



**KOREA OCCUPATIONAL SAFETY & HEALTH AGENCY**

## **INVESTIGATION REPORT**

### **Explosion in Compressor Operating Panel**



**Ulsan, Korea  
September , 2004**

#### **KEY ISSUES:**

- **Hydrogen trespass through nitrogen line for panel purge**
- **Inadequate design of purge line and inadequate pre-start-up review**

## ABSTRACT

● This report explains the explosion that occurred on September 20th, 2004 in a Polypropylene(P.P) Plant, Ulsan, Korea. The explosion was arisen due to hydrogen trespass through nitrogen line for compressor panel purge. Nitrogen was supplied to purge compressor suction part and also to pressurize compressor panel inside from the same header. After the replacement of compressor inside valves nitrogen purge line was not exactly blocked, and high pressure hydrogen trespassed in the compressor operating panel through the purge line according to compressor run and the explosion finally occurred in panel. Two employees were killed on the spot, and the plant was down. The key safety issues covered in this report were how to design the purge line and to perform proper pre-startup review. Recommendations concerning this issue were delivered to P.P Plant.

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## 1.0 INTRODUCTION



**Figure 1: Damaged compressor operating panel cover after explosion(weight about 60kg)**

## 1.1 BACKGROUND

On September, 2004, a explosion was occurred in a compressor operating panel in a P.P (Polypropylene) Plant, Ulsan, Korea. Two employees were killed on the spot, the panel was damaged itself. Because of the serious nature of the incident, the Korea Occupational Safety and Health Agency initiated an incident investigation. The purpose of the investigation was to identify the root causes of the incident and make recommendations to prevent similar incidents.

## 1.2 INVESTIGATION PROCESS

The KOSHA investigation team conducted an on-site investigation from September 20 to September 22, 2004. The scope of the investigation team was to examine and analyze the circumstances of the explosion to learn what happened, and to attempt to determine the cause of the incident. The team evaluated the process design, operating procedures, maintenance procedures, pre-start-up reviews, purge line design and operating procedures and safety management systems to determine their adequacy in controlling the cause of this explosion. The ultimate objective of this

investigation was to develop recommendations to help prevent similar incidents.

The team used the following investigation methodology adapted to address overlapping roles and responsibilities of other agencies investigating this incident. Facts were compiled by examining evidence at the incident site, conducting interviews, and reviewing documentation. To minimize duplication of effort, the team used the information collected by other agency to the maximum extent practical.

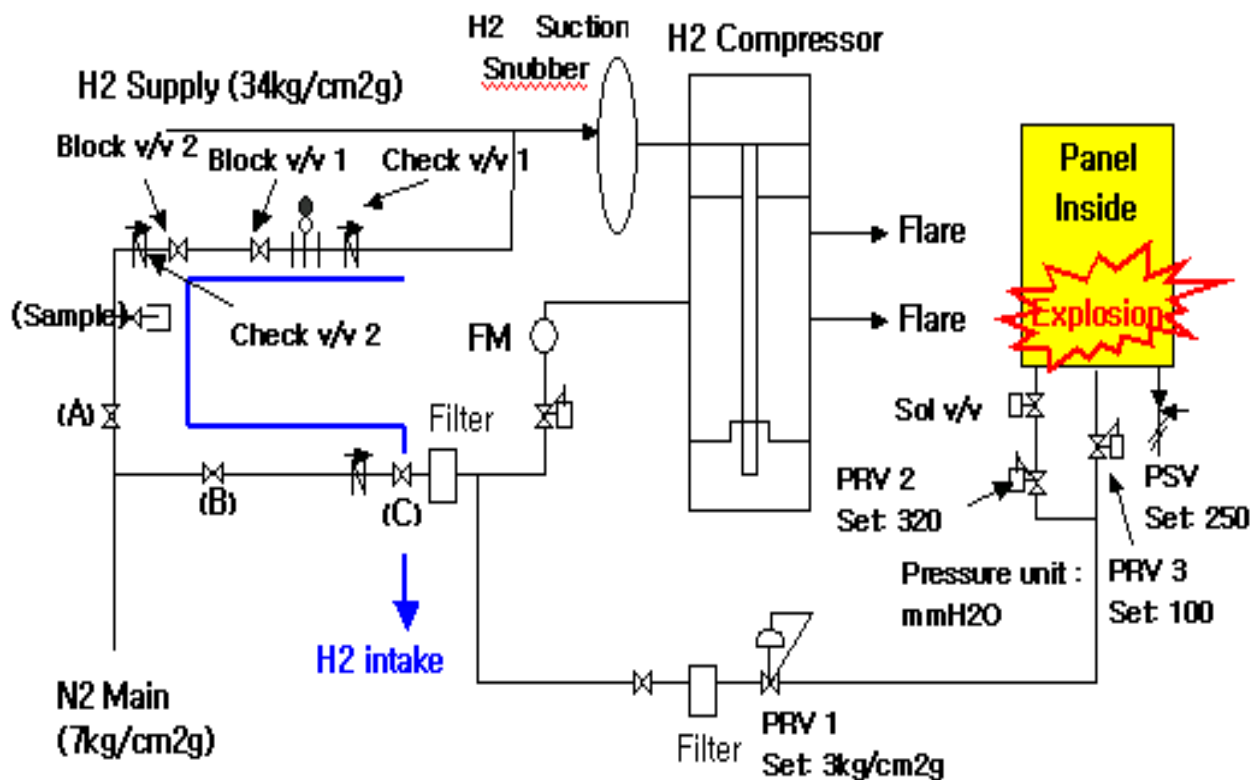


Fig. 2 : Schematic Drawing of incident

## 2.0 INCIDENT ANALYSIS

### 2.1 Description

In the morning of September, 2004 a explosion was occurred in a compressor operating panel in a P.P (Polypropylene) Plant, Ulsan, Korea. Two employees were killed on the spot, the panel was damaged itself. The explosion was arisen due to high pressure hydrogen trespass through nitrogen line for compressor panel purge. Nitrogen was supplied to purge compressor suction part during the maintenance period and also to pressurize and hold positive pressure compressor operating panel inside from the same header. And when nitrogen valve was opened to purge compressor suction part to replace the compressor inside valves, nitrogen valve connected to compressor operating panel was closed by mistake. So compressor operating panel inside finally remained in atmosphere and air entered in panel through openings.

After the replacement of compressor inside valves nitrogen purge line was not exactly blocked. Between compressor suction part and N2 header line two check valves and two gate valves and a globe valve and a spectacle blind was installed but two check valves passed, two gate valves(valve 1,2) opened, a globe valve passed, a spectacle blind unused. And high pressure hydrogen trespassed in the compressor operating panel through the nitrogen purge line according to compressor running and the explosion finally occurred in panel by electric sparks.



**Fig. 3: Impact mark on the adjacent drum by exploded compressor panel cover**



**Fig. 4 : Nitrogen purge line of compressor suction part**

**(Between compressor suction snubber and N2 header line check v/v 1 , blind, gate v/v 1, globe v/v, check v/v 2, gate v/v 2 were installed but check 1, 2 passed, gate v/v 1,2 opened, globe v/v passed, blind unused )**

### **3.0 Results of Investigation**

#### **3.1 Purge line Design Evaluation**

After the maintenance of compressor suction part N2 purge line should be blinded but a spectacle blind was not used because it was located in back of a check valve that is easy to be passed, and nitrogen for compressor operating panel purge was supplied from the same line that was used for the purge of high pressure hydrogen parts. Generally purge gas of an electric panel to hold positive pressure is instrument air.

#### **3.2 H2 Concentration Measure Result and Purge line leak test Result**

H2 concentration was indicated as the following in the nitrogen purge line connected to nitrogen compressor operating panel at the incident day.

- 5.4 vol % at 15:00
- 2.84 vol % at 17:20

And this actually shows the trespass of H<sub>2</sub> from compressor suction snubber. The leak test results of all valves of between N<sub>2</sub> header line and compressor suction snubber showed the same results, and two check valve was passed, blind unused, two gate valve opened, a globe valve passed.

### **3.3 Pre-start-up reviews Evaluation**

After the maintenance of compressor suction part all valves was not closed and only a valve passed was closed but pre-start-up reviews of purge line was not exactly performed.

## **4.0 ROOT CAUSE**

### **4.1 Inadequate Design of Purge line**

A spectacle blind was located in back of a check valve that is easy to be passed, and purge gas for compressor operating panel purge was not instrument air but nitrogen supplied from the same line that was used for the purge of high pressure hydrogen parts.

### **4.2 Inadequate Pre-start-up reviews**

Compressor suction part all valves to be blocked was not closed and only a valve passed was closed but pre-start-up reviews of purge line was not exactly performed.

### **4.3 Inspection of valves not performed**

Two check valve and a globe valve passed but any inspection was not performed.



## **5.0 RECOMMENDATIONS**

### **5.1 Purge line rearrangement**

A spectacle blind should be located in back of a block valve so that N2 purge line should be blinded after the maintenance of compressor suction part, and purge gas to hold positive pressure in an electric panel is recommended to change instrument air instead of nitrogen gas.

### **5.2 A thorough Pre-start-up reviews**

Pre-start-up reviews should be exactly performed after any change.