

DISTANCE PIECE EXPLOSION

Practice of using only two bolts on the distance piece cover may have averted a more serious incident

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A hydrogen explosion occurred in the packing gland area of a large reciprocating compressor during a piston rod failure. The ensuing fire was quickly extinguished and fortunately no one was injured, although one man had a close call. He was narrowly missed by the distance piece cover which was thrown some 25 feet by the explosion.

The first indication of this incident which occurred on January 3, 1966, was a very loud "knock" coming from the west compressor. For orientation purposes, we have two 4,500 hp, 8 cylinder reciprocating compressors mounted side by side pumping nitrogen in 4 cylinders, synthesis gas in 3 cylinders and raw hydrogen in the remaining. The foreman who was nearby attempted to shut the machine down but was unable to do so because of an inoperative switch. He left the floor to use the alternate circuit and consequently some 30 seconds elapsed before the machine was shut down.

The area operator and his assistant also heard the "knock" from a more distant position and, hurrying, reached the floor about the time the compressor was being shut down. They heard a loud report and saw a cloud of white smoke above the second synthesis gas cylinder and the cover plate flying through the air over the motor enclosure. As a matter of fact, this cover plate, which is 16 in. x 13 in. and weighs 47 pounds, landed at the feet of the assistant operator who was the nearest to this cylinder.

As soon as it was determined that it was safe to approach the compressor, steps were taken to put out the fire which could be seen shooting out of the cylinder packing gland and at the vent in the distance piece.

What the investigation showed

The investigation of this incident proved to be real interesting for reasons that will soon become apparent. The following mechanical damage was found on the compressor:

1. The wiper packing at the distance piece to bed section was loose and damaged.
2. The cross head slippers were sheared off the cross head and in pieces.
3. The cross head was distorted.
4. The bottom bed section was chewed up and had to be replaced.
5. Piston nut was loose.
6. Cylinder packing was damaged.

Based upon these findings, we could not arrive at a completely satisfactory explanation. The most likely causes advanced were:

1. A loose piston nut - The nut may have struck the cylinder head with sufficient force to cause shearing of the slipper bolts. (This was later disproved by computer analysis.)
2. Slipper failure - A portion of the top slipper broke off and wedged the bottom slipper causing it to shear. Resultant whip of cross head caused remainder of top slipper to shear. Slipper failure was result of casting flaw or unknown stress.

Piston rod in two pieces

A week later the cross head was cut open to remove the piston rod which originally had resisted all efforts to detach and much to our surprise the rod was found in two pieces. The cause of this failure was then obvious. The piston rod had failed, pulled out of the cross head, struck it causing the slippers to fail, destroyed the packing, and then in that one in a million shot slipped back in the cross head. Its already mushroomed end acted as a wedge, thus explaining why we could not remove it out of the cross head. The position of the break points to a loose locking rod nut which allowed the piston rod to flex. We are unable to fully explain why the nut should loosen at this time since the machine ran for four months after the nut had been last removed during a piston ring replacement. Our work procedures cover proper tightening and include a check for tightness after the machine has been put back on line. We also have a Magnafixing program to detect early signs of piston rod failure.

Turning to the explosion, we feel that when the piston rod failed it dropped down and distorted the packing which allowed the synthesis gas to escape into this pocket within the distance piece. This area allows access to the rod packing and the cover generally was held in place by two bolts. It has a small vent at the bottom of the pocket that leads into the stack to control any build-up of normal packing gland leakage. As this pocket is not purged, air is usually present and consequently the leaking synthesis gas formed an explosive mixture which was ignited by a hot surface possibly the wiper steel casing.

Two bolts saved serious loss

In retrospect our practice of using only two bolts on the distance piece cover may have averted a more serious incident. Its being blown off the compressor acted somewhat as a safety disc and allowed the gas pressure to escape out in the open where it simply burned. The confinement offered by the cover plate with all ten bolts in place could have forced gas through the damaged wiper packing into the main bed section where it would come in contact with quantities of air and oil. The chances of a serious explosion would then be considerably enhanced.

We investigated the pros and cons of replacing these covers and using a nitrogen purge to sweep out the air or leaving the covers off all together. Either step would minimize chances of an explosion reoccurring but the first step would not eliminate the possibility of forcing gas into the compressor bed section, however, remote it might be. We also find it advantageous at times to have ready access to the packing. For these reasons we have removed these covers from all cylinders where it was possible. Incidentally, we had already made it a practice to leave them off the nitrogen cylinders. On the ram cylinder because of configuration this is not possible so a continuous nitrogen purge has been installed and the cover is a light plastic. Incidentally, the compressor building is quite open with excellent ventilation.