# Interoffice Communication

To R. J. Reusch, Chemicals Research, Ponca City

From M. H. Lewis

Date January 18, 1980

Subject PREMATURE FAILURE OF PVC REACTOR RELIEF SYSTEMS

In the past, several of the safety relief systems on Conoco PVC reactors have failed prematurely, resulting in VCM emission to the atmosphere. Of the two configurations presently used, the double rupture disc arrangement was found to be less effective in preventing premature releases of VCM as compared to the rupture disc/relief valve setup. However, neither arrangement has proven to be 100 percent reliable in controlling VCM emission upon premature failure of the primary rupture disc. Discussions earlier in the year with BS&B Safety Systems, Inc. generated several ideas for preventive measures which were later carried out in the plants. In November 1979, consideration was given to the idea of changing all double disc setups to rupture disc/relief valve arrangements. The idea was accepted in December. Two experimental test programs were then drawn up to determine the configuration and optimum spacing required between the rupture disc and relief valve to contain the VCM upon premature failure of the primary disc. One of the tests was designed for BS&B and the other for Conoco R&D. The following report summarizes the progress made in December 1979.

Experimental Test Program

A joint meeting dealing with the premature failure of PVC reactor relief systems was held December 4, 1979, with Process Engineering Department personnel. In that meeting, the decision to change all double rupture disc setups to rupture disc/relief valve arrangements was confirmed. Also, an experimental test program for BS&B Safety Systems, Inc. was reviewed. The test program, which was drawn up by R&D, proposed two basic rupture disc/relief valve arrangements to prevent the premature release of VCM from Conoco's PVC reactors. Initially, testing of a 6" or 8" relief system was considered, but because of the limited size of BS&B's test facility (120-gallon vessel), a 3" rupture disc/3"x5" relief valve system was decided upon. Although the ability to scale up to larger sizes from the results obtained from the 3" relief system is questionable, the data collected should provide a good starting point for further work.

On December 10, 1979, the attached experimental test program was presented to BS&B at their Tulsa office.

BS&B not only agreed to carry out the experimental test program at no cost but also agreed to provide rupture discs and safety holders for additional testing by Conoco at no cost. In addition, BS&B volunteered to perform another series of tests based upon the results of the first.

A meeting between BS&B, Consolidated Valve, and Conoco was held on December 18, 1979, in Tulsa to finalize plans for the experimental test program. Consolidated Valve personnel were present and were willing to provide (at no cost) pressure gauges and relief valves for the experimental tests. The test program should begin January 22, 1980, with the following people present: George Lowrey (Dresser-Consolidated), Bob Lowrey (Dresser-Consolidated), John Strelow (BS&B), and Max Lewis (Conoco). The data from these tests should give Conoco a better understanding of the effects of the following variables on premature failures: (1) the space allotted between the rupture disc and relief valve, (2) a tee/elbow arrangement between the rupture disc and relief valve, and (3) the angle of the relief valve.

Premature Disc Failure

The reason for premature disc failure is still under investigation. During the past month, six 6-inch and seven 8-inch rupture discs, which which were taken out of service a couple of months ago, were tested by BS&B for their burst pressure. Although PVC buildup was found on several of the 6-inch discs, all broke within disc specification. However, of the seven 8-inch discs tested, four broke below the 5 percent tolerance limit. Further investigation showed that two of these discs that failed prematurely were from a double disc arrangement on the D-301 reactor, and the other two were from a double disc arrangement on the D-302 reactor. This may indicate that the premature failure of the four 8-inch rupture discs should be attributed to disc installation or setup, rather than to faulty disc manufacture. According to BS&B, crown damage is the most probable cause of premature disc failure. However, the alignment and weight of exhaust piping on the relief system can cause uneven stressing of the disc and also result in premature failure. The valve vendors were likewise concerned about the effect of exhaust piping on the relief valve.

The rupturing of four 8-inch rupture discs designated for Conoco PVC plants was witnessed while in Tulsa on December 18, 1979. The discs were rated for 206 psi at 72°F. The four discs burst at 204, 204, 198, and 202 psi--all within the 5 percent tolerance limit.

Recommendations

If desired in the future, BS&B will provide rupture discs that meet the ASME code. They will also provide strip chart recordings of the temperature and pressure experienced during the tests conducted to meet the ASME code. It is recommended that Conoco should purchase only ASME coded discs from BS&B. Although the quality of the ASME

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coded disc would not necessarily be superior to the disc now purchased, the presence of coded discs on the PVC reactors would be to Conoco's advantage if court action resulted from a premature failure. It is also recommended that all safety relief valves on PVC reactors be oriented vertically to assure proper functioning of the valve and that the feasability of altering the exhaust pipe be considered.

Heat Up

In documenting the premature failure of rupture discs on PVC reactors, Duane Lewis found that most premature failures occurred during heat-up (IOC of September 24, 1979). By viewing the polymerization reaction in the 50-gallon reactor during heat-up, it was found that the vapor space disappeared. As the contents of the reactor were heated, the vapor above the mixture became entrained into the liquid, the vortex disappeared, and the whole liquid surface rose inside the reactor. Also during heat-up, the torque on the agitator blades decreased as a result of the vapor entrainment. Whether or not this same phenomenon occurs in the large commercial reactors is not known. However, if it does, the presence of a liquid in the reactor dome would help to explain why the relief valve opens and then fails to close upon premature disc failure.

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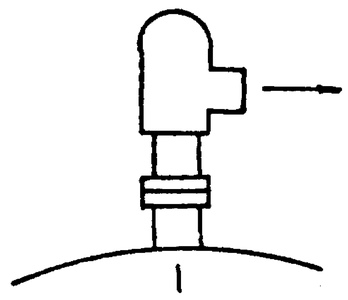
BSAB TEST PROGRAM

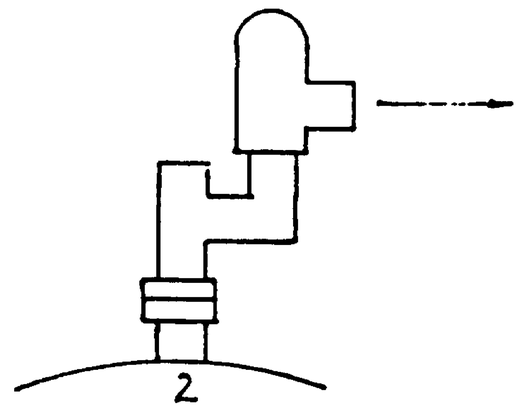
RUPTURE DISC/RELIEF VALVE SYSTEM

PRESSURE -200 PSI

TEMPERATURE -50°F

Basic Configurations




I. Spacing between disc and valve

Configuration 1

| Space (Pipe Diameters) | Disc Rating (Psi) / Valve Rating (Psi) | Test No. |
|---|---|---|
| 2 | 0.70 | 1 |
| 2 | 0.80 | 2 |
| 2 | 0.90 | 3 |
| 7 | 0.70 | 4 |
| 7 | 0.80 | 5 |
| 7 | 0.90 | 6 |
| 4 | 0.70 | 7 |
| 4 | 0.80 | 8 |
| 4 | 0.90 | 9 |
| 6 | 0.70 | 10 |
| 6 | 0.80 | 11 |
| 6 | 0.90 | 12 |

Configuration 2

| Space Past Elbow (Pipe Diameter) | Disc Rating (Psi) / Valve Rating (Psi) | Test No. |
|---|---|---|
| 0 | 0.70 | 13 |
| 0 | 0.80 | 14 |
| 0 | 0.90 | 15 |
| 3 | 0.70 | 16 |
| 3 | 0.80 | 17 |
| 3 | 0.90 | 18 |
| 2 | 0.70 | 19 |
| 2 | 0.80 | 20 |
| 2 | 0.90 | 21 |

II. Angle of Relief Valve

Use the pipe diameter spacing that successfully contained the rupture in Phase 1, Configuration 1.

| Spacing (Pipe Diameters) | Angle | Disc Rating (Psi) / Valve Rating (Psi) | Test No. |
|---|---|---|---|
| To be determined | 30° | 0.70 | 22 |
| To be determined | 30° | 0.80 | 23 |
| To be determined | 30° | 0.90 | 24 |