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# Interoffice Communication



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Subject Reactor PSV Set Pressures


## SUMMARY

Reactor reliefs for Conoco PVC reactors have been simulated using a recently modified Reactor Relief Simulation Program. The new version incorporates changes to the compressible flow relief valve model. These new simulations were performed to evaluate the feasibility of increasing the PSV set points to the same pressure as the corresponding rupture discs. The simulations indicated the maximum reactor overpressures for normal initiator loadings would only be one to eight psi higher than the lower PSV setpoint cases. The maximum percentage overpressure was 6.8 percent. This falls well within the ASME code requirement of 16 percent maximum overpressure for multiple relief device instllations.

We are recommending all PVC reactor relief valve set points be raised to the corresponding rupture disc burst pressure. We feel the minimal increase in simulated overpressure is outweighed by the decreased possibility of a VCM release. This action would also reduce the quantity of a release, should one occur, because the PSV would reseat at a higher pressure.


## BACKGROUND

The original relief systems on the large reactors consisted of two rupture disc/relief valve combinations and one double rupture disc assembly. The relief valves were calibrated with a set pressure ten psi lower than its corresponding rupture disc burst pressure. This was intended to insure that the disc would fully open and prevent a restriction caused by a partially open disc. It would also allow the relief valve to be more fully open and be relieving at its maximum rate at a lower actual reactor pressure.

When the decision was made to evaluate replacing the double rupture disc assemblies, PED decided to develop a PVC reactor relief simulation program to assist in the evaluation. Putting relief valves on all relief lines would reduce the possibility of a premature disc failure causing a relief and also would limit the amount of any release. The relief program developed by Mark Whitney and Walt Finch uses Kang Yang's reaction kinetics which pilot plant and large reactor data have proven to give reasonable and conservative results. A homogenious flow model was chosen for the program where the composition of the relief stream was the same as the

BACKGROUND (CONTINUED)

composition in the reactor. Relief system flow rates were calculated using a method suggested by Siegfried Richter. The program followed API recommended guidelines for sizing two-phase flow relief valves and iterated until the flow matched the actual relief valve flow area.

The program as developed had and continues to have several limitations that require a careful analysis of the results before making decisions. The two-phase flow equations recommended by API and used in the program are generally thought to be conservative but not much data is available to support that conclusion. The program calculates reactor temperatures and pressures based on a kinetic model and assumes cooling has been lost but the reaction continues. Generally, loss of cooling is caused by a power failure which shuts down the cooling water pumps. In a power failure the reactor agitators would also stop and the reactor contents would probably separate into separate phases. If this were to occur, the water in the reactor could be less effective as a heat sink and the reaction could proceed quicker than expected. The program does not include allowances for this effect since the kinetic equations are not known. The program also does not predict the effects of rupture disc fouling on the process side. This is known to occur but it is not known how it would affect relief flow rates through the nozzle.

Based on these unknowns, it was decided to try to replace the double discs with the number of relief valves required to duplicate the double rupture disc relieving conditions and the corresponding maximum reactor relief pressure. The double rupture disc system had existed for several years and had successfully prevented excessive reactor overpressures. The program results indicated it would take several relief valves and probably would require more than the available room on the reactor to install them. Each valve would require a rupture disc and would increase the probability of a premature rupture disc failure causing a VCM release. Therefore, it was decided to accept a minimal increase in simulated overpressure and to replace the double rupture discs based on relieving area; two "T" orifice 8" by 10" valves were added.

PREMATURE RUPTURE DISC FAILURE

Several premature failures of rupture discs have occurred in our plants, some of which have resulted in reportable VCM releases. This has been a major problem and a program has been established to solve it. Vendor demonstrations were arranged which indicated a bursting rupture disc could momentarily open a relief valve at a pressure as low as 70 percent of the valve set pressure. Conoco's reactors typically operate at pressures above 70 percent of the lowest relief valve setting. Low molecular weight resins are produced at about 85 percent of the PSV setting.

PREMATURE RUPTURE DISC FAILURE (CONTINUED)

There is much interest in raising the relief valve set points to match the rupture disc set points to minimize the risks of causing a release. One of the concerns about taking this action has been a question about whether the rupture disc would fully open if the relief valve were set at the same pressure. Since there is a manufacturing tolerance of five percent on the rupture disc burst pressures, it would be possible for the PSV to not open at the same time the rupture disc burst. However, BS&B has stated that a prescored reverse buckling S-90 disc, when burst at its set pressure, should fully open regardless of whether or not the relief valve opens. L. B. Magruder, A Du Pont rupture disc specialist, has offered the same opinion. In fact, Du Pont typically designs all new installations to have the same RD/PSV set points. A bench test at the Oklahoma City plant has confirmed that the rupture disc will fully open.

A recent survey by the Vinyl Chloride Safety Association (issued September 13, 1982) did not establish an industry consensus of opinion on the subject of PSV set points. Some producers used equal set pressures; some set the relief valve pressures lower than the rupture disc pressures. The survey did compare reactor sizes and relief system components. For reactors larger than 14 M gallon, two producers (one being Georgia Pacific) have capacities quirte a bit higher than Conoco. However, we have learned Georgia Pacific has plans to reduce the number of PSV's they use, presumably to minimize opportunities for releases. This change would give them lower relief capacity than Conoco. Air Products have about the same capacity as we do. Three other producers, including Huuls, have lower relief capacities. We think we have higher reactor productivity than other producers and thus probably have higher initiator loadings which could require a higher relief system capacity. Given all the uncertainties in the survey we can only conclude that our relief system capacity is comparable to others. There does not appear to be sufficient reason to prevent changing PSV set points if the relief system capacity is adequate.

NEW SIMULATIONS

PED has spent many man-months in the development and documentation of the relief simulation computer program. Much effort has been expended to insure reasonably accurate and consistent results. Additional relief system design information has been obtained at a recent Design Institute for Emergency Relief Systems (DIERS) meeting. This data has been incorporated in the most recent version of the program. The changes from the previous version are discussed in the Appendix.

The relief valve flow model used (modified API) has been discussed with both Du Pont and DIERS. At the time the original program was written, API was the best method available and felt to be conservative. After

NEW SIMULATIONS (CONTINUED)

extensive testing by DIERS, both Du Pont and DIERS recommend using a homogeneous equilibrium flow model or a homogeneous rate flow model. The rate model predicts areas approximately 20 percent less than the equilibrium model but is still always conservative. They felt the model we used is also conservative but they have not tested our particular flow model. Du Pont is sending a copy of their computer listing of the homogeneous rate model which we will evaluate.

The new version of the program has been used to evaluate the effects of increasing the PSV set points. Input data used in the previous simulations were repeated with this version to compare the results of the change. The reaction recipes used are shown in the attached Table I. Each of the conditions was simulated for cooling water failure at 10, 30, 50, and 70 percent conversion. The maximum reactor pressures for each case are given in Tables II through V. Data is supplied for both the old and new relief valve flow models and for the different PSV set point cases. The comparison indicates the maximum reactor pressures increase only one to eight psi. This should be considered reasonable and still falls well within the ASME requirements. We are recommending the PVC reactor PSV set points be raised to the corresponding rupture disc burst pressures.

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