HAZOP STUDY FOR THERMIC FLUID HEATER

Mr. Ganesh Prasanna PK¹, Ms. Anugeetha Shine²

¹Postgraduate Student, Department Of Industrial Safety Engineering, Bannari Amman Institute Of Technology, Erode, Tamil Nadu, India.
²Assistant Professor, Department Of Food Technology, Bannari Amman Institute Of Technology, Erode, Tamil Nadu, India.

ABSTRACT

Hazard and Operability study (HAZOP) is a technique in which it is used to identify the possible hazards in a systematic and step by step manner through which consequences and deviations could be found in several ways during the design stage, commissioning stage and running stage. In Thermic fluid heater the HAZOP study is carried out at the running stage by finding the possible deviations, causes, consequences through the use of guide words and providing appropriate recommendations to the actions based on the severity, occurrences and detection. The main process is to eliminate the hazards in a proactive manner in the thermic fluid heater process by using this qualitative approach and showing results based on the quantitative approach.

Keywords: Hazard And Operability Study (HAZOP), Thermic Fluid Heater, Hazards, Deviations, Causes, Consequences.

I. INTRODUCTION

The hazard and operability study (HAZOP) is a structured and systematic examination of a complex plan or operation in order to identify and evaluate problems that may represent risks to personnel or equipment. The intention of performing a HAZOP is to review the design to pick up design and engineering issues that may otherwise not have been found. The technique is based on breaking the overall complex design of the process into a number of simpler sections called 'nodes' which are then individually reviewed. It is carried out by a suitably experienced multi-disciplinary team (HAZOP) during a series of meetings. The HAZOP technique is qualitative, and aims to stimulate the imagination of participants to identify potential hazards and operability problems. Structure and direction are given to the review process by applying standardised guide-word prompts to the review of each node. The relevant international standard calls for team members to display 'intuition and good judgement' and for the meetings to be held in 'a climate of positive thinking and frank discussion'.

The HAZOP technique was initially developed in the 1960s to analyze major chemical process systems but has since been extended to other areas, including mining operations and other types of process systems and other complex systems such as nuclear power plant operation and software development. It is also used as the basis for reviewing batch processes and operating procedures.

II. HAZOP ANALYSIS MECHANISM

HAZOP analysis is now a mandatory activity. It is a qualitative, experience-intensive exercise. It is in the form of deviation analysis. After the process design, the steady-state specifications of each stream in the flow sheet are known.

The HAZOP analysis team exhaustively asks itself questions as to what will happen if this specification deviated on the positive or negative side of the expected steady-state value. It debates the possible causes and consequences of each such eventuality. Anything which appears to them as likely to lead to hazardous situations is debated further and possible means of avoiding the same or raising alarm if it happens so that remedial action can be taken etc. are recommended. This may lead to the recommendation of additional instrumentation on lines and equipment, Hi-Lo alarms and trips, etc. may be required to be provided.

The idea of HAZOP analysis is to foresee a hazardous situation and take measures and abundant precautions to avoid them and increase process safety.

HAZOP analysis is a structured analysis, conducted after the design review, to ensure the design is suitable for all the intended operating conditions and complies with the HSE requirements. This process also ensures that the fundamentals of the design are thoroughly explained, understood, and examined.
III. METHODOLOGY

Build a HAZOP team
Create a multidisciplinary HAZOP team composed of a team leader and members who can collaborate and provide different perspectives based on their fields of expertise at realizing sources of risks and possible deviations from design. An example of HAZOP team members would be design engineers, those who are very familiar with operations, and safety professionals.

IDENTIFY PROCESSES, P&ID, AND HAZOP NODES
When beginning a HAZOP study, it is important to identify the processes in operations, be familiar with the process/piping and instrumentation diagram (P&ID), and be aware of all the nodes.

P&ID are drawings or diagrams that provide the visual representation of interconnected processes, equipment, and controls in the physical plant. HAZOP nodes are sections in the entire process where changes happen and they need to be reviewed along with Material Safety Data Sheets (MSDS) so that parameters can be defined and deviations are identified.

Define the parameters, determine deviations, and select guide words.

Define parameters or safe operating limits during the review of nodes so that deviations can be determined and guide words are selected.

Examples of common HAZOP guide words:
- No or not
- More
- Less
- High
- Low

With the use of guide words, workplace hazards can be clearly identified as they are the deviations that go beyond acceptable parameters or safe operating limits.

IDENTIFY CONTROLS AND ESTABLISH SAFETY MONITORING
With hazards identified, the corresponding hazard mitigation or elimination strategies should be applied to maintain the safety of the workplace. With ongoing processes and production, monitoring should also be established to ensure that safeguards are still effective and safety procedures are being followed.

Monitoring is only effective when it is actually conducted regularly. With Safety Culture as mobile safety monitoring software, you can ensure that safety checks and audits are conducted regularly through scheduled inspections and automated notifications. Administrators can schedule and assign inspections and be made aware if inspections are indeed being done on time and on a regular basis.

Another safeguard is to automate safety monitoring through sensors. Sensors can trigger automated notifications for intended personnel whenever safety parameters are exceeded in real-time.

COMMUNICATE HAZOP RESULTS AND IMPROVE PROCESSES
The result of the HAZOP analysis can be used to help elevate safety within the plant and improvements in safety practices and processes should be communicated to as appropriate to employees e.g. occupational safety, chemical safety and hygiene safety processes.

An effective approach to safety training or program will also help hasten the implementation of changes and reinforce safety across the board.

HAZOP is rigorous and can take a lot of time and resources to complete, but by following HAZOP steps and using tools that can help hasten the process without compromising the quality of the process and its result, HAZOP can be effectively conducted and completed sooner and the workplace can be made safer and more efficient.
HAZOP TECHNIQUE

TERMINOLOGY USED IN HAZOP STUDY

STUDY NODES
The locations (on piping and instrumentation drawings and procedures) at which the process parameters are investigated for deviations.

INTENTION
The intention defines how the plant is expected to operate in the absence of deviations at the study nodes. This can take a number of forms and can either be descriptive or diagrammatic; e.g., flow sheets, line diagrams, P&ID.

DEVIATIONS
These are departures from the intention which are discovered by systematically applying the guide words (e.g., "more pressure").

Guide word + Parameter = Deviation

CAUSES
These are the reasons why deviations might occur. Once a deviation has been shown to have a credible cause, it can be treated as a meaningful deviation. These causes can be hardware failures, human errors, an unanticipated process state (e.g., change of composition), external disruptions (e.g., loss of power), etc.

CONSEQUENCES
These are the results of the deviations should they occur (e.g., release of toxic materials). Trivial consequences, relative to the study objective, are dropped.

GUIDE WORDS
These are simple words which are used to qualify or quantify the intention in order to guide and stimulate the brainstorming process and so discover deviations.
IV. MODELING AND ANALYSIS

INTENTION: 1 DIESEL FEED CIRCUIT TO THERMIC FLUID HEATER

NODE: A TRANSFER OF FUEL FROM STORAGE TANK TO FUEL OIL SERVICE TANK

<table>
<thead>
<tr>
<th>Guide word</th>
<th>Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>No forward flow/ reverse flow</td>
</tr>
<tr>
<td>More of</td>
<td>More of any relevant physical property there than should be Eg: higher flow, higher temperature, higher viscosity</td>
</tr>
<tr>
<td>Less of</td>
<td>less of any relevant physical property there than should be Eg: lower flow, lower temperature, lower viscosity</td>
</tr>
<tr>
<td>Part of</td>
<td>Composition of system different from what it should be Eg: change in ratio of component or component missing etc</td>
</tr>
<tr>
<td>As well as</td>
<td>A transfer of some component in addition to the intended component. Eg: transfer of water with benzene in the transfer line.</td>
</tr>
<tr>
<td>More than</td>
<td>More component present in the system</td>
</tr>
<tr>
<td>Not</td>
<td>If some thing is not operating Eg: control valve</td>
</tr>
<tr>
<td>Other than</td>
<td>What else can apart from normal operation Eg: static electricity</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>More</th>
<th>More flow</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Increased pumping capacity, increased suction pressure, reduced delivery head, greater fluid density, control</td>
</tr>
<tr>
<td></td>
<td>Leaks obtained through flanges could lead to fire &amp; explosion.</td>
</tr>
<tr>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>250</td>
</tr>
</tbody>
</table>

Install flow metering valve and flow meter with alarm system, clean filter, strainer periodically.
<table>
<thead>
<tr>
<th></th>
<th>More pressure</th>
<th>Pressure can create bursting or rupture of pipe lines, damage equipments, instruments, water hammer, noise etc. and cause fire &amp; explosion.</th>
<th>Check fuel flow control system through pressure indicator, Install flow metering valve</th>
</tr>
</thead>
<tbody>
<tr>
<td>More flue gas</td>
<td>Leakage of heat carrier into the system, fouling of combustion chamber and uptake, incorrect air/fuel ratio and blockage of air filter.</td>
<td>Fire &amp; explosion.</td>
<td>Clean the furnace and uptake, adjust the air/fuel ratio, clean the air filter and check for any damage of the coil tube.</td>
</tr>
<tr>
<td>Other than</td>
<td>Static electricity</td>
<td>Ignition of vapour leads to fire &amp; explosion.</td>
<td>Ensure proper earthing to all equipment, pipelines and storage tanks; ensure the integrity of joints and earthing continuity across flange joints.</td>
</tr>
</tbody>
</table>

**NODE: B TRANSFER OF FUEL FROM FUEL OIL SERVICE TANK TO THERMOPAC HEATER THROUGH FUEL OIL PREHEATER**
<table>
<thead>
<tr>
<th>GUIDE WORD</th>
<th>DEVIATION</th>
<th>CAUSES</th>
<th>CONSEQUENCES</th>
<th>RECOMMENDED ACTION</th>
<th>PRESENT SYSTEM</th>
<th>O</th>
<th>S</th>
<th>D</th>
<th>RPN</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>No flow</td>
<td>Service or fuel tank empty, Line blockage, power failure, Pump failure, Line fracture, fouled gate valve, burst pipe, large leak, flange leaks.</td>
<td>Delay in burner start up, delay in process, pump gets hotter, impeller blades can be damaged, fire &amp; explosion could occur by hot casings.</td>
<td>Flow level meter with alarm system to be installed every 250cm, periodic checking of pump, periodic maintenance required, duplex filter, strainer to be cleaned periodically.</td>
<td>Non return valve, Check valve, Duplex filter, 2-Needle valve, Angular safety valve, Gate valve, Strainer, Interlocks (Pressure switch high, Temperature switch high, Temperature indicator, Pressure indicator, Temperature alarm low, Temperature switch low).</td>
<td>9</td>
<td>10</td>
<td>1</td>
<td>90</td>
</tr>
<tr>
<td>Less</td>
<td>Less flow</td>
<td>Line restrictions, filter blockage, defective pumps, fouling of valves, and tuberculation.</td>
<td>Delay in burner start up, pumps, impeller blades could be damaged.</td>
<td>Install flow metering valve and flow meter with alarm system, clean filter, strainer periodically</td>
<td></td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>125</td>
</tr>
<tr>
<td>Less pressure</td>
<td>Less pressure</td>
<td>Generation of vacuum condition, condensation, air dissolving in liquid, restricted pump/compressor suction line, undetected</td>
<td>Delay in process, leaks could cause fire &amp; explosion</td>
<td>Check fuel flow control system through pressure indicator, Install flow metering valve, NDT test to be carried.</td>
<td></td>
<td>6</td>
<td>9</td>
<td>4</td>
<td>216</td>
</tr>
</tbody>
</table>

NODE: C RETURN OF FUEL FROM THERMOPAC HEATER TO FUEL OIL SERVICE TANK
<table>
<thead>
<tr>
<th>GUIDE WORD</th>
<th>DEVIATION</th>
<th>CAUSES</th>
<th>CONSEQUENCES</th>
<th>RECOMMENDED ACTION</th>
<th>PRESENT SYSTEM</th>
<th>O</th>
<th>S</th>
<th>D</th>
<th>RPN</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>No flow</td>
<td>Line blockage, power failure, Line fracture, fouled gate valve, non return valve, motorised valve, burst pipe, large leaks in flange and burner leaks.</td>
<td>Fire &amp; explosion could occur by hot casings, nearby heat source and by burner.</td>
<td>Flow level meter with alarm system to be installed every 250cm, periodic maintenance to be done, eliminate the nearby heat source or make some substitution process, isolate the area.</td>
<td></td>
<td>9</td>
<td>10</td>
<td>1</td>
<td>90</td>
</tr>
<tr>
<td>Less</td>
<td>Less flow</td>
<td>Line restrictions, filter blockage, defective pumps, fouling of valves, and tuberculation.</td>
<td>Delay in burner start up, pumps, impeller blades could be damaged.</td>
<td>Install flow metering valve and flow meter with alarm system, clean filter, strainer periodically</td>
<td></td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>125</td>
</tr>
<tr>
<td>Less</td>
<td>Less pressure</td>
<td>Generation of vacuum condition, condensation, air dissolving in liquid, restricted pump/compressor suction line, undetected leakage, vessel drainage.</td>
<td>Delay in process, leaks could cause fire &amp; explosion</td>
<td>Check fuel flow control system through pressure indicator, Install flow metering valve, NDT test to be carried.</td>
<td></td>
<td>6</td>
<td>9</td>
<td>4</td>
<td>216</td>
</tr>
<tr>
<td>More</td>
<td>More flow</td>
<td>Increased pumping capacity, increased suction pressure, reduced delivery head, greater fluid density, control faults</td>
<td>Leaks obtained through flanges could lead to fire &amp; explosion.</td>
<td>Install flow metering valve and flow meter with alarm system, clean filter, strainer periodically</td>
<td></td>
<td>5</td>
<td>10</td>
<td>5</td>
<td>250</td>
</tr>
<tr>
<td>More</td>
<td>More pressure</td>
<td>Surge problems, specifications of contraction &amp; expansion of pipes, vessels, fittings, instruments.</td>
<td>Pressure can create bursting or rupture of pipe lines, damage equipments, instruments, etc. And cause fire &amp; explosion.</td>
<td>Check fuel flow control system through pressure indicator, Install flow metering valve</td>
<td></td>
<td>7</td>
<td>10</td>
<td>3</td>
<td>210</td>
</tr>
<tr>
<td>Other</td>
<td>Static electricity</td>
<td>Not electrically grounded, escape of material</td>
<td>Ignition of vapour leads to fire &amp; explosion.</td>
<td>Ensure proper earthing to all equipment, pipelines</td>
<td></td>
<td>2</td>
<td>10</td>
<td>8</td>
<td>160</td>
</tr>
</tbody>
</table>
through cracks of flanged joints.

and storage tanks; ensure the integrity of joints and earthing continuity across flange joints.

V. RESULTS AND DISCUSSION

After the usage of HAZOP studies in thermic fluid heater we found that maximum potential danger occurs in the area of diesel pipe lines, care must be taken based on the given recommendations provided and periodic check-up of equipment and maintenance to be carried at regular intervals to avoid the dangerous fire hazards accident happening in future.

Thus HAZOP studies makes easier to show the complexity process of thermic fluid heater in a detailed manner with making process simple with the help of guide words, deviations.

VI. CONCLUSION

After the usage of HAZOP studies in thermic fluid heater we found that maximum potential danger occurs in the area of diesel pipe lines and burner areas, care must be taken based on the given recommendations provided and periodic check-up of equipment and maintenance to be carried at regular intervals to avoid the dangerous fire hazards accident happening in future. Thus HAZOP studies makes easier to show the complexity process of thermic fluid heater in a detailed manner with making process simple with the help of guide words, deviations, and also makes HAZOP of qualitative approach in to quantitative manner to show the impact factor of thermic fluid heater process with the help of risk priority number.

VII. REFERENCES

[3] Ozog H, Bendixen LM. Hazard identification and quantification: the most effective way to identify, quantify; and control risks is to combine a hazard and operability study with fault tree analysis. Chem Eng Prog 1987;83:55-64.


