



Loop - Slurry Reactor Pressure Relief Device

05/22/2008



Pressure Relief Device (PRD) Key Issues

- Improve the PRD reliability by eliminating material accumulation under the rupture disk
- Simplify the PRD installation by eliminating olefin-free isobutane (iC4) flush:
 - Eliminates flush fluid flow control instrumentation
 - Reduces operator job duties to monitor flush



Historical Perspective

Historical Data (approximate as of Oct. 2002)

- Loop-Slurry Reactors - Worldwide
 - 2,261 reactor operating years without a catastrophic failure due to overpressure.
- PE Loop-Slurry Reactors - Pasadena
 - Since 1990 over 600,000 reactor operating hours
 - Zero overpressure events where the pressure relief system did not function as designed

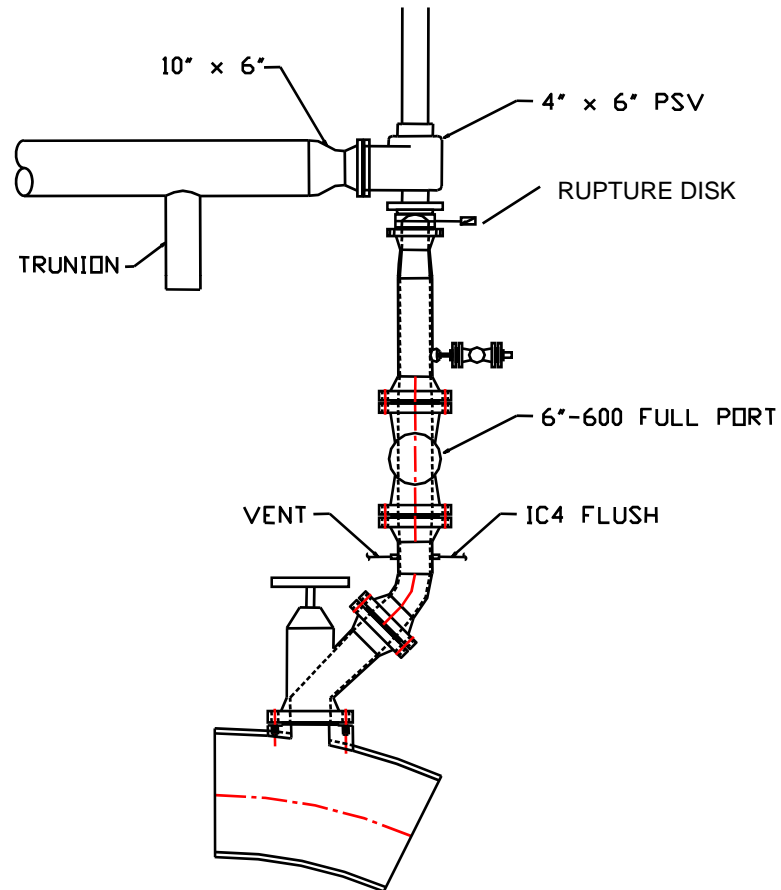
The original pressure relief device configuration has functioned reliably over many operating years.

Industry Practices

- Worldwide survey of pressure relief systems on loop-slurry reactors revealed:
- Pressure relief systems with PSV as primary relief device → 100%
- Pressure relief systems with rupture disks only → 0%
- Pressure relief systems venting to atmosphere only → 50%
- Pressure relief systems venting to flare → 50%

Approximately 60% of industry reactors and 85% of operating years were represented in the survey.

Typical PRD Installation



Typical Installation

Typical PRD Installation



Rupture
Disk

PSV
4N6



October 2002

Ram
Valve

iC4
Flush

Ball
Valve



Material Accumulation Under Rupture Disk

- Discovered material accumulation in relief piping under rupture disk in June 2002
- Relief system on each loop reactor was disassembled and physically examined
- Interim measures were implemented
 - Increased olefin free flush
 - Increased frequency of PSV inspections
 - SOP changes to monitor and maintain flush

Material Accumulation Under Rupture Disk

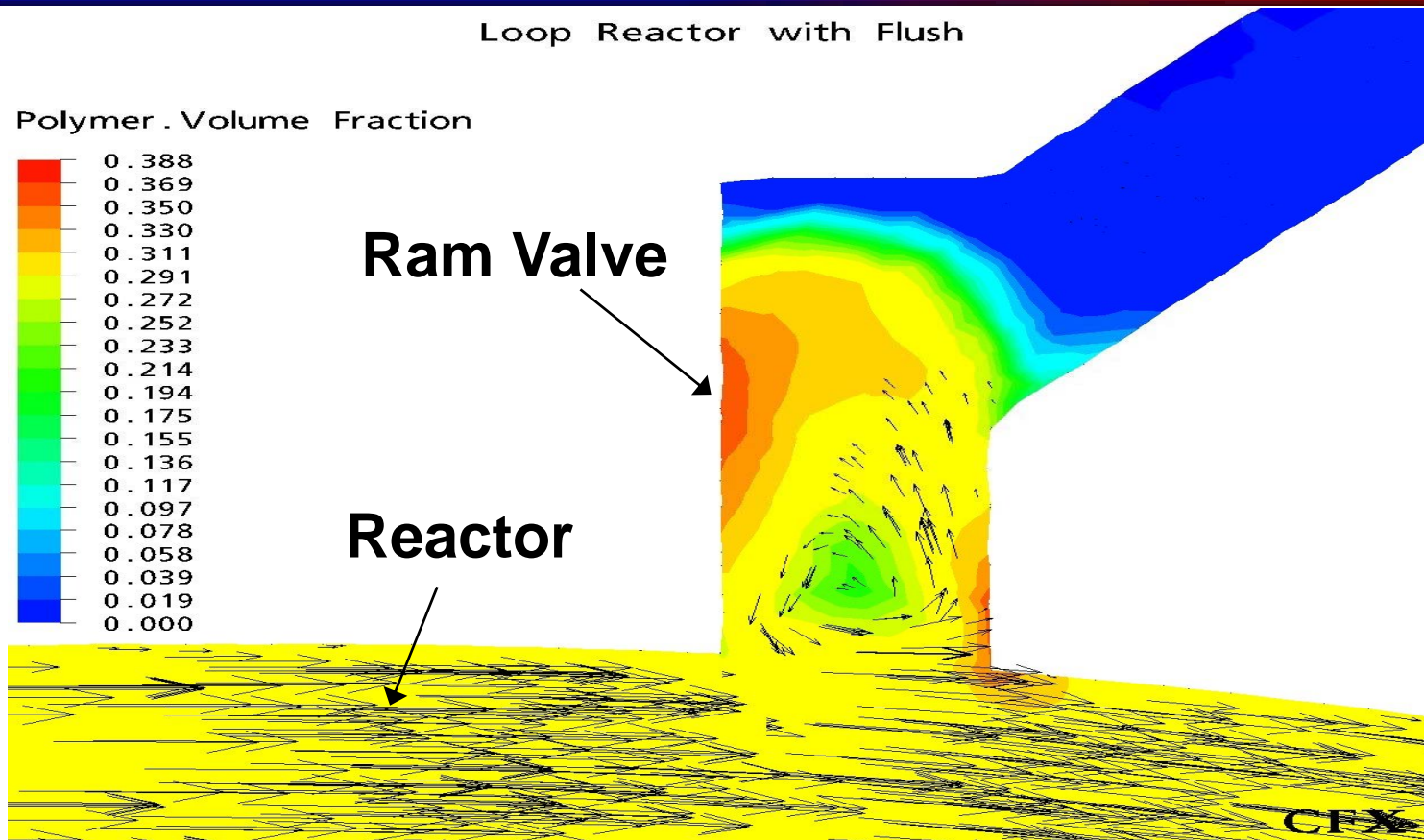


Inlet Pipe



Rupture Disk

Flow Patterns in Original PRD Inlet Piping



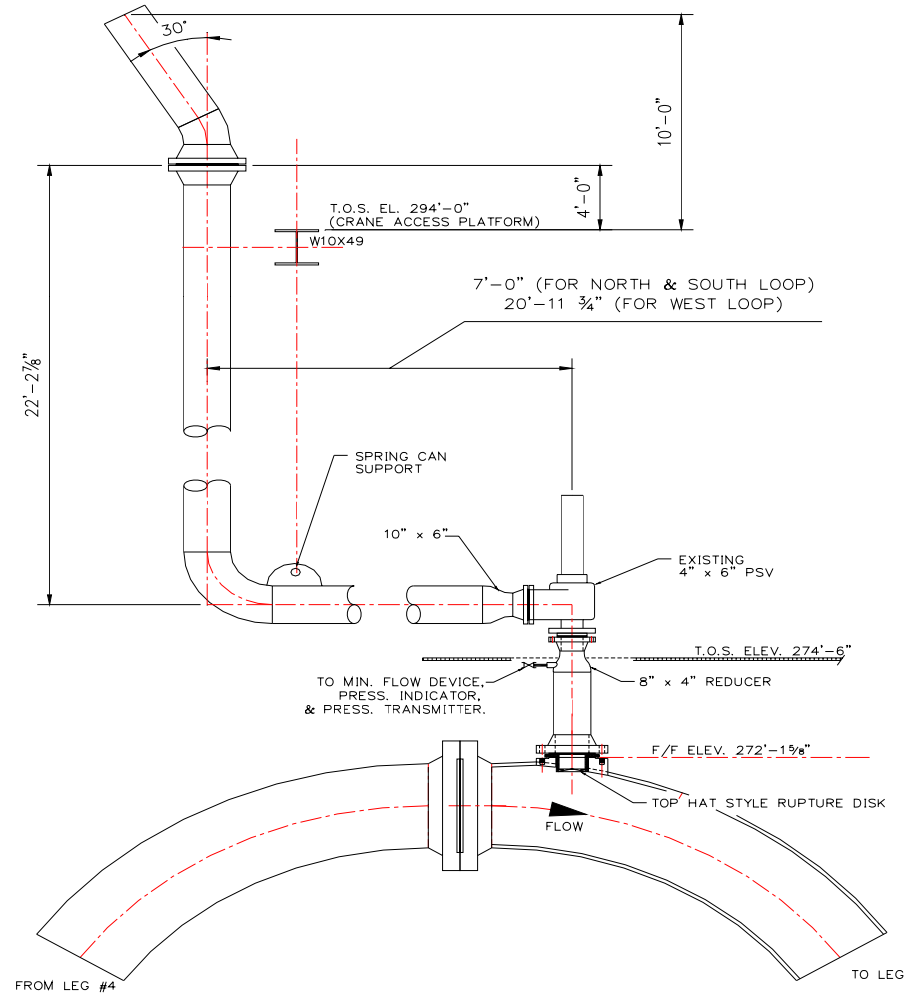
Computational Fluid Dynamics (CFD) simulations show eddies carrying material into the ram valve.



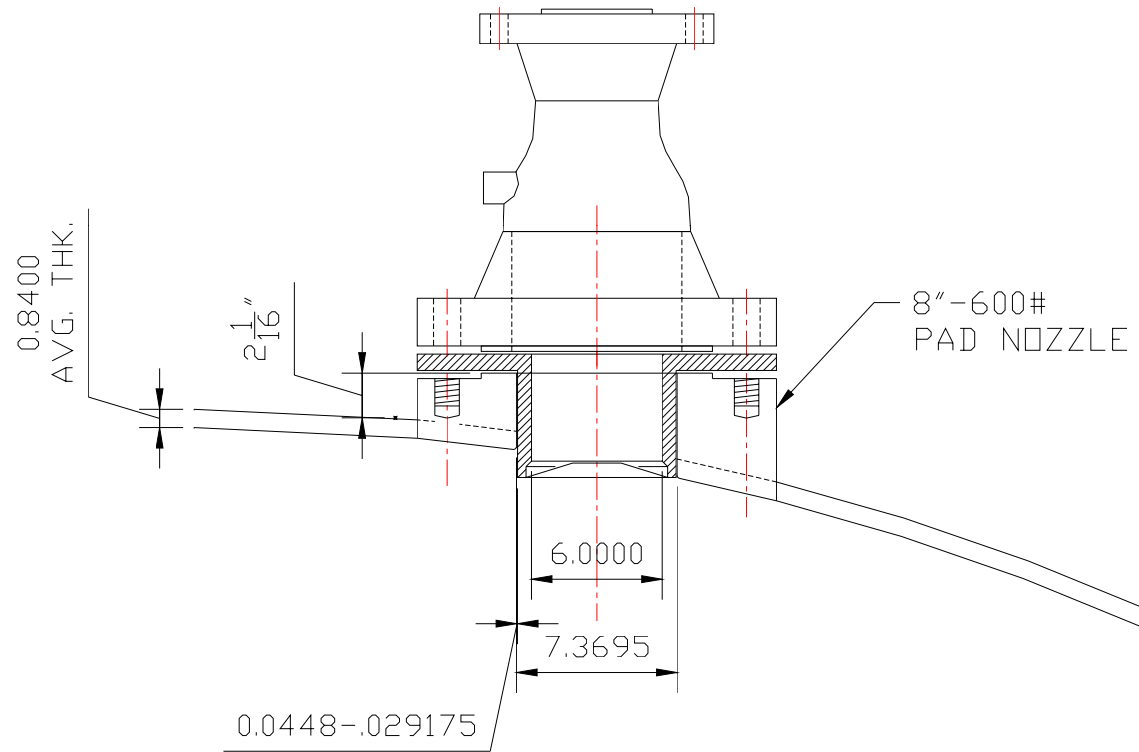
Reliability Improvements

- “Top Hat” rupture disk design adopted to prevent material accumulation in PRD inlet piping
- Inlet piping revised to minimize inlet pressure drop
- Specified liquid trim relief valve to minimize valve “chatter”
- Eliminated requirement for olefin free isobutane flush

PSV – Top Hat Rupture Disk Combination



Top Hat Rupture Disk Assembly



NOZZLE DETAIL

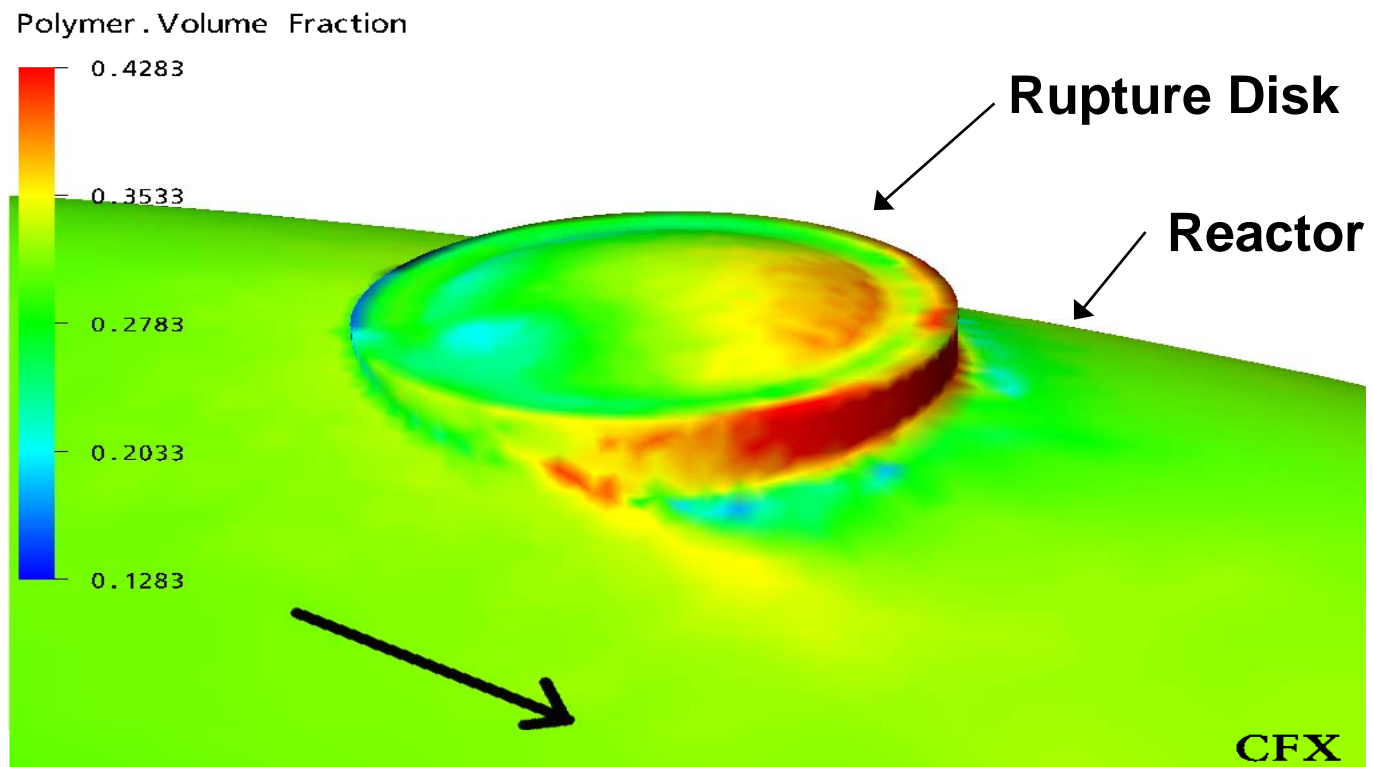
Rupture Disk Simulations

Computational Fluid Dynamics (CFD) was used to evaluate the performance of a top hat rupture disk:

- 6-Inch Rupture Disk in a 7.5” OD Holder.
- Positioned both Upstream and Downstream of center flange at top-of-loop.
- Both images have scale of 0.1283 - 0.4283 Volume Fraction Polymer.
- Both simulations have inlet concentration at 0.2783 Volume Fraction Polymer

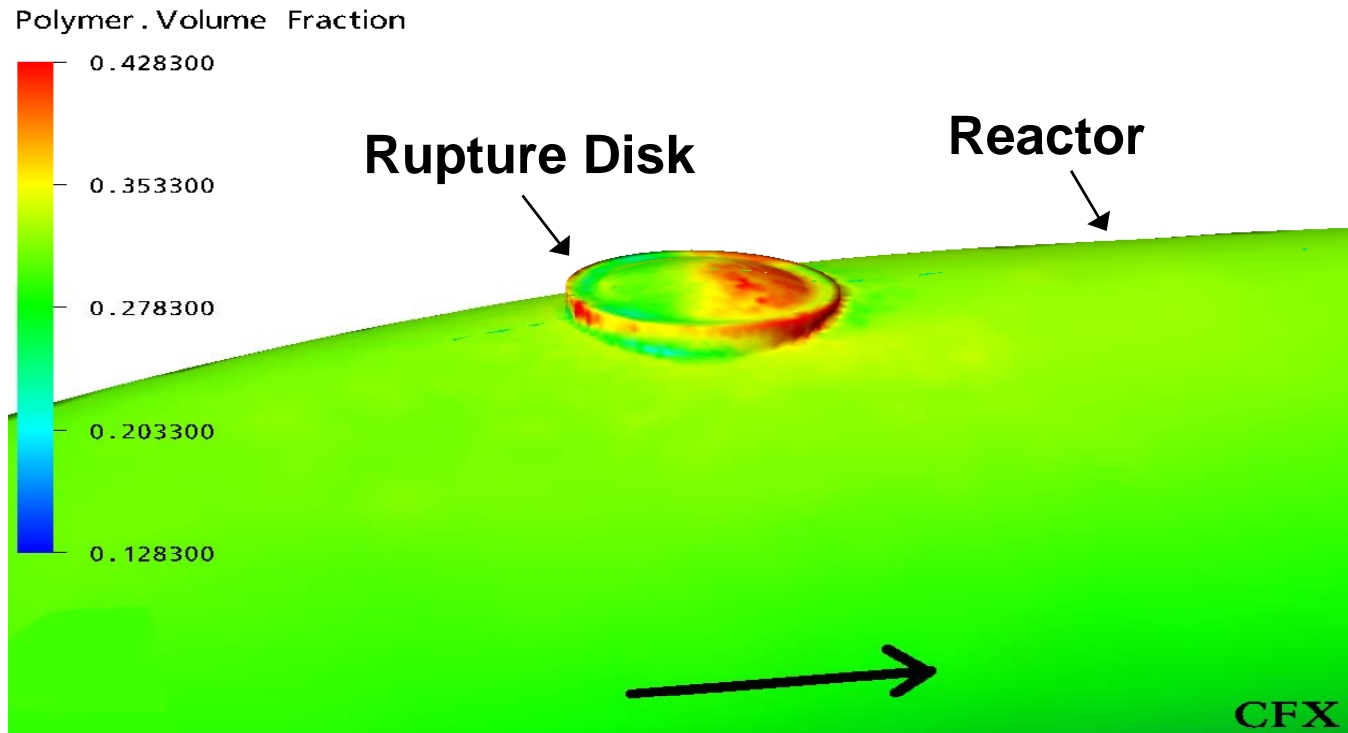
CFD Model Result

6-Inch Rupture Disk



CFD Model Result

Rupture Disk 6-inch Upstream





CFD Simulation Conclusions

- Flush-mounted with disk protruding into the reactor is better than a flush-mounted with disk outside of the reactor.
- Minor differences in accumulation (<5%) predicted between Upstream and Downstream positions.
- Larger disks have greater accumulation than smaller disks.
- Flush mounted disks are “swept” clean of polymer accumulation by loop-slurry flow

Top Hat Rupture Disk Inspection

Service duration: Nov. 2002 thru Oct. 2003



No material accumulation found on top hat rupture disk after 11 months in service.

Summary

- Installation of Top Hat rupture disks flush with reactor inside wall has eliminated material accumulation under the pressure relief valve
- Minimizing the reactor inlet piping minimized the inlet pressure drop
- The new configuration does not require olefin-free isobutane flush