Cryostat Vacuum Relief Valve Sizing Calculation

R Sanders

April 26, 2008

Introduction

Determine the required size of the relief valve, SV-50-V, on the T962 Cryostat vacuum space as per CGA S-1.3 --1995, section 4.4.2.. The valve SV-50-V is a 2 inch Circle Seal 220B-16PP check valve in a vertical position with the spring removed.

Internal Vessel Volume

The first step is to find the water volume of the Cryostat internal vessel. The water volume is the quantity of water it can hold. The outside diameter and overall length of the internal vessel are, from PHPK drawing # 07-2032-6501, SHEET 2 :

```
InnerOD  =  30**in      (outside diameter of inner vessel)
Convert(ToFt)InnerOD
InnerOD  =  2.5**ft
InnerL  =  (799/16)**in     (overall length of inner vessel)
InnerL  =  49.9375**in
Convert(ToFt)InnerL
InnerL  =  4.1614583333**ft
```

The inner vessel neck is 18 in pipe.

```
NeckOD  =  18**in       (outside diameter of 18  pipe)
Convert(ToFt)NeckOD
NeckOD  =  1.5**ft
```

From PHPK DRW # 07-2032-6500, SHEET 4 of 5

```
NeckL  =  15.5**in       (length of vacuum insulated portion of neck)
Convert(ToFt)NeckL
NeckL  =  1.2916666666**ft
```

The water volume is:

```
V  =  InnerL*Pi*InnerOD^2/4+NeckL*Pi*NeckOD^2/4      (internal volume)
V  =  0.2271007423e2**(ft^3)
```

Required Discharge Area

Find the required discharge area, using the formula from CGA S-1.3, section 4.4.2.

```
rhoH2O  =  62.4**(lb/ft^3)      (density of water)
rda  =  0.24e-3**(in^2/lb)*V*rhoH2O      (required discharge area)
rda  =  0.3401060717**(in^2)
```

Available Discharge Area

A Circle Seal 220B-16PP was disassembled and the flow area measured. The flow through the relief valve first goes through holes in a moving poppet, then through an annular space and exits the valve through stationary holes in the valve body.

The poppet has four 1 inch diameter holes, the flow area for the poppet is:

```
Ap  =  4*1**in^2*Pi/4
Ap  =  3.1415926537**(in^2)
```

The annular space has a flow path of:

```
Aa  =  (3**in^2-2.25**in^2)*Pi/4
Aa  =  3.0925052682**(in^2)
```

After the annular space, the flow exits the valve, through six stationary 1 inch diameter holes with area:

```
Ae  =  6*1**in^2*Pi/4
Ae  =  4.7123889804**(in^2)
```

The flow path of the six holes are about 20% blocked so the flow area of the exit is

```
Ae  =  0.80*Ae
Ae  =  3.7699111843**(in^2)
```

To summarize, the relief valve has a discharge area of at least 3 square inches, about ten times greater than the required discharge area. The relief valve SV-50-V is adequately sized.