Hazard Identification And Risk Assessment of Cogeneration Power Plant in Chemical Industry

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Abstract- *The cogeneration power plant is a electricity generation unit in industries. This project deals with various types of hazards identification and finding a risk assessment in cogeneration power plant. It consists several processes by mean to generate electricity in industries by use of fossil fuel and consists of several major equipment and operation in this process. The operation of cogeneration power plant needs to identify the hazards, assess the risk and this risk bring to a tolerable level on a continuous basis. There are various unsafe conditions and various practices in various process and equipment of cogeneration power plant and it lead to a number of accident and which can cause injury to the human and damages to the property and interrupting the production. The purpose of hazard identification and risk assessment of cogeneration power plant in chemical industry is to identify chemical, physical, biological and environment hazard in the industry. It analyses the event sequences to those hazards and it calculate the frequency and the consequences of the hazardous events. The risk level is applied to each hazard to identifying the corrective action to minimize the risk and eliminate the hazard.*

Keywords- Cogeneration power plant; Risk matrix; Risk assessment; Hazard identification and risk assessment (HIRA).

I. INTRODUCTION

In this paper the risk is associated with the consequence effect and the frequency of failure. The present scenario of any industries to be successful it should to be meet not only the production requirement but also maintain and stable the safety standards for all concerned. The cogeneration power plant is susceptible to a wide range of hazards and processes in various operational areas.The hazard identification and risk assessment are the proper and best approach to protect the health and minimize danger to environment, property and life.

This paper highlight report on HIRA applied in the Cogeneration power plant, NAGDA (M.P). It involving the methodological steps to identifying the hazards related to the operation and condition and material. It assesses the risk level with risk matrix of hazards and apply the safety precaution and the corrective action to minimize the level of risk.

The hazard identification and risk assessment are to developed a Comprehensive source of events and risks. The hazard identification is the process of defining and describing a hazard, including its magnitude and severity, physical characteristic, causative factor, frequency and probability and location and area affected. There are five method of hazard identification that identified the hazards:

- Data from previous accident and case studies.
- Scenario development and judgement of knowledge individual.
- Generic hazard checklist.
- Formal hazard analysis techniques
- Design data and drawings.

When identifying the hazard present in the system, all effort and Safety precaution should be made to identifying and the whole universe of the potential hazard.

II. METHODOLOGY

The hazard identification and risk assessment is a combination of probabilistic, deterministic and quantitative method. In this the deterministic method taking into consideration the product, the qualification of various target such as equipment, environment and people. In this the quantitative methods analyses the various data numerically.

Risk analysis is about developing an understanding of the risk. It provides an input to decisions on whether risks need to be treated and the most appropriate and cost-effective risk treatment strategies. Risk analysis involves consideration of the sources of risk, their positive and negative consequences and the likelihood that those consequences may occur. Factors that affect consequences and likelihood may be identified. Risk is analysed by combining consequences and their likelihood. In most circumstances existing controls are taken into account. Risk analysis aims to establish an understanding of the level of risk and its nature. Aside from the absolute level of risk, analysis will help to set treatment priorities and options. The level of risk is determined by combining consequence and likelihood. Suitable scales and methods for combining them should be consistent with the criteria defined when establishing the context. For more technical analysis, the nature of the data and required output will dictate the required analysis methods

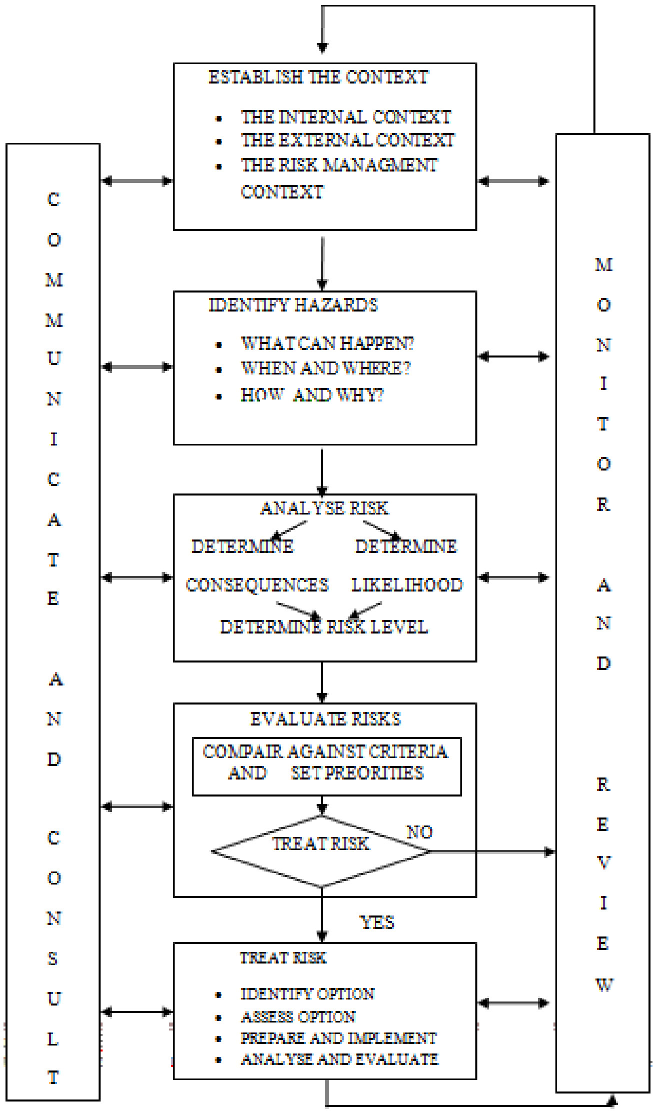

Fig:1 Methodology process

There are five step of hazard identification and risk assessment are-

Step1: Establish the context: Define the internal, external and the risk management context and their process and operations.

Step2: Identifying Hazard: Defining and describing a hazard, including its magnitude and severity, physical characteristics and causative factors or area affected.

Step3: Analyze Risk: Analyzing the consequences and likelihood and determine the risk level.

Step4: Evaluate Risk: Evaluating the risk classification table is formed and hazard or calculating the risk class gives the required safety precaution to be taken.

Step5: Treat and resolve the risk: Identifying the option, assess the option, prepare and implement, reducing or transferring the risks, by short- and long-term planning.

III. SYSTEM DESCRIPTION

Combined heat and power (CHP) or Cogeneration is the use of a power station and heat engine to generate electricity and useful heat at the same time. Combined cooling heat and power (CCHP) or Trigeneration refers to simultaneous generation of electricity and useful cooling and heating from combustion of a fuel and solar heat collector. The term Cogeneration or Trigeneration can also be applied to the power system simultaneously generating heat, electricity, and industrial chemicals (e.g.: syngas).

Cogeneration power plant is the electricity generation unit for the industry which converts fossil fuel energy to electrical energy by means of generating electricity. In other words, it is merely a chain of Energy conversion as follow:

- Chemical energy in the fuel is converted to Heat energy of steam
- Heat energy of steam is converted to Mechanical or rotating energy of a rotating wheel called Turbine.
- The mechanical energy of Turbine is converted as Electrical Energy in a Generator.

There are following operation and processes in Cogeneration power plant:

1. Boiler and furnace
2. Switch yard and Transformer
3. Steam turbine and generator
4. Biomass handling plant
5. Ash handling plant
6. Fuel storage tank / Pump house and battery
7. De-mineralized (DM) plant
8. Cable gallery

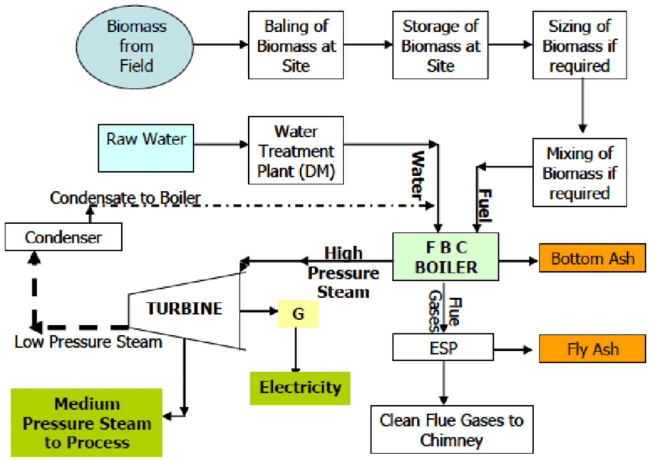

Fig:2 Cogeneration power plant

IV. DATA COLLECTED

Table 1.1: Hazards in Cogeneration Power Plant

Accidents	Number of accidents	Percentage (%)
Burn	5	17.86%
Fall from the height	6	21.43%
Slip & trip on the operational area	5	17.86%
Electrical burn	4	14.29%
Stroked by the object	3	10.71%
Electrical shock	1	3.57%
Accident by transport vehicles	1	3.56%
Other	3	10.71%

Hazard Identification in Cogeneration Power Plant

Table 1.2 Hazards in Turbine and Generator:

S.No	Hazard	Description
1.	Fire & Explosion	Explosion in turbine due to the cooling system failure, On cooling oil, Fire on cooling oil, Fire and explosion on the hydrogen tank.
2.	Equipment damage	Damage on generator due to the lack of lubrication in the coupling shaft.
3.	High noise level	Due to the operation and vibration of the equipment.

Table 1.3 Hazard in Boiler and furnace:

S.No	Hazard	Description
1.	Physical injury	Catches on the moving part of the machinery like motors and F.D fans.
2.	Burn injury	It is due to the hot steam pipeline leakage and the hot water. Exposure to the hot surface of the pipelines or machineries, by hot fly ash.
3.	Equipment damage	Rupture of the equipment body due to the over temperature and over pressure.
4.	Water tube burst	It is due to the failure in boiler water level control.
5.	Explosion in boiler	Due to the improper combustion of fuel, Inoperable trip system, due to the over pressure and temperature caused faulty gauge.
6.	Fire in diesel supply line	Due to leakage and over pressure rapture of pipe.
7.	Slip, Trip and Fall from the height	Due to maintenance or inspection, routine work, slippery surface, avoidance of PPE, Imbalance of the object or foot of the worker, Fallen structure etc.

Table 1.4 Hazards in Cable gallery:

S.No	Hazard	Description
1.	Cable room fire hazard	Overheating, and due to the electrical short circuit failure.

Table 1.5 Hazards in Biomass handling plant:

S.No	Hazard	Description
1.	Fall from height during work on conveyor belt and conveyor room etc.	Slippery surface, avoidance of PPE, Fallen structure and Imbalance of the object or foot of the worker.
2.	Transport line accident	Carelessness of driver and personnel can cause accident.
3.	Struck by falling object	Tools, wood pieces can fall from height of the operational area.
4.	Fire in Biomass storage area	The fire can occur in the biomass storage due to the excess environmental temperature in summer days and come in contact with the external fire and explosion.
5.	Injury during biomass handling like slip & trip	The various obstruct in the handling pathways of the workers.
6.	Catches on the conveyor belt	It is caused by loose clothing of the workers can be catch by the moving parts.
7.	Respiratory problems due to the Biomass dust	Very fine biomass dust can cause respiratory problems.

Table 1.6 Hazards in Ash handling plant:

S.No	Hazard	Description
1.	Fire hazard	It is due to the overheating, electrical short circuit or failure and ignition in accumulated biomass dust.

Table 1.7 Hazard in Hydrogen plant:

S.No	Hazard	Description
1.	Electrocution	Electrodes used in generation panel can cause electric shock.
2.	Fire & Explosion hazard	It is highly explosive. In any case of leakage of Hydrogen in turbo generator area or hydrogen plant area may lead to explosion and fire.

Table 1.8 Hazards in Fuel storage tank/ Battery/ Pump House:

S.No	Hazard	Description
1.	Fire hazard	Spillage and drain is risky because it may result in to back fire and consequent damage to the plant.

Table 1.9 Hazards in Transformer and switch yard:

S.No	Hazard	Description
1.	Electric shock and electric burn	Routine work, Maintenance or inspection of electrical panels in the switch yard.
2.	Fire on transformer	The transformer oil may splash up to long distance if transformer gets exploded due to the fire, nearby Pneumatic actuator cylinder installed.
3.	Slip, Trip and fall form the height	During the routine work and maintenance on switch yard.

Table 1.10 Hazards in D.M (De- mineralized) plant:

S.No	Hazard	Description
1.	Chemical burn	By spillage of caustic soda and sulphuric acid during unloading, overflow and damage on storage tank and pipe line.
2.	Fire hazard	Fire in Electric panel and electric motor short circuit.
3.	High noise level	By various equipment's vibration and pump operation.

V. RESULT

Table 1.10: Risk Classification Table:

S. NO.	Hazard Description	Initiating Event Likelihood	Unmitigated Consequences		Risk Class
			Life Safety	Property Damage	
1.	Boiler Hazard				
a.	Burn injury due to hot water and hot steam pipeline leakage	3	3	3	B
b.	Slip, trip and from the height during routine work, maintenance or inspection	4	4	2	B
c.	Boiler explosion due to improper combustion of fuel.	1	4	4	C

d.	Diesel supply line fire	3	3	3	B
e.	Catches in moving part of the machinery like F.D. fans or motors	3	2	1	A
f.	Exposure in machineries and hot surface of the pipelines	3	1	-	A
g.	Burn on hot fly ash	4	1	-	A
h.	Burst of the equipment body due to over pressure and over temperature	3	1	4	A
i.	Water tube burst due to Failure in boiler water level control	2	-	4	C
j.	Exposure to the hot surface of pipeline or machineries.	3	1	-	A
2.	Biomass Handling Plant Hazard				
a.	Struck by falling objects	4	2	1	B
b.	Transport line accident	4	2	1	A
c.	Respiratory problem due to the biomass dust	3	3	-	B
d.	Fall from height during the work on conveyor control room and conveyor belt	3	4	-	C
e.	Catches on the conveyor belt	2	2	2	B
f.	Slip & trip injury during handling	4	1	-	A
g.	Fire in Biomass storage	2	1	2	B
3.	D.M. Plant Hazard				
a.	Chemical burn by the spillage of sulphuric acid and caustic soda during unloading and damage on storage tank or the pipelines.	4	3	2	A
b.	Fire hazard	2	3	3	B
c.	High noise level	1	3	-	A
4.	Switch Yard Hazard				
a.	Electric burn and electric shock, routine work, maintenance and inspection of electrical panels in switch yard.	5	4	1	B
b.	Maintenance on switch yard on working on height during routine work and slip, trip hazard	4	4	1	B
c.	Fire on transformer	3	-	4	C
5.	Turbine and Generator hazard				
a.	Damage on generator due to the lack of lubrication in the coupling shaft	2	1	4	A
b.	Fire and explosion in hydrogen tank	2	5	4	D
c.	Fire on cooling oil	3	3	3	B
d.	High noise level	1	3	-	B
c.	Explosion in turbine cue to the cooling system failure	1	4	5	C
6.	Other Hazard				
a.	Respiratory problem and eye irritation from the exposure of the ammonia leakage from the pipeline and storage tank	4	1	-	A
b.	Fire on ammonia storage tank	2	4	4	C
c.	Fire hazard in control room	2	1	3	A
d.	Fire hazard on fuel storage tank	2	4	4	C

Table 1.13: Risk Classification Table:

Class	General Description	Action
A	Low risk	No further risk reduction action required
B	Moderate risk	It required minor risk reduction improvements, generally addressed by the standards, codes, company and industry practices.
C	Moderate High risk	It required further analysis to the determine an optimal risk reduction strategy or reliability analysis of the propose risk controls.
D	High risk	It required immediate risk reduction analysis.

VI. CONCLUSION

The conclusion of this paper is that risk assessment is very helpful for finding hazards conditions in power plant. Hazard analysis and risk assessment can be used to establish priorities so that the most dangerous situations are addressed first and those least likely to occur and least likely to cause major problems can be considered later. In this project report we observe present scenario of existing safety measures and its efficiency. The risk rating of the present and possible hazard is evaluated which divide them into acceptable, tolerable and unacceptable risk level. Which risks are in unacceptable level their possible corrective action also recommended to improve safety measure and analysis. The results of this analysis will be of valuable to find out the consequence on emergency situation that may occur. With this knowledge, the level of preparedness can be assessed and measures taken to enhance capabilities through training and preparation of a more effective response to such occurrences

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