PVC RESEARCH AND PLANT MEETING

MEMPHIS, TENNESSEE

NOVEMBER 15-16, 1979

RUPTURE DISC STUDIES

D. J. LEWIS

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I. Reactors

We have been seeing an excessive number of premature disc failures on the PVC reactors. The discs we are now using are a reverse buckling, pre-scored type. We operate typically at 70-80 percent of the disc rating and are not seeing any apparent fatigue problems. A documentation of this problem has been completed and three factors associated with premature disc failure have appeared:

A. The majority of the failures occurred during production of 5305 resin.

B. A particular 4-inch disc under a 4" x 6" relief valve on the reactor shell seems to be prone to failure.

C. Most failures occurred during heat up.

This problem has been discussed with the rupture disc manufacturer, BS&B. They stated that the two most common causes of premature failure are: 1) inadequate torquing of the disc flanges, and 2) damage to the disc during handling and installation. Other factors which reduced the disc rating slightly were severe over-torquing or uneven torquing of the disc flanges. They also stated one instance where equipment vibration caused premature failure. The following recommendations were issued to the plants:

A. Be sure that all plant maintenance personnel have had seminar training concerning rupture discs (BS&B will do this on our request).

B. Each time a disc is put into service on a reactor, the reactor should be hydrotested to 90 percent of the disc rating (~170 psig). Any routine hydrotesting should also be to 90 percent of disc rating. An operations supervisor should observe each test.

C. Inspect discs regularly for PVC buildup.

D. A maintenance supervisor should observe the installation of every disc.

E. Use a torque wrench when installing discs to insure that minimum torquing specifications are met.

F. Install maximum readout pressure gauges between discs and on the reactor.

G. When an unfailed disc is taken out of service, the seat area should be inspected for uneven depth of "bite" (from uneven torquing) and for slippage (from inadequate torquing). Each of these discs should also be placed in a test stand and the actual burst pressure recorded.

H. Accurate records should be kept of each disc changeout and should include dates of service, and observations on the seat area, and the burst pressure recorded at the test stand.

All rupture discs on the reactors are used either under a relief valve or under a secondary disc. The secondary device, however, has not been containing the process upon premature failure of the primary disc. A test program is currently being arranged with BS&B to study this. The program will include separating two rupture discs by 0, 2, 4, and 8 pipe diameters and by placing a tee between them. The rating of the primary disc will be varied from 70 to 100 percent of the rating of the secondary disc.

II. Initiator Bomb Safety

Concern has arisen as to whether the initiator bombs have adequate relief area. Of particular concern is the case where the vessel is filled with catalyst and surrounded by fire. The manufacturer of the initiators was contacted and provided the following information.

A. Summary of Initiator Behavior (L-223, L-188, L-11, L-10)

1. The initiators do not detonate, and therefore, it is possible to control the violence of a decomposition by venting.

2. The initiators do not auto-ignite, but the decomposition products are extremely flammable.

3. L-11 decomposition is much more violent than that of L-223, L-188, and L-10.

4. Dilution of the initiators (say with OMS) helps "tame" the decomposition.

5. Small-scale testing indicates that the greater the loading (by volume) of a vessel, the greater the pressure generated upon decomposition.

6. The effect of dilution is greater than the effect of loading.

7. The effect of a water phase present may be to help control the decomposition.

B. Conclusions

The manufacturer has done some low pressure rupture disc testing (up to 45 psi) in full-scale vessels (6, 18, and 32-gallon). They found that a vent ratio of 1 in^2/gallon was probably the minimum that would be required to relieve safely. This corresponds to a 4-inch disc on a 12-gallon bomb. At higher rupture disc ratings, however, this minimum vent ratio is expected to increase, but just how much is not known. Lucidol also experienced a "second pulse" pressure several minutes after the disc failed. It is believed that this was caused by decompotision of the initiator which remained in the bomb after the initial relief. It was Lucidol's experience that this "second pulse" was greater than the original pulse. Again, it is not known how a 300 psi disc will affect this sequence. This data is sufficient to provide several conclusions concerning the relief devices on our initiator bombs.

1. Initiator bomb modifications should be made so that at least the minimum relief area (1 in^2/gal) is provided.

2. It may be necessary to employ a bottom-mounted relief device in order to empty the bomb and avoid a second pulse.

C. Recommendations

1. Short Term

   a. Aberdeen

      1) Dilute L-11 to 50 percent assay with OMS.

      2) Partially fill bomb with water prior to loading initiator.

      3) Replace safety valves with largest rupture discs possible.

      4) Install valves on the bottoms of the bombs which will open in fire conditions.

      5) Review fire fighting procedures (considering second pulse phenomena).

      6) Secure bombs to withstand second pulse reaction force.

b. Oklahoma City

1) Replace 2-inch discs with 4-inch rupture discs.

2) Partially fill bomb with water prior to loading initiator.

3) Install valves on the bottoms of the bombs which will open in fire conditions.

4) Review fire fighting procedures (considering second pulse phenomena).

5) Secure bombs to withstand second pulse reaction forces.

2. Long Term

a. Run sufficient small and large-scale testing to design an adequate relief system.

b. Consider a plant layout where the initiator charge bombs are isolated.

c. Consider other means of initiator additions.

Small-scale testing is currently underway. Full-scale testing is also planned.

Lucidol has recently completed the first phase of the small-scale test program. This test has examined the violence of decomposition of initiators placed in a 20 ml, unvented bomb and heated at 20°C/min. The effects of loading and assay were of particular interest. Lucidol has issued a report on this phase containing the following results:

1) Lupersol 11 is the most hazardous, followed by Lupersols 10-M75, 188-M75, and 223-M75 respectively.

2) Because of the pressures generated upon decomposition, L-11 could not be tested at greater than 65 percent assay with 50 percent loading.

3) The rate-of-pressure-rise increases exponentially when either assay or loading density is increased.

4) An increase in either loading or assay produces a higher maximum temperature.

5) It is expected that, due to conduction and mixing phenomena, a much greater rate of pressure rise

would be produced in a small thermal bomb than in a larger vessel. Large-scale tests have shown that loading density has a small effect on the rate of pressure rise within the vessel.

6) Although Lupersol 11 undergoes a violent decomposition, the reaction is greatly mitigated by dilution. Luperson 11 at 55 percent assay is comparable to Luperson 223 at 75 percent assay.

Lucidol is now prepared to begin additional small-scale testing using 300 psi rupture discs. The effects of a water phase being present will also be examined. This testing will be carried out using the peroxide composition of our choice. This should be the most hazardous material we are willing to employ. The information gathered in this first phase of testing should provide the information for this decision.

The data issued with Lucidol's report is attached.