# LIQUID OXYGEN PUMP FAILURES

A bearing failed; the impeller of the pump came in contact with the pump casing; an oxygen booster pump exploded

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This report covers the oxygen pump failures at Airco - Huron, Ohio on Saturday, May 21, 1966 and Monday, May 23, 1966.

The first incident was caused by the ignition of the pump parts. Examination of the pump indicated that an impeller rub resulted from a thrust bearing failure. The front shroud of the impeller had rubbed the volute casing creating sufficient heat to cause ignition. This rub was caused by the pump shaft moving axially toward the pump suction as a result of a ball bearing failure. This bearing failure has been attributed to rust and or water in the lubricant. Apparently, this accumulation of water was a result of either improper storage of the unit prior to installation, or a defect in the design which allowed breathing of air (moisture) into the lubricant during temperature changes.

The failure of this equipment caused minor personal injury - one person was slightly injured, requiring hospital treatment, but was released on the same day.

## Standby found unsatisfactory

After this failure, the standby pump was inspected and its condition was found unsatisfactory. A bearing failure in this pump would also have made it possible for the impeller to come in contact with the pump volute casing. The manufacturer then supplied a new, modified pump so that a thrust bearing failure would not cause the impeller to move forward. This new unit failed after a few seconds of operation on Monday, May 23, 1966.

The second failure has been the subject of some confusion. Preliminary reports indicated the failure to be similar to the first incident. Fortunately, no one was injured.

Analysis of the liquid oxygen in the storage tank verified plant analytical instruments that it was of excellent purity.

The thrust bearing in the newly designed pump did not fail and the axial position of the pump impeller was maintained. This leads to the conclusion that some foreign object entered the pump suction, passed through the inducer and impeller and became lodged between the front impeller shroud and the volute casing. This created a rub which caused enough heat for ignition. This foreign object could have been a piece of weld slag or something similar. It never was recovered, or identified.

Both damaged units were shipped back to the manufacturer.

To provide backup protection for the customer during these periods, a reciprocating pump, approximately one-half the capacity of the centrifugals, was installed on May 26, 1966.

## Steel barrier plate installed

Two more centrifugals were sent by the manufacturer and installed. To isolate all the operating valves from the pump, a steel barrier plate was installed. This was done to protect operating personnel.

These new units were modified by the manufacturer to provide a greater clearance between the impeller and the pump volute casing. A locking device on the end of the shaft was installed to prevent forward axial movement of the shaft in case of a thrust bearing failure. The set screw which held the impeller inducer on the shaft was changed to a higher strength stainless steel. In addition to these modifications, the units were pretested in oxygen service by the manufacturer prior to their shipment.

Another test for vibration and performance of these units was carried out upon their arrival at the plant site. The motor and gear on Unit No. 1 indicated an excessive vibration level - 5.4 to 5.7 mills. A dynamic balance was performed which reduced this vibration level to approximately ½ mill. At present, these pumps are operational.

The pump units described are installed on a liquid oxygen backup system, and was so designed that upon interruptions to the main air separation plant, the backup system would come on automatically to supply oxygen to the customer. This backup facility consists of a low pressure liquid oxygen storage tank. The liquid from the storage tank is pumped to 800 lb. sq.in. by a centrifugal pump. This pressurized liquid is then vaporized by a steam heated vaporizer and fed to the customer. To provide sufficient time for the liquid system to become operational, there is a bank of 2,400 lb/sq.in. gauge ASME tubes. These 30 ASME tubes are kept at pressure by a high pressure liquid oxygen pump. The pumping rate is 26,000 std. cu.ft./hr. at 2,400 lb./ sq.in. gauge.