Research Paper Engineering

Hazard Analysis in Distribution Section of P-Lng using Hazop Methods

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ABSTRACT

All major processes for the production of Ammonia depend on the synthesis of its separate Nitrogen and Hydrogen components in about 1:3 ratio. The source for Nitrogen is air, while Hydrogen can be obtained from a variety of sources such as natural gas, water, oil refining products like Naphtha or residual oils, coal etc. This paper considers the propo sed feed switchover from Naphtha to Regasified Liquefied Natural Gas (R-LNG) in Ammonia production at Fertilisers and Chemicals Travancore (FACT) Udyogamandal, as a case study. R-LNG has a lower Carbon to Hydrogen Ratio (CHR), which reduces CO2 generation and makes the process environment friendly. Also R-LNG is cheaper compared to Naphtha, which reduces the cost of production and thereby increases the profitability. HAZOP (Hazards and operability study) is an appropriate tool to assess the safety of a system prior to proceeding with the detailed engineering and operation. The aim of the HAZOP study is to identify potential hazardous events and significant operability problems associated with the proposed operations at FACT. A detailed study was done to find all possible causes and consequences. These provided an in-depth knowledge of all possible combinations of undesired events or maloperations. Also this paper proposes necessary safety interlocks in the plant based on the HAZOP study.

KEYWORDS Regasified Liquefied Natural Gas; HAZOP;

Introduction

Traditional industrial automation supposes the operator responsibility on monitoring and controlling of processes in real time. As complexity of industrial processes increases, the need for remote controlling and monitoring from a central location increases also. This will make the operator function (monitor and control) easier and proficiently. Furthermore, aggregation of feedback data, which gives supervisors and management personnel the ability to monitor trends, forecast requirements, and optimizes procedures. A common term used to describing this solution is a PLC and SCADA system.

The Fertilizers and Chemicals Travancore Limited (FACT), Udhyogamandal has an Ammonia plant with an installed capacity of 900 MTPD of Ammonia. The Ammonia plant was based on Naphtha as feedstock, which acts as a source of Hydrogen, and the required Nitrogen is obtained from air. To reduce the cost of production and thereby increasing the profitability, FACT has decided to revamp the existing Ammonia plant for using Re-gasified Liquefied Natural Gas (R-LNG) as feed stock. The plant was originally designed based on steam reforming of naphtha and using naphtha as fuel. R-LNG is also used as fuel for various heaters, furnaces and boilers.

The LNG has more hydro carbon ratio than naphtha .When it is used as fuel there will be less particulate emissions. So, this method is pollution free and profitable. As part of the project requirements, a HAZOP (hazards and operability study) [1] is done. The aim of the HAZOP study is to identify potential hazardous events and significant operability problems associated with the proposed operations. Hazard and Operability analysis is a systematic procedure for determining the abnormal causes of process deviations from normal behavior and their adverse consequences in a chemical plant. After doing HAZOP study, next step is proposing safety interlocks using PLC in the plant.

PROCESS DESCRIPTION

The R-LNG supplied by Petronet is at the pressure of 45 Kg/cm2g and at 0oC temperature. This is the Battery limit condition of R-LNG. At the receiving section, R-LNG passes through a filter; it blocks all the unwanted particles. The R-LNG is then passed through a Custody Transfer Flow meter. It is then separated into fuel and feed section.

The fuel section has two stage heat exchangers. All of them are shell and tube type. A part of water from the Cooling-Water-Return-Header enters the tube side of the primary heat exchanger. The R-LNG [3] passes through the shell side of the heat exchangers. The outlet from the tube side is given to the basin of the Ammonia plant cooling tower. Total water requirement will be 170m3/hr. An additional raw water connection will be provided to all the exchangers to meet the requirement during shut down of Ammonia plant.

R-LNG from heat exchanger is passed through the pressure control valve and is converted to a pressure of 4.5 Kg/cm^{2}g at 13°C. An alarm is also provided to indicate if the temperature of the R-LNG goes below 10°C. The output of the valve is supplied to the second stage heat exchanger, where it is heated to a temperature of 30°C.

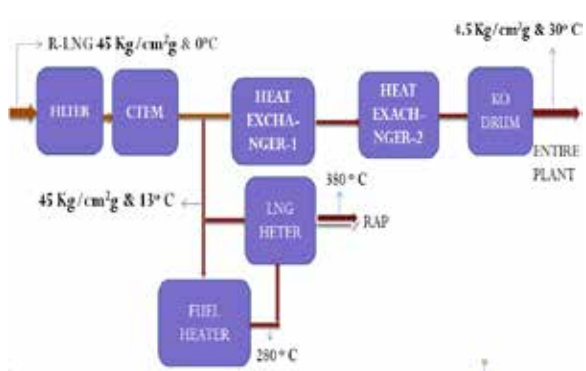


Fig 1. Process Block Diagram

The heat exchanger output is supplied to the Knock-out Drum to filter out the water contents in the stream. It is a vapor–liquid separator used in several industrial applications to separate a vapor–liquid mixture. For the common variety, gravity is utilized in a vertical vessel to cause the liquid to settle to the bottom of the vessel, where it is withdrawn. The outlet stream is at temperature 30°C and at pressure 4.5Kg/cm^{2}g. This stream is used as fuel in all sections of the plant.

The feed section is used for the production of ammonia. In this section, a fired heater is required to preheat natural gas from battery limit temp to 380°C. The R- LNG heater will be a natural draft type fired heater using natural gas as fuel. Depressurization to fuel gas pressure will result in significant reduction in temperature; therefore a fuel preheater is required to heat the LNG fuel around 280°C. Outlet of R-LNG heater is fed to the Ammonia production.

HAZOP ANALYSIS

HAZOP analysis is a kind of assessment method that can be used to identify design defects, process hazards and operability problems, which are based on an engineering system that can be used for qualitative analysis or quantitative evaluation. The analysis process is to divide the group process into a reasonable analysis node (or process unit) according to certain principles by professionals, and then to identify those potential dangerous deviations, which can also be used for determining the risks in production equipment and processes to seek the necessary measures. By analyzing the diversification of parameters in the process state and the possible biases in the operation control. Next, we must identify the reasons about those changes and deviation to find out the major risks in devices or systems, and the production process. Finally, measures should be taken to correct the changes and deviation. This is the core of HAZOP analysis technique.

HAZOP analysis is in the form of a series of meetings by a professional group, which analyse the problems in the device process and operational risk. The flowchart of the preparatory work and entire process are demonstrated in Figure 2.

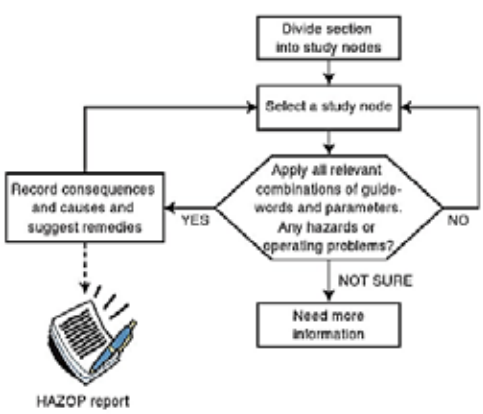


Fig 2. Analysis of the entire process

HAZOP analysis is usually carried out at the design stage, which is to determine the hazards and operational problems that exist in engineering and to take comprehensive measures to reduce the accidents caused by ill-considered. Analysing the special points called "the node" in the process or operation. By the way we can identify those potential dangerous deviations, which are leaded by guiding words (also known as keywords). One purpose of the use of guiding words is to ensure that analyse all the deviation parameters of the process and then analyse their possible causes, consequences.

Analysis node

For the continuous process, the object of HAZOP analysis [2] is to analyze the node or process unit. The first step is to divide the production process into reasonable nodes, which is made by the head of the HAZOP analysis. But the analysts should understand the principle of the node division, as it is conducive to in-depth analytical work. Anglicizing the node division should consider the specific function of the completion. Basic rules are as follows:

- Carry out based on the P&ID diagrams and process;
- Begin with the pipeline from the P&ID diagram;
- Until the next change of designing intent;
- Until the major changes in process conditions;
- Until the next device;

In addition, the division of the node must also consider the purpose of HAZOP analysis, reasonable border/cut-off point, the approach of dividing consistency and so on. It is important to keep it simple, because large and complex analysis of the node will increase the possibility of mistakes.

Determine deviation by guiding words

The following table for the commonly used guiding words and their meaning:

TABLE I. GUIDING WORDS AND THEIRMEANING

GUIDE WORLD	MEANING
None	Complete negation of intentions
More	Quantitative increase
Less	Quantitative decrease
As well as	A qualitative increase
Part of	A qualitative decrease
Reverse	The logical opposite of intention
Other than	Quantitative decrease

The most common method of determining bias is guiding words that are to identify meaningful deviation by the role of leading on the process parameters. The advantage of the method could ensure the uniformity of HAZOP analysis, [4] while the problem can be analyzed systematically. With a complete setting of guiding words, you can export all the possible deviation, without being missed.

TABLE II Example of HAZOP study in one node.

PROJECT: AUTOMATION OF RECEIVING AND DISTRIBUTION SECTION OF R-LNG IN AMMONIA PLANT				NODE: 1	PAGE:1
Node Description: FIRST STAGE HEAT EXCHANGER				DATE:	
GUIDE WORD	**DEVIATION**	**CAUSES**	**CONSEQUENCE**	**AVAILABLE SAFETY PROVISION**	**REMARKS**
NONE	FLOW	**Tube side:**	R-LNG temperature not increased	1. TT 5102 and low temperature alarm	Installation of flow meter and replace HCV to automatic control valve
		1. Failure of inlet heating water valve to open(HCV5101 OR HCV5102)			
		2. Heating water pump failure		2.Additional heating water is provided	
		3. No raw water			
		Shell side:	1. Plant will be shutdown.	1. FT 5101 and high , low flow alarm	Install a R-LNG storage tank in FACT division
		1. R- LNG not getting from Petronet			
		2. Petronet to HE pipeline rupture.	2. Form R-LNG vapour cloud		

The summary of analyzing

From the HAZOP study it was found that in built safety [5] measures are provided in distribution system for normal as well as an abnormal case. If the operator is vigilant, the possibility of a Hazard is nil. In HAZOP study some additional

safety remarks are also be included. It will increase the safety provision of the system. But in some case if the trip system is buy pass and safety provision are not working ,a failure can occur –extent events of earth quake ,fire near bye etc may be lead to catastrophic failure. Hazardous situation may arise by R-LNG lead into atmosphere due to flange leak, weld leak and seal failure etc. safety provision are adopted in the system to avoid leakage of LNG [3] in atmosphere. Include Hydro carbon detector at the cooling tower basin. This is to detect whether the hydro carbon has reach the basin. Safety relief outlets and vents are hooked to the flare stack header. Flare is continues in line with LPG OR LNG business on line. In case of any excess pressure vented to flare.

Conclusion

The ultimate aim HAZOP analyzing is to reduce the operational risk, that is, to reduce a variety of hazards in the production process, to lower various types of accidents, to avoid the personal injuries caused by traffic accidents, property losses, resource damages, environmental pollution and other losses in the water. This study gives an in-depth knowledge of all possible combinations of undesired events or

maloperations. This can help to serve as a guide for identifying a correct approach for handling the operational problems and combating them.

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