RISK AND OPPORTUNITY STUDY IN HYDROGEN GENERATION PLANT

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ABSTRACT

The Hazards and safety of hydrogen generation facilities is the main concern in this study. This study was conducted to identify the hazards and evaluate the risks of machine operation in a hydrogen generation plant. The study was conducted in the hydrogen production unit of NTECL (1500MW) in the year 2018.The project site is located near village Kuruvimedu in Ponneri Taluk of Thiruvallur District, Chennai. The Hazard identification and risk assessment in machine operation like filling/re-filling, loading/Unloading cylinders and to move the cylinders from one place to another place were identified and effective control measures were identified/implemented. In the process of risk assessment, the records of the accidents and plant flow diagrams were also studied.

Keywords: *Hydrogen Generation plant, Risk assessment, Hazard identification*

1. INTRODUCTION:

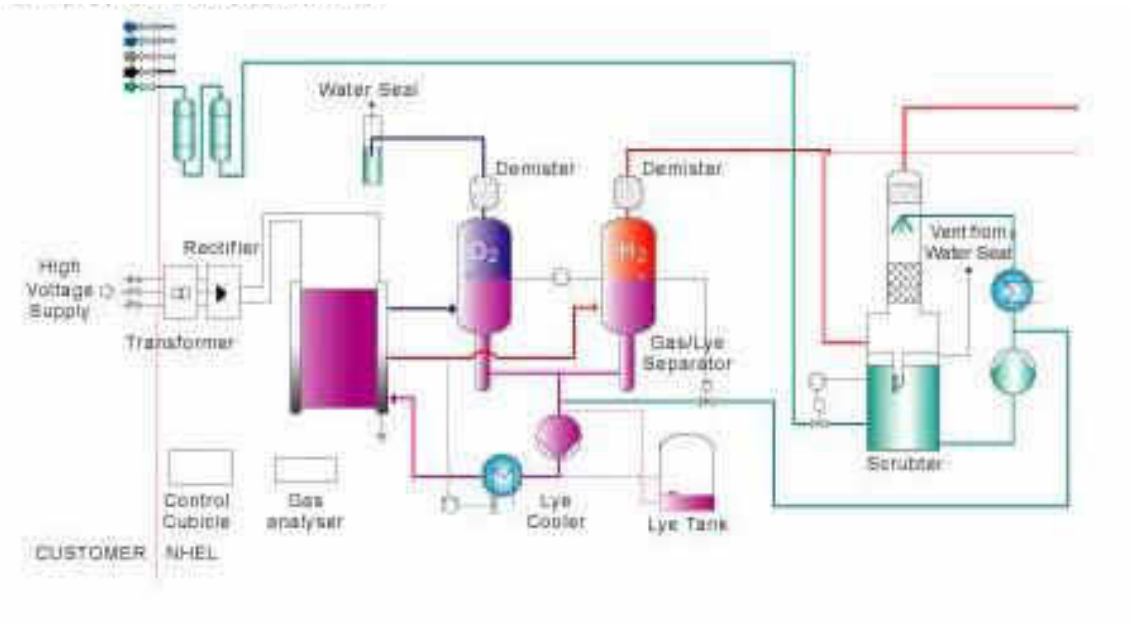
Nowadays, many countries are increasingly trying to establish the full commercialization of hydrogen technologies. They want to diversify energy resources and raise their economic growth with the development of environmentally friendly renewable energy sources. The industry's relationship with the material, dangerous products and manufacturing processes, usually have been the causes of many historical events. In the process of generating, storage, transmission and consumption of hydrogen, the safety of the process is the main issue. US Energy Database Department has collected 190 hydrogen incidents from 1995 to 2011 which plots the image of the subject [1]. Hazard identification and risk assessment is systematic approach to protect the health and minimize danger to life, property and environment.

The objective of this study was to identify hazards in the hydrogen generation plant and corrective actions to reduce the risks, were suggested.

2. HYDROGEN GENERATION UNIT:

The study was carried out in Hydrogen generation unit of NTECL-NTPC TAMILNADU ENERGY COMPANY LIMITED (NTECL), which is currently setting up Vallur Thermal Power Project (VTPP) near Chennai with 2 × 500 MW under Phase – I and 500 mw in Phase – II in 1184

acres of land. This project site is located near village Kuruvimedu in Ponneri Taluk of Thiruvallur District, Chennai.



2.1 DESCRIPTION OF HYDROGEN GENERATION UNIT:

The Hydrogen generation unit was divided into 4 main nodes.

- Hydrogen Generator
- Compression
- Purging system
- Hydrogen Gas filling unit and
- Other areas

2.1.1 HYDROGEN GENERATOR:

The Hydrogen generator unit has three generators in a single room, which was closely located near each generators. This generator unit was designed complicated, to fill up KOH in the KOH container, which is near to feed water pump, electrolyser and the gas separation containers. Earthing for each generators were commonly connected with one earth raiser. Only two roof ventilators and hydrogen leak detectors are there.

2.1.2 COMPRESSOR UNIT:

The produced hydrogen will after being dried and purified, is transferred to the compression unit where it will be compressed to about 150 bar. The compressor unit has three compressors, which was located very near to each other in a room. These compressors were connected with pipelines from generator and filling manifold, which is so complicated to reach one compressor in the time of emergency. Earthing for each compressors was commonly connected. Only two roof ventilators and hydrogen leak detectors are there.

2.1.3 PURGING SYSTEM:

Inert gas (N_2) purging systems, which is initiated manually in the filling station. Inert

gas purging systems is used during start up and shutdown and in emergency situations.

2.1.4 GAS FILLING STATION:

Gas filling station was divided into gas manifold area, cylinder drying rack, cylinder purging rack and cylinder storing rack

2.1.5 CYLINDER STORAGE YARD:

Storage yard is located outside from the hydrogen generation unit. Gas filled cylinders are stored in this yard.

2.1.6 CYLINDER TRANSPORTATION:

Hydrogen gas filled in cylinders were transported through vehicles from one to another place inside the units in NTECL.

2.1.7 ELECTRICAL SWITCHGEAR AREA:

AC and DC panel for this hydrogen generation unit is placed in switchgear area. AC panel supplies power for interior lighting and other sources. DC panel supplies 180 DC for hydrogen generator Electrolyser, which was rectified from AC panel (440 AC).

3. HAZARD IDENTIFICATION:

As described earlier, the Hydrogen generation unit was divided into 4 nodes. The more likely hazards for each node were identified and tabulated below (Table 1) [2].

Table 1:

Risk identification and suggestion for risk reducing measures

Node	Identified Hazards/risks	Suggested corrective actions for hazards/risks
Hydrogen Generator Unit	• No proper ventilation	• Ventilation diameter should be increased. • Exhaust motor should be 'ON' always. • More Ventilators can be fixed.
	• Naked DC power cable	• Cable lug should be fixed properly
	• Normal cable	• Fire retarder cable should be used
	• Normal light fittings	• Fire retardant lights should be used
	• No emergency push button in the entrance of generator area	• Master push button required
	• Inadequate earthing connection	• Individual earth connection should be given for each generator.
	• Improper cable laying	• Cable laying should be kept outside of the generator unit.
Compressor	• Power cable laid inside room	Cables should be fixed outside the room

Unit	• Fire retarded cables not used	Fire retarded cables should be used
	• Compressor emergency push button not available	Emergency push button should be fixed
	• Electrical panel erected inside room	Panel should be erected away from the compressor
	• Inadequate H_2 leak detector available	Sufficient number of leak detector should be fixed
	• Fire retarded floor not available	Fire retarded floors to be fixed to avoid the static electricity
	• H_2 I/O pipe lines not fixed properly	To be fixed properly
Purging System	• Manual purging system	Automated purging system should be implemented
Gas filling unit	• Fire retarded wall was not placed	Fire retarded wall to be fixed
	• Using Naked cable	Proper insulated cables to be used

4. RESULTS AND DISCUSSION:

The hazard identification of the study was analysed and tabulated above (Table 1). Corrective measures for those identified hazards were also recommended.

***Severity of Consequences*:**

Gas filling station has the highest severity of 4 among all studied identification. Though the gas filling station was most important area in hydrogen generation unit, there was no operators with process knowledge. Also, no trained supervisors. Proper training should be given to operators and supervisors to overcome high risks in the unit. Standard operating procedures to be displayed in the filling station for risk free processes.

Moreover, the hydrogen generation unit should possess Walls/fences around the units to reduce safety distances requirements, if they are designed so that flammable concentrations will not reach outside these fences. In design of such fences the following should be considered:

 Flow pattern, wake effects, increased probability of gas accumulation

 Larger probability of explosion or larger explosion pressure in case of ignition due to increased confinement

 Probability of flying debris in case of explosion

 Splint proof window panes

Risk Assessment:

In order to reduce all risks, it was recommended to follow the risk assessment methodology namely qualitative, semi-quantitative and quantitative methods, which have been developed and successfully applied to the industries.

5. CONCLUSION:

The risks of all focused areas in the present study were acceptable. The application of the proposed suggestions will significantly reduce all risks and will lead to a safe production in the hydrogen generation unit.

REFERENCES:

[1] US Department of Energy. Hydrogen Incident Reporting and Lessons Learned. Available online in: http://www.h2incident.org, (2011).

[2]Sandra Nilsen, Henrik Solgaard Andersen, Gerd P. Haugom, Harald Rikheim. EIHP2 project Contract: ENK6-CT2000-00442, DNV and Norsk Hydro ASA.