

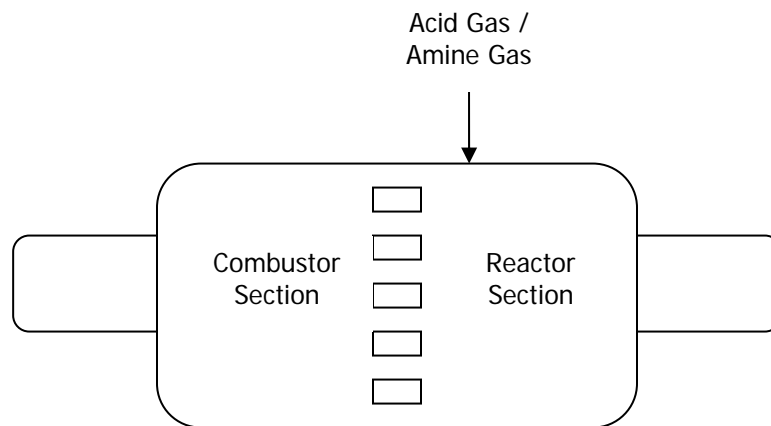
## Memorandum

From:	Edward M. Marszal
To:	Professional Staff, Technical Memo File
CC:	
Re:	SRU Thermal Reactor Backflow Scenario
Date:	28 May 2005
Reference:	TM003.emm
Keywords:	

During the course of recent project work Kenexis became aware of a potential hazard in sulfur recovery units that may exist in a significant number of standard SRU designs, but is not typically safeguarded against. This hazard should be considered and presented to the project team on all future SRU SIS design basis development projects or any other risk analyses of SRU.

### Scenario:

A typical SRU design will include reactor vessel that includes both a combustor section and a reactor section. The acid gas / amine gas feed is routed into the reactor section which is operating at very high temperatures ( $>>1000$  F). The schematic below gives a rough presentation of the equipment layout.



For certain designs, in certain operating circumstances, there is a potential for backflow from the Reactor Section into the acid gas / amine gas line. This scenario could result in a significant hazard. If backflow were to occur for a prolonged period of time, the high temperatures of the reactor section would be transferred into the acid gas / amine gas piping, which may not be designed to withstand the high temperatures of the reactor section (carbon steel piping is not uncommon in this service). These high temperatures could result in mechanical damage to the piping and potential release of

the acid gas / amine gas which contains a high concentration of hydrogen sulfide and is extremely toxic.

This scenario can occur if the pressure at the reactor suddenly becomes higher than the feed pressure resulting in reverse flow. This situation is not uncommon, and can occur as the result of upstream equipment (such as the amine regenerator) being de-pressured to the flare system. Some SRU designs are more resistant to this type of backflow than others, but all SRU should be critically analyzed to determine whether or not this type of hazard can exist. One refinery reported that this reverse flow situation has occurred three times over a 10 year time span. The first occurrence resulted in overheating of the inlet piping which was visually identified by an operator making his rounds prior to a release event. The other two occurrences were mitigated with a SIF that injects cooling nitrogen into the amine gas / acid gas inlet piping when high temperatures were detected.

Recommendation:

All SRU units that are under risk analysis should be critically reviewed to determine whether or not reverse flow from the reactor is a credible scenario, and whether or not this scenario can result in a significant consequence. If this scenario poses significant risk, several engineered safeguards should be considered, including the following:

- High temperature alarms on the amine gas / acid gas inlet piping
- Mechanical means for backflow prevention (non-return check valves)
- A SIF that injects cooling nitrogen (or other inert gas) into the acid gas / amine gas piping
- A SIF that prevents backflow through valve closures
- A combination of the above engineered safeguards, as required