

TUBE AND PIPING FAILURE

Localized overheating resulted in rupture
of air piping and a subsequent fire

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This report covers the failure of tubes and adjacent air piping in two parallel air preheaters operating in a reformer section of a small ammonia synthesis plant. The preheater tube failures produced localized overheating which resulted in rupture of air piping and a subsequent fire.

The preheater tubes are bayonet type construction and are located in the reformed gas header downstream of the secondary reformer, such that the reformer gas is used to preheat the air feedstream to the secondary reformer.

The tube failure occurred after approximately three years of service. There were no personnel injuries as result of the rupture and fire but equipment in the preheater section was significantly damaged because leakage occurred during a start-up following a normal shut-down. Had the leak occurred during a period of normal operation, it is quite probable that the abnormal operating conditions would have been detected early enough to effect a systematic shut-down thus preventing the rupture and fire.

Damage was limited to the air preheater itself and to the stainless steel gas header, and to the over-heated 4 in. air-line.

Complications with repairs

Repairs were complicated by the fact that approximately 8 feet

of the stainless steel tubes melted and dropped as a huge mass into the stainless steel lined reformer gas header. This mass was responsible for blocking the reformer gas line and caused the pressure buildup which resulted in reverse flow and combustion inside the air-line. This combustion generated temperatures to a point of air-line failure.

Prompt shutdown action on the part of operating personnel limited damage and prevented further fires.

Corrective measures taken involved changing of the metallurgy of the tube along with increased frequency of inspections, as well as periodic pressure testing of the air preheater tubes. In addition, temperature measurements and alarm devices for early warning of possible leakage have been installed.

Metallurgical analyses by two independent laboratories on samples of the failed tubes resulted in conflicting reports as to cause of the failure. At any rate, the failure of the tube was in the form of metal cracking along the heat affected zone, along the welds, as well as transversely across the weld itself. These were the welds at the hottest points of the bayonet type tubes where approximately 1,500 F. process gas contacted the tubes.