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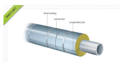

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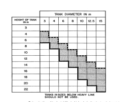

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Api 521 Heat Exchanger Tube Rupture Case

Started by smuk, Jan 12 2020 10:04 PM

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smuk

Posted 12 January 2020 - 10:04 PM

Hello everybody

The purpose of presenting this analysis of a tube rupture scenario of the Steam Heater (refer the attached sketch) is to obtain a confirmation of the correctness of the analysis form domain experts in the group.
A description of the process is given below:
Whole range naphtha from Whole Range Naphtha Tank is pumped by Naphtha Feed Pump to Heavy Naphtha Flash Drum through the Steam Heater, under flow control with FIC-1. Complete tube rupture in the Steam Heater is considered, as it is a possibility as per API 521 6th Edition. In normal operation, isothermal flash takes place in the Heavy Naphtha Flash Drum. The vapors (light gas) from the isothermal flash is routed to Flare under pressure control of PIC-1. The Heavy Naphtha Flash Drum is also protected by a PSV set at 11.2 barg.
The heavy naphtha from Heavy Naphtha Flash Drum is pumped by Heavy Naphtha Pump under level control by LIC-1 through a Cooler before routing to the Heavy Naphtha Tank.
Process flow during tube rupture in the Steam Heater:

When tube rupture takes place, both upstream and downstream section of Steam Heater on the naphtha circuit gets pressurized to the maximum pressure of 17.5 bar based on steam header relief valve with 10% accumulation. Since the shutoff pressure of the Naphtha Feed Pump is 11.2 barg (same as flash drum relief set pressure), the Naphtha Feed Pump will trip on overload leading to closure of ESD-1, thus preventing reverse flow. The flow from the Steam Heater (mixture of naphtha and steam) will flash adiabatically in the Heavy Naphtha Flash Drum. The disengaged vapors will escape through PIC-1 and through the PSV. The bottoms from Heavy Naphtha Flash Drum will continue to be pumped out by Heavy Naphtha Pump under LIC-1 control to Heavy naphtha tank. It will be ensured that temperature of naphtha from the Cooler is cool enough not to flash the Heavy Naphtha Tank.

Design data of Steam Heater:
Design pressure: 12.2 bar (tube side)
Design temperature: 155 C. Maximum temperature during tube rupture: 202 C (steam saturation temperature)
Material: ASTM 515 Grade 70
Design code: ASME Section VIII, Div I (2008)
Hydrotest @ 130% of design pressure
Hydrotest temperature: 25 C
Allowable stress @ 25 C & 202 C: 138 MPa
Actual hydrotest pressure: 15.86 bar (per C.7 of API 521 6th Edition)
Corrected hydrotest pressure: 15.86 bar (per C.7 of API 521 6th Edition)

To protect against overpressure during tube rupture per API 521 6th Edition:

1. Mitigate tube rupture scenario by increasing the design pressure of the low-pressure side
2. Assuring an open flow path can pass the tube rupture flow without exceeding the stipulated corrected hydrotest pressure
3. Providing pressure relief

The first two options are examined. The third option is not considered.
Increasing design pressure of low-pressure side:
If the design pressure of the low-pressure side is increased to 13.5 bar, the corrected hydrostatic pressure of the low-pressure side will equal to the maximum steam side pressure of 17.5 bar. The flow of steam during tube rupture will cease due to equalization of pressure.
Open flow path without exceeding the stipulated corrected hydrotest pressure:
For this option, the flow path is shown in red in the sketch. The flow path remains same as that existed prior to the tube rupture. Also, as the relief valve set pressure (11.2 barg) is lower than the corrected hydrotest pressure of the Steam Heater of 15.86 bar (tube side), it meets the condition stipulated in API to protect from overpressure, this is also considered as an option.

Questions requiring confirmation from domain experts:
Are the above two options acceptable for protection against overpressure of the tube side of the Steam Heater in case of tube rupture.

Thanks
smuk

Attached Files

- (https://www.cheresources.com/invision/index.php?app=core&module=attach&section=attach&attach_id=14505) **Sketch Tube Rupture.pdf** (https://www.cheresources.com/invision/index.php?app=core&module=attach&section=attach&attach_id=14505) **55.71KB** 35 downloads

Posted 13 January 2020 - 12:57 PM

breizh

Hi,
For those interested with the subject , **using safety valve** , let you consider the resource attached .
Breizh

Attached Files

- (https://www.cheresources.com/invision/index.php?app=core&module=attach&section=attach&attach_id=14506) **PRV Sizing for Exchanger Tube Rupture.pdf** (https://www.cheresources.com/invision/index.php?app=core&module=attach&section=attach&attach_id=14506) **2.34MB** 75 downloads

Posted Yesterday, 10:59 PM

Technical Bard

The hydrostatic test pressure is irrelevant. The low pressure side will NOT equalize, because it's pressure relief valve (located downstream) will open and maintain at the lower design pressure plus accumulation. Flow will continue. Designing for the 10/13th rule DOES NOT prevent tube rupture scenario. It only says the exchanger shouldn't catastrophically fail. In some jurisdictions, this isn't legal, even though API 521 allows for it.

Letters to the editor

Corrections needed

Please note the following corrections for "PRV sizing for exchanger tube rupture" (February 1992):

1. The orifice area equations on pages 60 and 61 should be changed to

$$d^2 = 4A_V/3.1416 \text{ and}$$

$$d^2 = 4A_L/3.1416\text{, respectively}$$

2. The following paragraph should be added under the header "Notes":

For fluid flowing from tube to shell

$C = 0.74$

$Y = 1-0.4\ dP/P_1$

Eqs. 3 and 4 can be rewritten as:

$$W_V = 1{,}781.7\ A_V\,(1-0.4\ dP/P_1)\,(dP/LO_V)^{0.5}$$

$$W_L = 1{,}781.7\ A_L\,(dP\ LO_L)^{0.5}$$

Wing Y. Wong, P.E.
Senior Process Engineer
Stothert-Christenson Engineering Ltd.
British Columbia, Canada

Rerating heat exchangers

Although late, I would like to add a view on an article dealing with exchanger temperatures written by Manfred Fehr ("Exchanger temperatures: estimates for new services," November 1982, pp. 215–216).

We in developing countries often have to face situations like these:

- Rerating the very same existing piece of equipment working on a given basis for another, very different operation
- Using existing shop drawings of an existing piece to foresee whether they can be used for constructing a new, just calculated or needed piece.

Both situations have to do with heat transfer processes in shell and tube heat exchangers most of the time. What we do is the following:

If we have an equation for an existing shell and tube heat exchanger (not being afraid of F)

$$Q1 = U1\,A1\,LMTD1$$

And we like to know if that heat exchanger satisfies another service, let's say

$$Q2 = U2\,A2\,LMTD2$$

It follows that

$$Q2 = Q1\,(U2/U1)\,(LMTD2/LMTD1)$$

$Q1$, $U1$, $LMTD1$: from previous operation

$U2$: to be estimated using references such as *Chemical Engineering* (May 13, 1974, p.126).

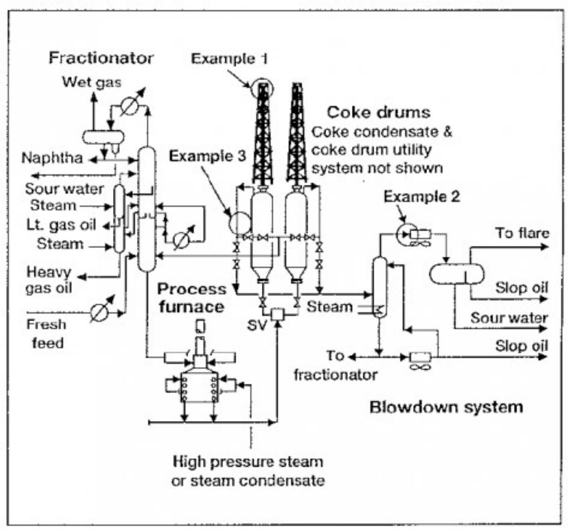
$LMTD2$: the requirement for the new service.

As long as $Q2$ is less than or equal to $Q1$ and there is no problem with the metallurgy of the piece for the new heating/cooling fluids or with their flows or ΔP, one can put the heat exchanger to work expecting a reasonably good operation.

Luis Guillermo Rios
Project Engineer
Polimeros Colombianos S.A.
Medellin, Colombia S.A.

Change the figure!

Fig. 1 of "Assure delayed coker safety" (March 1992, p. 109) needs to be clarified and corrected.



1. The identification of Examples 1 and 3 should be indicated. As printed, all "Examples" were shown as "Example 2."
2. For clarity and correction, add or change various flow directions.
3. The fractionator should be indicated with a total draw pan at the heavy gas oil product draw.
4. Releases from the blowdown system that are labeled "Stop oil" should be correctly labeled "Slop oil."

Gordon H. Stockman, P.E.
PetroCarbon
Pearland, Texas

Landfill as option to recycling

In reference to the March 1992 Editorial, p.15, on recy-

$Q2 = Q1\,(U2/U1)\,(LMTD2/LMTD1)$

In which one knows everything in the right side:

cling magazines and recycling in general, you may wish to consider the following option—a specialized landfill.

Many products are not recycled due to market condi-

WongWYLettertoEditor.HCP9205.png - Size: 1.02MB