Preliminary Design of IHTS Piping Support for PGSFR

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1. Introduction

A pipe support is a designed element that transfer the load from pipe to the supporting structures. Providing sufficient pipe wall thickness and installing proper supports are most important elements for structural integrity of the piping system. Piping supports are generally referred to as device used in supporting the weight of the piping. The weight includes that of the pipe proper, the content the pipe carries, and the pipe converting, such as insulation.

2. Variable spring hanger selection procedure

In conceptual design phase, variable spring hangers are used to support the IHTS (Intermediate Heat Transport System) piping at those locations subject to vertical movement due to temperature differences. A typical variable spring hanger is shown in Figure 1.

The variable spring hanger selection procedure is summarized into the following steps[1].

Step 1 - Determination of hot load

Hot load is the balanced load that exerts the least weight stress to the system. This load is obtained by analyzing the weight load with all supports considering as rigid. To minimize the load carried by the equipment, occasionally the vertical constraint at the equipment is mathematically released while the balanced load is being calculated. This balanced load is called hot load because we want the spring to carry at operating condition.

Step 2 - Calculating the operational displacement

This operational vertical displacement is determined by analyzing the operation condition with weight and thermal expansion combined. The hot load determined in the previous step is applied as an external support force. Spring rate of the spring hangers are ignored, because the spring load applied is the hot load.

Step 3 - Selecting allowable load variation

The maximum allowable load variation is 0.25 [2]. Within this maximum variation, other limitations may be used depending on experiences and project specification .

Step 4 - Calculating the maximum spring rate

After determining the hot load, vertical pipe movement, and allowable load variation, the maximum spring rate is calculated by following equation.

$$Spring\ rate = \frac{Load\ variation \times Hot\ load}{Displacement} \qquad (1)$$

A higher load variation results in a high spring rate. The actual spring used shall be less than the maximum spring rate calculated.

Step 5 - Selecting the basic spring

The supplier's catalog provides a selection chart.

Step 6 - Checking the working range

The selected spring has to work within working range. The cold load is calculated by:

$$Cold\ load = Hot\ load + (Displacement \times Spring\ rate)$$

If the cold load in not within the working range, the other hanger size that also contains the hot load may be tried.

3. Variable spring hanger selection of IHTS piping for PGSFR

3.1 Geometry

The hot leg T-branch pipe is in 559 mm O.D. (one from each IHX), and one hot leg through the hot leg T-branch pipes is in O.D. 559 mm. The front and top views are shown in Figure 2.

3.2 FE analysis

Elastic numerical simulations were performed using the finite element software package ABAQUS v.6.13 [3]. Figure 3 illustrate a typical FE mesh for analysis. Two node linear beam element (B31) and two node linear interpolation element (ELBOW31) were used and the small strain assumption was employed in the elastic analyses. The material of the IHTS is 9Cr-1Mo-V. The material properties are in accordance with the ASME B&PV Section II, Part D [4]. The weight of coolant was considered. Thermal expansion was considered. Initial ambient temperature and full power operation temperature was assumed to be 21 ^{o}C and 528 ^{o}C, respectively.

4. Results

Thermal gravity analysis is performed. The boundary condition at the end of pipe is fixed. The hot load and operational displacement are 22415.9 N and 66.7 mm, respectively. The maximum spring rate is 84.0 N/mm

from equation (1) with maximum allowable load variation (0.25). The variable spring hanger will be selected with these calculated values.

5. Conclusions

A FE analysis was performed to select variable spring hanger of IHTS hot-leg piping for PGSFR. The calculated values will be used to design variable spring hanger.

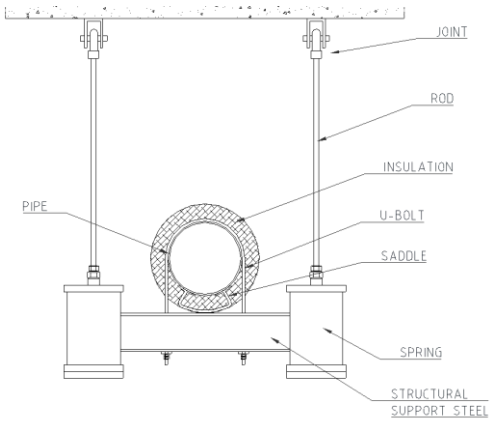

Fig. 1. Typical variable spring hanger

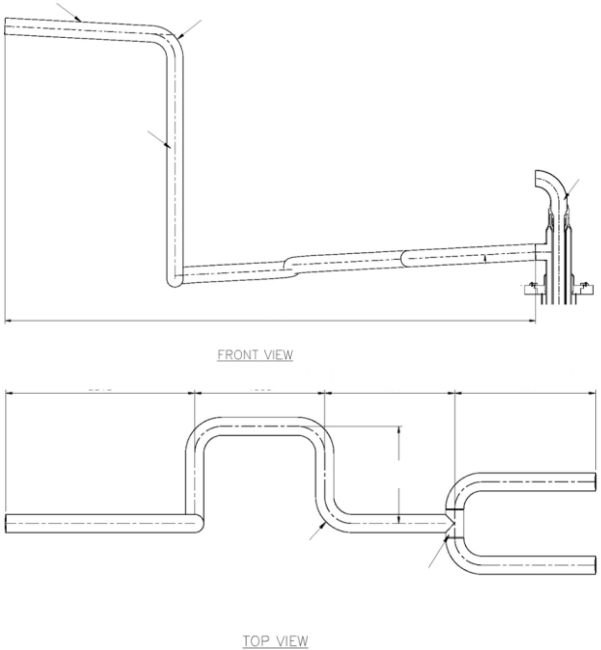

Fig. 2. Front and top views of the hot leg

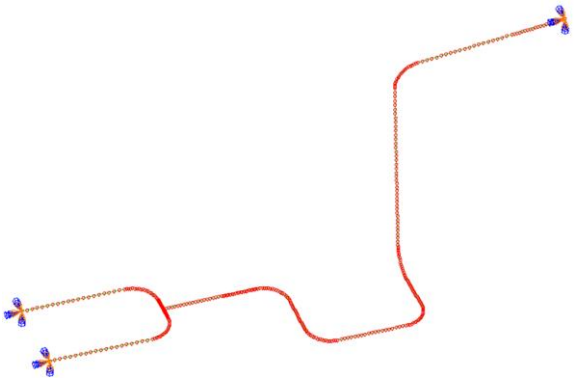

Fig. 3. Typical FE mesh of hot-leg

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