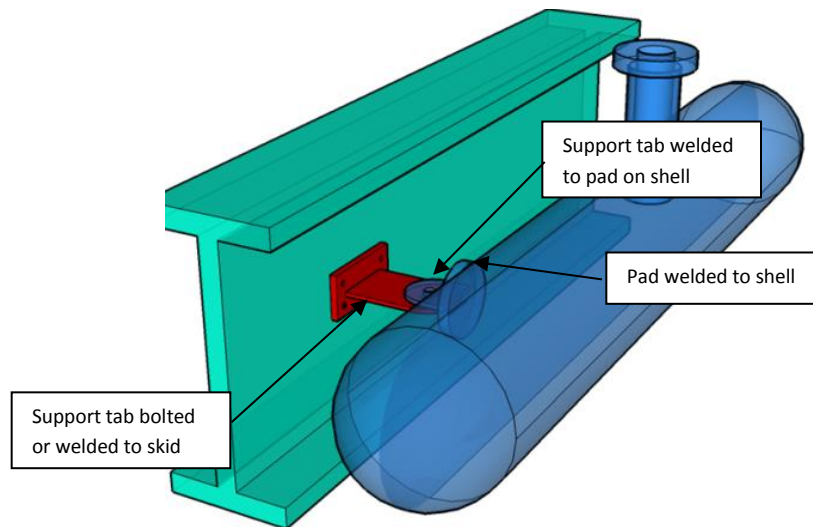
### Summary

Wedge supports are a common method of supporting discharge bottles to control vibrations. However, they have many disadvantages. Two alternative discharge bottle support designs are presented here.

### Horizontal Stiffness Support

The concept behind the design of the Horizontal Stiffness Support is to add stiffness in the horizontal direction to increase the bottle mechanical natural frequency. The typical approach for implementing this support is to add a support between the skid and the discharge bottle. The support needs to have high stiffness in the horizontal direction and flexibility in the vertical direction to allow for vertical thermal growth. A support fabricated of plate or flat bar has these stiffness properties when the support is oriented with the plate's width in the horizontal plane.

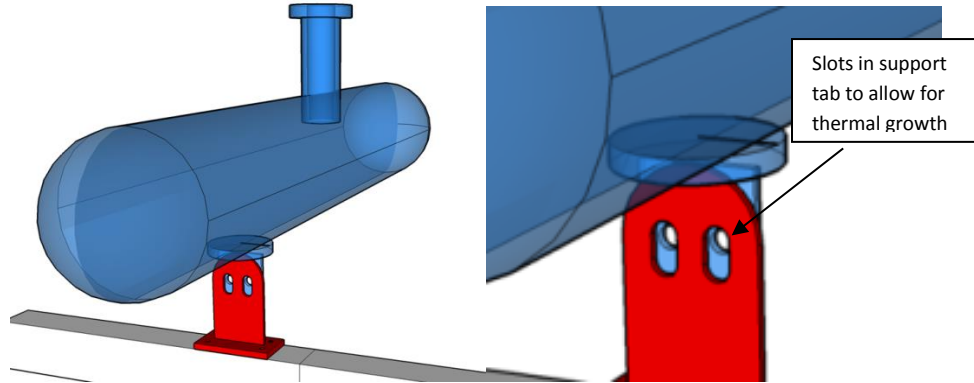
An illustration of the Horizontal Stiffness Support is shown in Figure 1. The Support includes a welding pad or reinforcing pad welded to the bottle shell and a tab welded to the pad. A separate support tab is bolted or welded to the skid or compressor pedestal. The two tabs are then bolted together.



**Figure 1:** Typical Horizontal Tab Design

### Vertical Stiffness Support

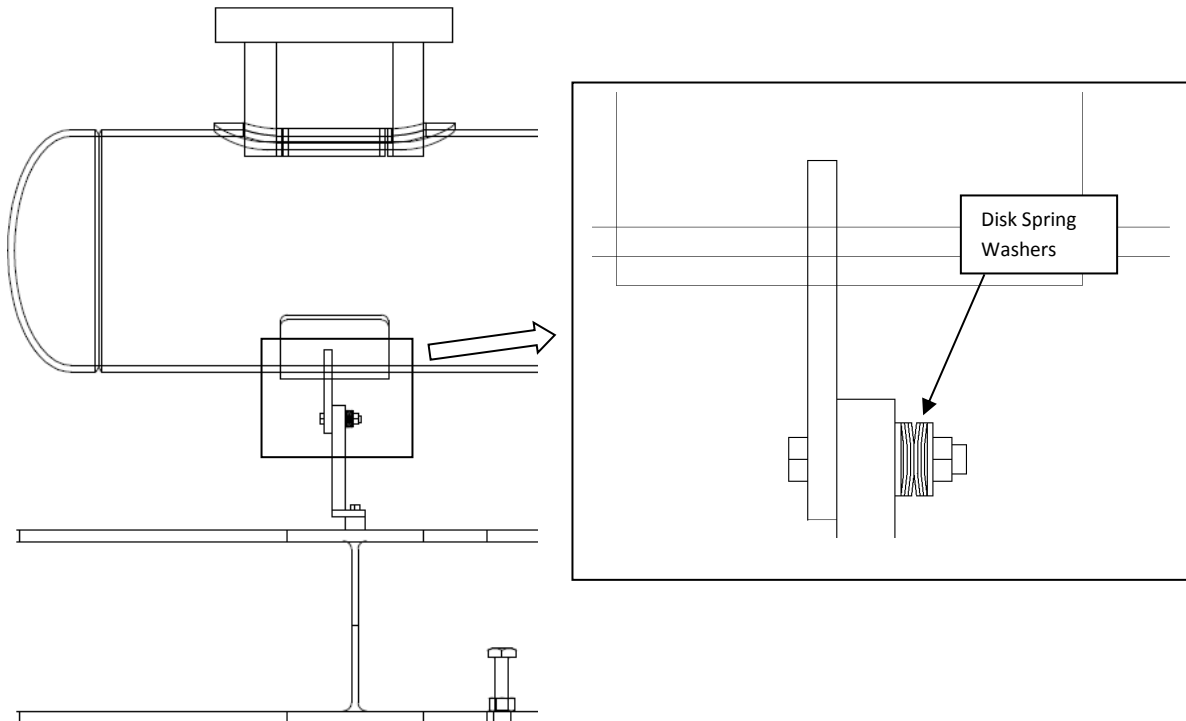
A Vertical Stiffness Support between the discharge pulsation bottle and the skid beam or foundation below the compressor can be installed to increase the bottle mechanical natural frequency and reduce vibration. One configuration is shown in Figure 2. The Support includes a welding pad and support tab on the bottle, similar to the Horizontal Stiffness Support, and a support tab connected to the skid beam or foundation. This orientation of support tab will add horizontal stiffness and vertical stiffness.



**Figure 2:** Vertical Stiffness Support

The support must allow for the discharge bottle to displace in the vertical direction due to thermal growth. One method to account for the discharge pulsation bottle thermal growth is by allowing relative movement between the two pieces of the support tab. Adding slots to the bolt holes in the tab and controlling the clamping force between the tabs will allow for relative movement. Controlling the clamping force between the tabs is important as this force determines the friction force between the tabs. A common method for controlling bolt preload is by using disk spring or Belleville washers. Using a certain configuration of spring washers along with tightening of the bolt and nut a predetermined amount will result in a specific amount of preload or normal force between the support tabs. The end result is that the tabs can move relative to each other to minimize loads from thermal expansion, yet have sufficient clamping force to prevent vibration between the plates.

Figure 3 is an illustration of an installation of a Vertical Stiffness Support using disk spring washers on the fasteners. Vibratory loosening can sometimes occur for fasteners on bottle and pipe restraints. A common solution is to double-nut the fastener. Another approach is to use a castle, or castellated, nut.



**Figure 3:** Disk Spring (Belleville) Washers

## Application Notes

Drawings of the discharge pulsation bottle support design are presented in BETA standard drawings DB-1 to DB-4. The design of the discharge pulsation bottle support is important but proper installation and application of the support is equally as important.

A pulsation and vibration analysis of the compressor package is recommended in the design stage to reduce pulsation forces, assess mode shapes and requirements for discharge bottle supports, and assess stiffness and design for support connections on the skid.

The following are some key points about the application of these supports.

- The base to which the support is connected must be at 5 to 10 times the stiffness of the support in the direction in which the most stiffness is required.
- The best location of the support on the bottle is near the head or an internal baffle.
- The Horizontal Stiffness Support is more effective when offset vertically from the bottle centerline. A support location of 30 degrees between the horizontal plane and the bottle tangent at the shell connection is preferred as shown in standard drawing DB-3.
- Minimum ½" wall thickness is recommended for the vessel shell.
- Larger bottles, such as applications with a common bottle on more than one compressor cylinder, or large over-hung bottles on a single compressor cylinder may require multiple supports.
- Post Weld Heat Treatment will improve the resistance to fatigue.
- The supports can be installed on existing bottles by adding a flat bar band clamp around the pulsation bottle and welding the support to the clamp.

## Other Considerations

Many factors need to be considered in the discharge pulsation bottle support design. The designs proposed in this analysis are based on a limited number of pulsation bottle sizes and bottle arrangements (single cylinder discharge bottles with bottle diameters of 18" to 24"). The proposed designs are expected to be acceptable for other configurations; however some adjustments of the design may be necessary. The main goal of the horizontal and vertical stiffness supports is to increase the discharge bottle mechanical natural frequency above 2.4x compressor speed. There may be cases where dynamic forces at higher frequencies, such as 30 to 100 Hz, can cause high discharge bottle vibration if the bottle is resonant. It is recommended that the pulsation and vibration analysis include an API 618 Design Approach 3 Step 3b1 study if the compressor application has high power/throw (>750 HP/throw) or high gas rod load (>80% of rated). The study must include all of the compressor dynamic forces such as pulsation shaking forces, crosshead guide forces, and gas forces (cylinder stretch).

The support for discharge bottles must consider factors to control vibration as well as allow for flexibility and thermal expansion to minimize nozzle loads and permissible deflection of the cylinder flange. A flexibility study should be conducted in parallel with the API 618 Design Approach 2 Step 3b1 study for new applications. Locating a support directly below the compressor cylinder nozzle may impose undesirable static loads or displacements on the compressor cylinder. Offsetting the support closer to the head rather than the cylinder nozzle connection is often beneficial to reduce the harmful effects of thermal expansion.