iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 Issue: VII Month of publication: July 2022

DOI: https://doi.org/10.22214/ijraset.2022.45310

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue VII July 2022- Available at www.ijraset.com

Hazop Study for Thermic Fluid Heater (At Industry by Heterogeneous Method)

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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 word 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.The design and operation of thermal fluid-based heat transfer systems (hot oil systems) is often poorly understood and hence preventable accidents occur due to system failure.
Keywords: Failure Hazard, HAZOP, Operability, Thermal Fluid,

I. INTRODUCTION

Incidents relating to thermal fluid systems are unfortunately more common than we might realise, and can be extremely serious. The fire and explosion hazards with thermal fluid systems have been re-emphasized by recent incidents. These incidents have a direct bearing on the estimated 4,000 UK companies that operate thermal fluid systems. Water or steam can be used as heat transfer fluids, but when high temperatures are needed organic fluids, which are capable of forming explosive atmospheres, are often used. Although fire and explosion hazards of low flash point flammable liquids are generally recognized, similar hazards with high flash point materials, such as thermal fluids, are often missed. These heat transfer fluids are often handled at temperatures above their flash point. The Health and Safety Executive recently issued a prohibition notice to a UK company following a major thermal fluid incident and significantly, following that incident, has identified thermal fluid systems as a fire and explosion hazard. There have been other serious incidents this year. Although not under HSE jurisdiction, there was a recent thermal fluid-related explosion and fire at a German panel products plant which tragically caused three fatalities. Most companies will be aware that any system that operates above the flash point of the thermal fluid falls under the “Dangerous Substances and Explosive Atmosphere” Regulations 2002 (DSEAR). However, many people are unaware that heat transfer fluids based on mineral oils degrade over time. This degradation can cause the fluid’s flash point to decrease dramatically, so that thermal fluids which were not flammable at the operating temperature when they were initially installed may, over time, become flammable at the operating conditions. Also, high flash point materials (such as thermal fluids), can form explosive mist atmospheres.

II. LITERATURE SURVEY

Glenn E. Mahnken et al investigated the use of case histories to energize your HAZOP in that it explains about the process safety management programs of many companies include formal process hazards analyses, using methods such as hazard and operability (HAZOP) studies and “what-if” reviews, as key elements of these programs. Klutz

Alison McKay et AL have investigated Fire and Explosion Hazards with Thermal Fluid Systems with case studies where explosions have occurred in thermal fluid systems, and the flash point of the thermal fluid was found to have decreased below the operating temperature. The paper emphasizes the need to consider thermal fluid systems under the “Systems are also presented.

Ali Musyafa et al has investigated the Hazard and Operability study in Boiler System of The Steam Power Plant where it found the Pulverize is a major part of the boiler combustion system and an important part in the system of steam power plant (PLTU). Pulverizer plant serves to break chunks of coal into the coal ash was then fed to the burner.

Ali Musyafa et al has predicted an risk management and safety system assessment from power plant steam boiler in power systems unit 5, paiton-indonesia where part of the power plant system that has a high risk of danger is a Boiler and therefore in danger of such a system is necessary to study and review of safety systems for the prevention of danger arising in the Boiler. Therefore, hazard analysis used in this study using HAZOP.

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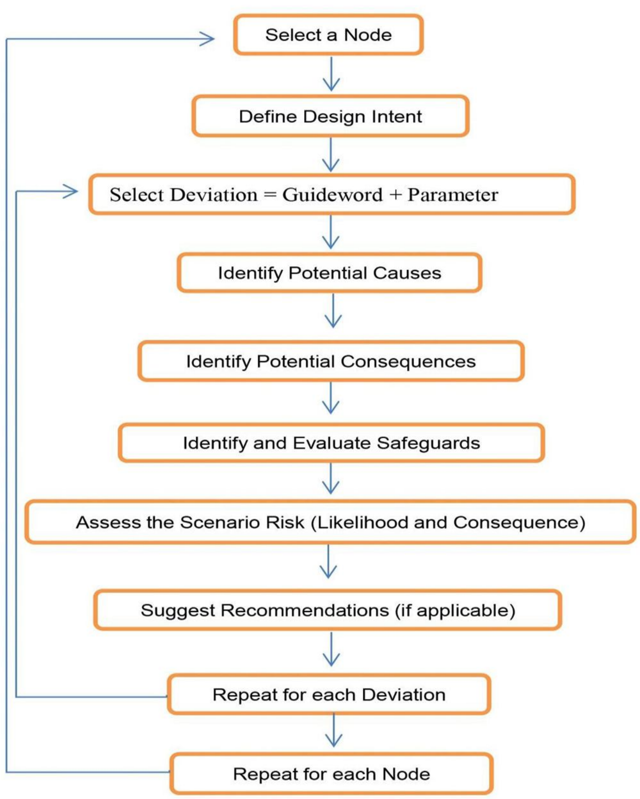
L. Pugi et al has investigated a thermo-hydraulic tool for automatic virtual HAZOP Evaluation Development of complex lubrication systems in the Oil & Gas industry has reached high levels of competitiveness in terms of requested performances and reliability. In particular, the use of HAZOP (acronym of Hazard and Operability) analysis represents a decisive factor to evaluate safety and reliability of plants.

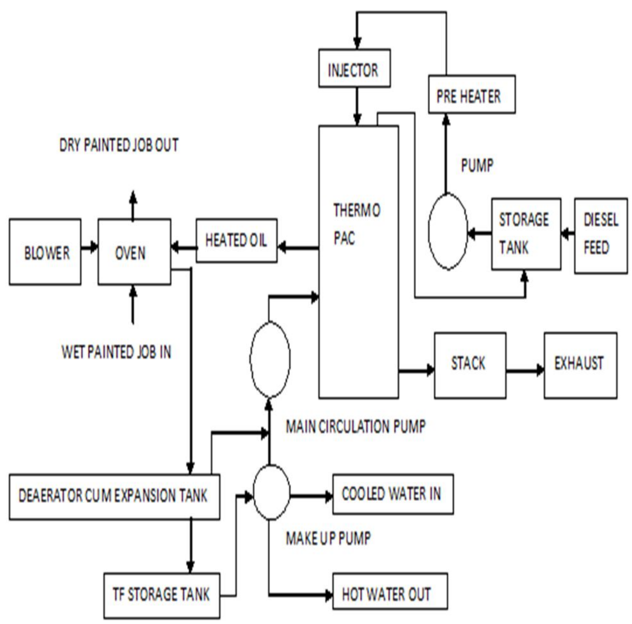
N.A. Siddiqui et al has investigated Risk Management Techniques of HAZOP & HAZID Study Risk assessment and management techniques are used in industrial activities to reduce accidents by applying preventive and protective methods. Recommendations are made on the basis of the findings to improve the installation and make it better and safer place to work. Attempt has been made to carry out HAZID and HAZOP study thoroughly through the Effluent Treatment Plant (ETP) and recommendations were given to make the plant safer place to work.

Karthika S investigated accident prevention by using HAZOP study and work permit system in boiler in which accidents can never be eliminated completely, employers can prevent many of the injuries and fatalities that occur each year. HAZOP study provide a safe system of work during inspection, maintenance operation especially in boilers, through that work permit system formed to prevent the accident.

III. WHATISHAZOP

The figure 1 and 2 shows the process & instrumentation diagram and flow diagram of the complex process of a thermic fluid heater in a manufacturing industry respectively. Based on the diagrams the intention and nodes are found out as shown in table 1 with three intentions and nine nodes respectively. The process thermic fluid heater in this manufacturing industry is used for paint shop areas to dry the wet painted jobs quickly. The process works with the help of shell heat transfer oil, diesel, thermo Pac burner, de-aerator cum expansion tank, some valves, pipes, flanges, motors, pumps, etc. The diesel is used as the fuel source medium to heat the shell mineral oil. First the diesel is feed to the fuel service tank from the fuel storage tank. Then from the fuel service tank the diesel is passed to the thermo Pac heater with the help of motorized pump located at the bottom of the thermo Pac. Before the diesel send to the thermo Pac burner it is pre heated with the fuel oil pre-heater.





IV. THERMAL FLUID SYSTEMS

A. Incidents Of Fires & Explosions In Thermal Fluid Systems

Recent instances of explosions in thermal fluid systems include the following examples: A polystyrene manufacturing facility in Greater Manchester was operating with 22,000 liters of Esso therm 500 (Mineral Oil) at 2858C. Although the plant had defined hazardous areas the thermal oil system was operated as a utility with no formal risk assessment. No formal training had been undertaken with the maintenance personnel having little knowledge of the risks associated with high temperature oil systems. The thermal oil system was a closed loop system with no desecration facility, which meant that as the fluid degraded the gaseous VOCs generated could not be removed easily from the fluid stream. The result was that the system 'lack of circulation' warning would regularly trip causing production disturbance.

Without understanding the significance of the 'lack of circulation' trip, an engineer 'wired out' the switch to prevent the recurrence of the alarm.

Recurring differential pressure alarms is an indication of rapidly dropping flash points and increasing vapor pressure. In this instance the switch also acts as back up to the low-level switch in the expansion tank. On this site, following routine maintenance, some fluid was lost from the system and as the low level switch indicated that there was oil in the expansion tank, the system was started up as normal. Unfortunately, the low level switch had failed and air was being drawn into the system on the suction side of the circulation pump. This condition would normally have been detected by the differential pressure switch. However, as the switch had been disconnected the system ran as normal.

B. Regular Monitoring Of The Thermalfluid Flash Point

To prevent the reduction of the flash point over time via degradation, the thermal fluid needs to be sampled regularly, and the flash point of the sample determined. If the flashpoint has reduced considerably, then the thermal fluid will need to be replaced. However, as stated above, although replacing the thermal fluid will avoid the formation of explosive atmospheres when handling the fluid at atmospheric pressure, the formation of a flammable mist atmosphere is still possible if the fluid is handled under pressure. It is important to emphasize that flash point testing alone is NOT sufficient to comply with DSEAR. Some companies are offering to test the flash point of a customer's thermal fluid, giving them the impression that if this is done, the customer will be compliant with the DSEAR regulations. This is not the case.

C. Safety In Design Of Thermal Fluid Heat Htf Storage

It is often useful to have an empty tank which is sized for the total capacity of the HTF system in order to provide an emergency dump facility. This tank can be used if there is a serious problem with the system to prevent a total loss of the HTF. The hold tank may be fitted with a cooling coil to cool the fluid down and prevent vaporization and also a heating coil to ensure that it is kept at a temperature to allow pumping.

D. Cold Seal/Header Tank

For liquid systems not operating under pressure, a cold seal tank is required in order to minimize losses from the system and also to compensate for any changes in level e.g. due to thermal expansion. The design of the cold seal is very important to the overall system because it performs several functions: Allows removal/venting of water at start-up Minimizes losses of HTF from system due to vaporization Provides nitrogen blanket to eliminate oxygen Provides make-up capacity for minor losses & leaks

E. Emergency Dump Tank

An emergency dump tank may be provided so that in the event of a serious problem, the whole system inventory can be dumped to a safe place rapidly to minimize the hazard. The dump tank must be designed to cope with the thermal stress of the hot liquid being fed into it. A cooling coil may also be incorporated in order to reduce the temperature of the dumped fluid and prevent vaporization.

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H. System/Fluid Cleaning

The level of system cleaning required depends on the amount of contamination and degradation that has occurred. If only light degradation of the HTF has occurred then it may be sufficient to filter the fluid to remove particulates. This can be done by filtering through a fine filter (100 micron) at the operating temperature until the fluid is clear. The filter media must be able to withstand the normal operating temperature and therefore conventional polypropylene media are not suitable. Glass fiber filter media are available and are suitable for the elevated temperatures. If the level of degradation is higher with some limited fouling of heat transfer surfaces then other cleaning methods may be appropriate. If severe degradation has occurred then the fluid can be fractionally distilled to remove both high and low boilers.

V. HAZOP WORK SHEET

A. Step 1

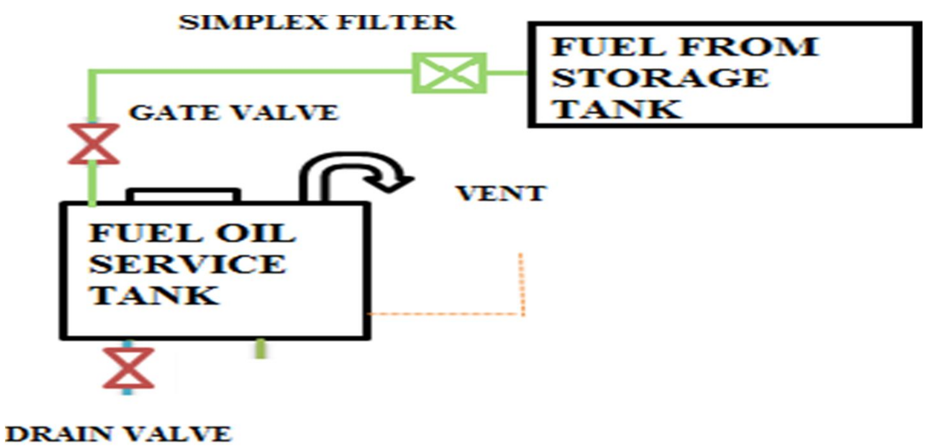

Figure 1: Diesel Feed Circuit to Thermic Fluid Heater

B. Step 2

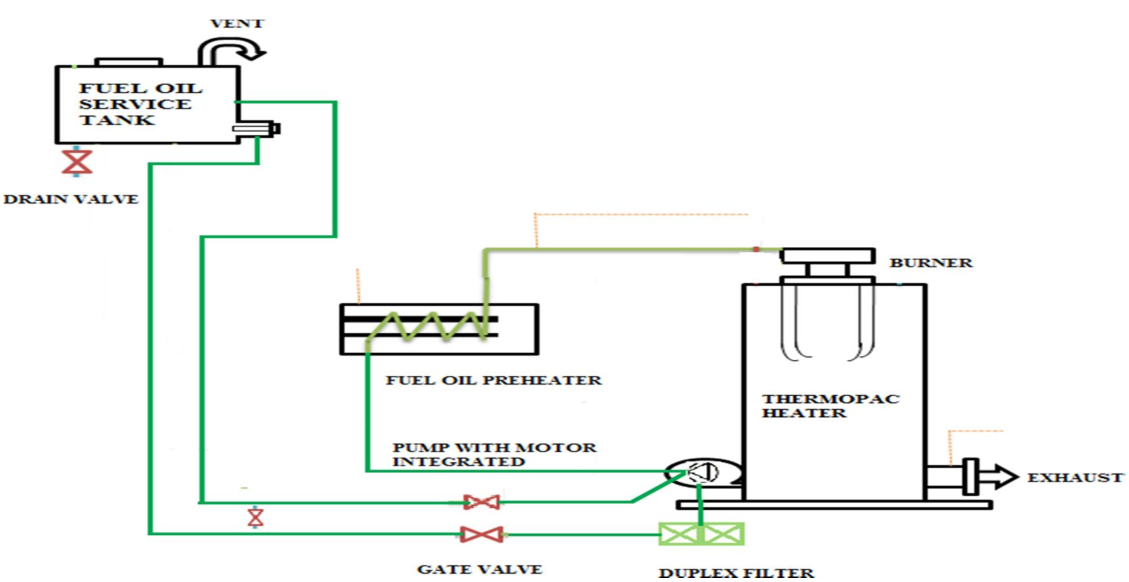

Figure 2: Transfer of Fuel from Fuel Oil Service Tank To Thermo Pac Heater Through Fuel Oil Preheater

C. Step 3

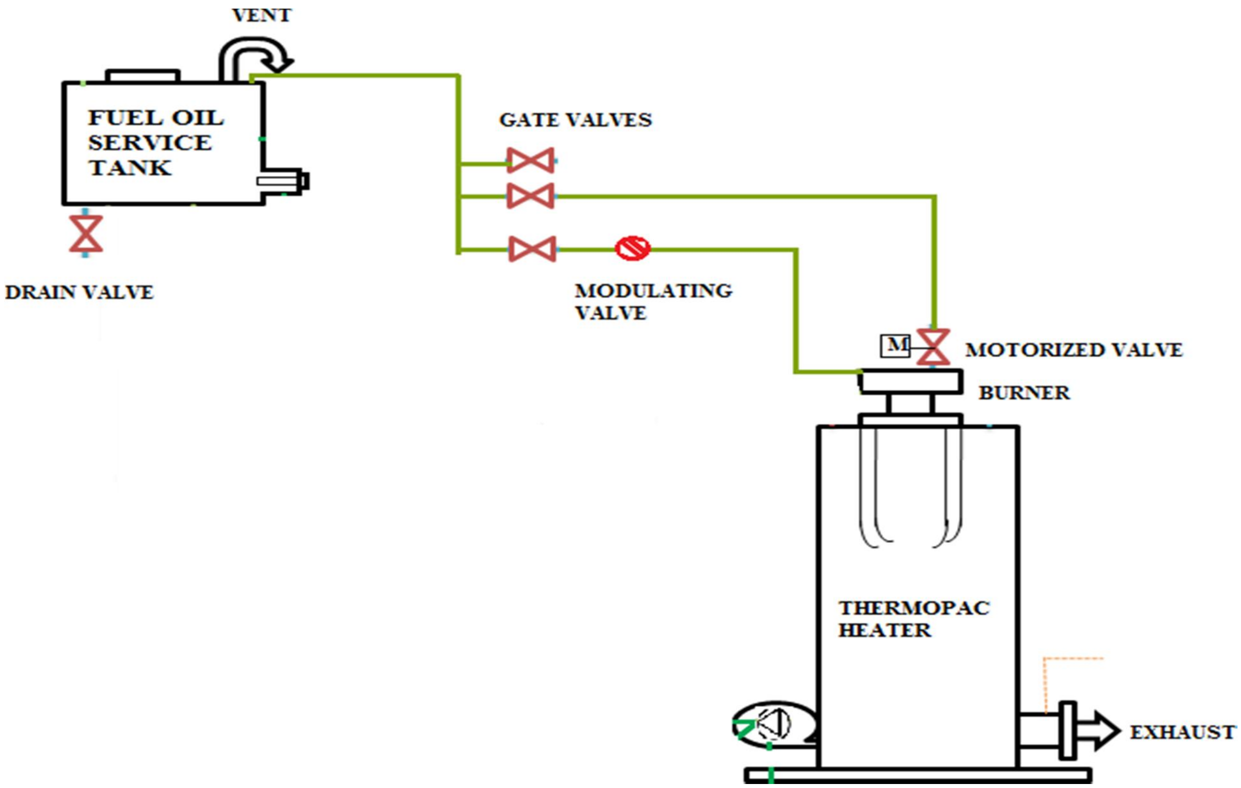

Figure 3: Return of Fuel from Thermo Pac Heater to Fuel Oil Service Tank

D. Step 4

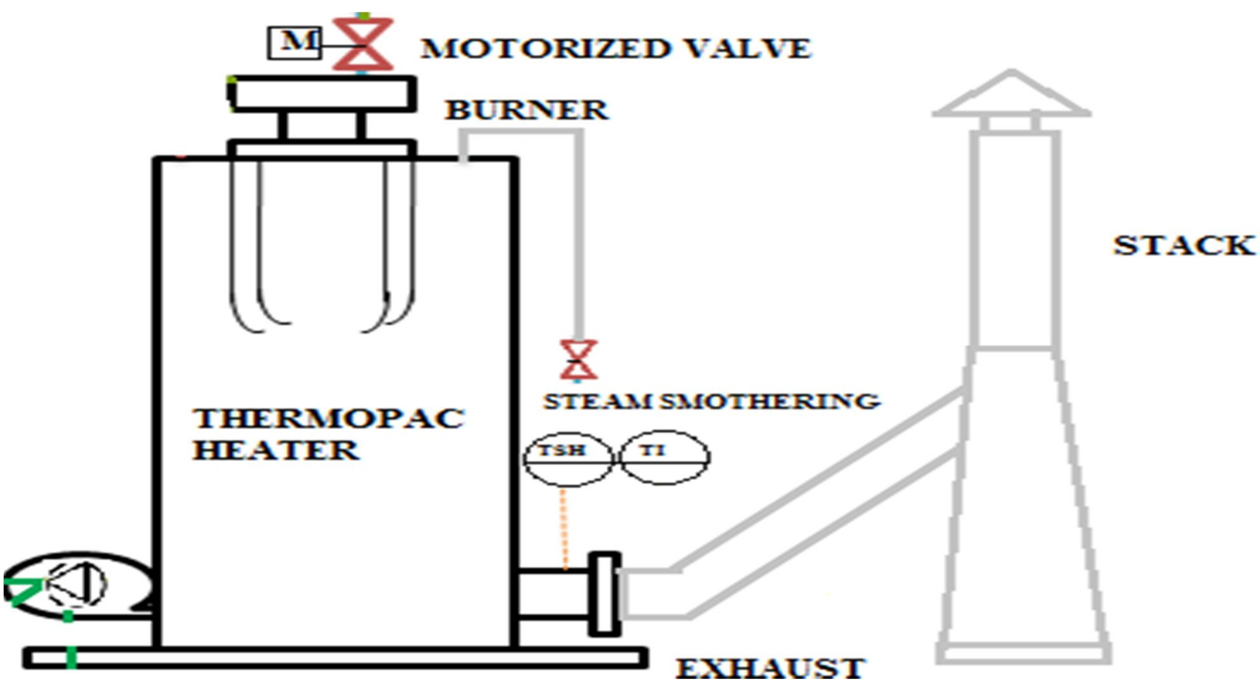

Figure 4: Transfer of Smoke From Thermo Pac Heater To Stack

E. Step 5

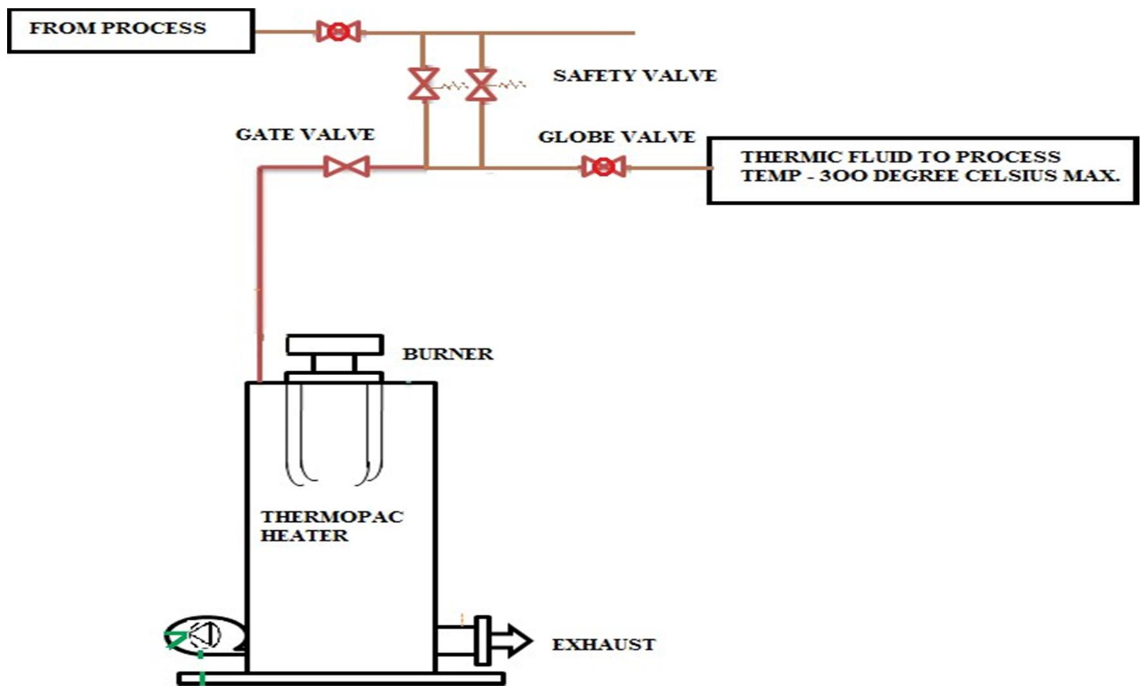

Figure 5: A Transfer of Heated Thermic Fluid from Thermo Pac Heater to the Process

F. Step 6

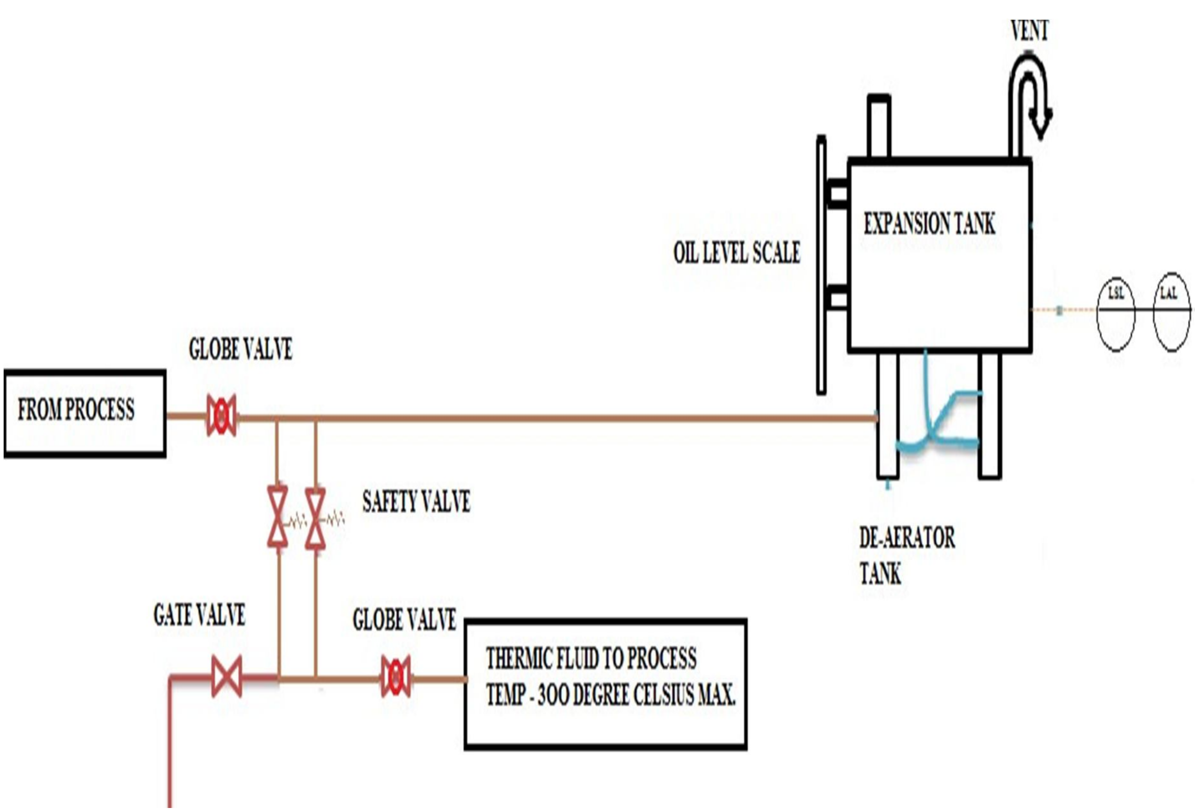

Figure 6: Return Of Oil from Process to Thermic Fluid Tank Heater

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G. Step 7

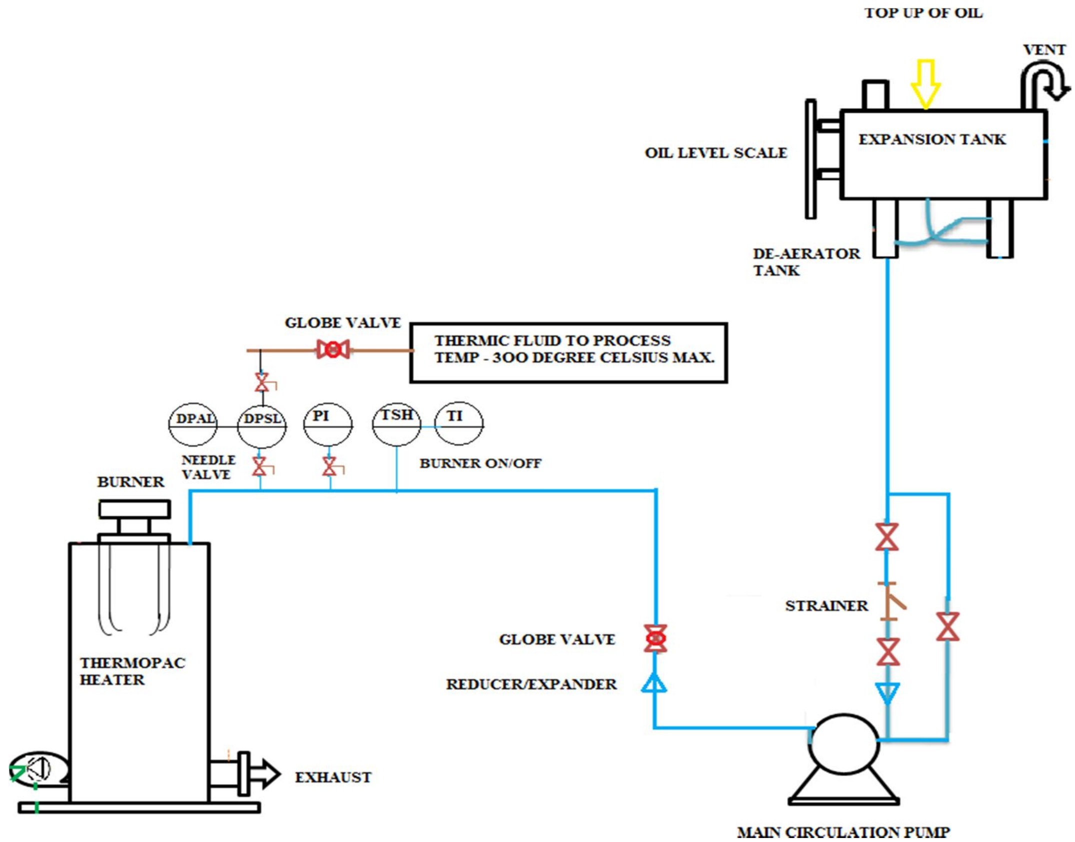

Figure 7: Transfer of Oil from De-Aerator cum Expansion Tank to the Main Circulation Pump and To the Thermo Pac Heater

H. Step 8

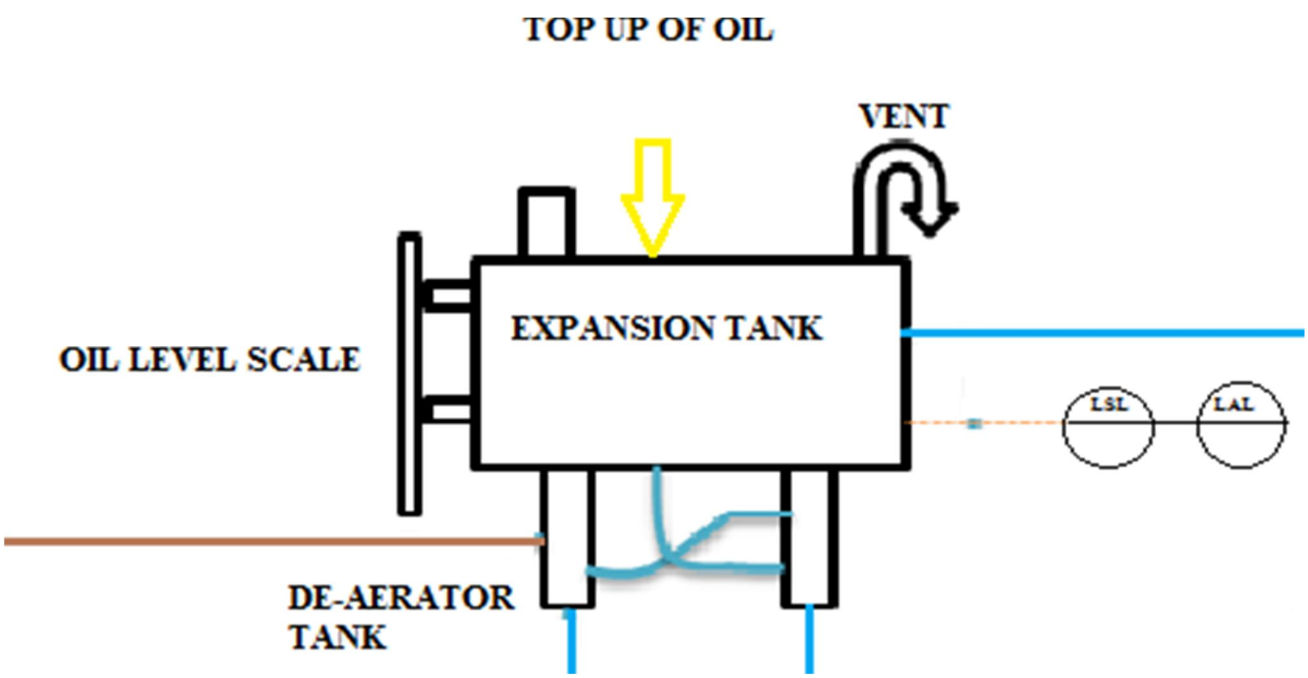

Figure 8: Top Up Of Shell Mineral S2 Oil from Barrel to the Expansion Tank

I. Step 9

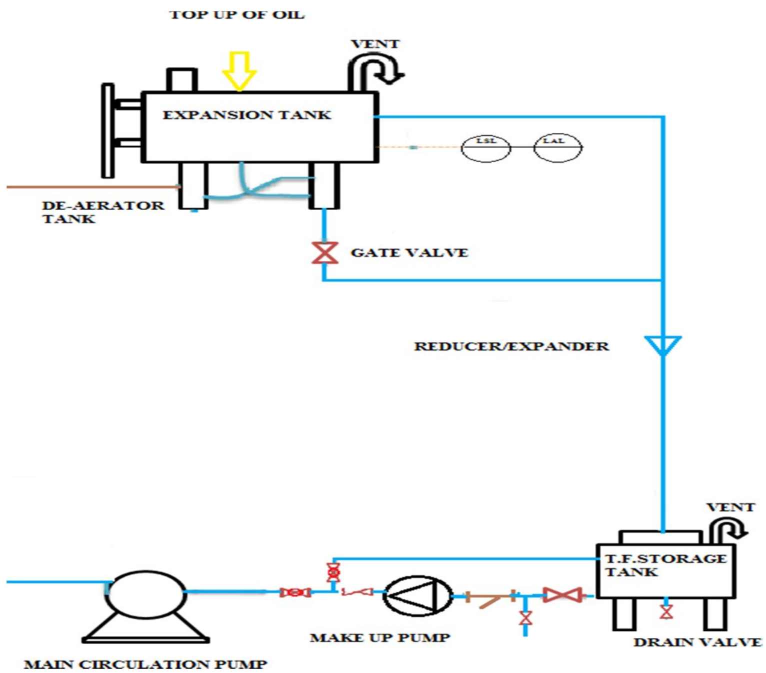

Figure 9: Transfer of Excess Oil from Expansion Tank to T.F.Storage Tank and To Main Circulation Pump through Make up Pump

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 checkup 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.

REFERENCES

[1] Alison McKay and Richard Franklin, 2011. Fire and explosion hazards with thermal fluid systems. Symposium Series No. 156 Hazards XXII.I ChemE.
[2] Wassila Benaissa, B., A. Nadine Gabs, A. Michel Cabassud, B. Douglas Carson, A. Se´ bastien Elgue, B.Michel Demissy, 2006. Evaluation of an intensified continuous heat-exchanger reactor for inherently safer characteristics, INERIS (Institute National de Environment Industrial et des Risques).
[3] Bodkhe, R.G., Y.Y. Nandurkar, S.S. Akant, S.L. Bankar, 20140. Performance Analysis of Separating and Throttling Calorimeter to Determine Quality of Steam on There max Diesel Fired Water Tube Boiler. International Journal of Research in Engineering and Applied Sciences (IJREAS), 02: 01.
[4] Triloki Nath Mishra, 2015. Modeling and CFD Analysis of Tube in Tube Helical Coil Heat Exchange, International Journal of Science and Research (IJSR), 4: 8.
[5] Atul N. Pote1, Pramod R. Pachghare2, 2015. Experimental Analysis on Thermal Performance of Closed Loop Pulsating Heat Pipe Using Zno/Water Nano fluid, International Journal of Science and Research(IJSR), 4: 5.
[6] Jorge Sanchez, 2009. SIL Application in Burner Management Systems - A Case Study: Thermal Burner, Safety Control & Instrumentation Systems Conference – IDC Technologies.
[7] Ali Musyafa, Hardika Adiyagsa, 2012. Hazard and Operability study in Boiler System of The Steam Power Plant, IEESE International Journal of Science and Technology (IJSTE), 1(3)1-10 ISSN: 2252-5297.
[8] Christopher Ian Wright, 2014. Thermal heat transfer fluid problems following a system flush with caustic and water, Elsevier, Case Studies in Thermal Engineering, 2: 91-94.9. Glenn, E., 2001. Mahnken, Use Case Histories to Energize Your HAZOP.
[9] Karthika, S., 2013. Accident Prevention by using HAZOP Study and Work Permit System in Boiler, International Journal of Advanced Engineering Research and Studies, IJAERS/Vol. II/ Issue II.
[10] Beavers, J.E., Moore, J.R., Rinehart, R., and Schriver, W.R. Crane-related fatalities in construction industry, Journal of Construction Engineering and Management, Vol. 132, Number 9, pp 901–910, 2006.
[11] Bureau of Labour Statistics (BLS). Crane-Related Occupational Fatalities, United States, Fact Sheet BLS, 2008
[12] Annex, B. Crane safety analysis and recommendation report. Workplace Safety and Health Council, the Ministry of Manpower and the National Crane Safety Taskforce, Singapore, 2009

[13] Idoro, G. I. Health and safety management efforts as correlates of performance in the Nigeria construction industry, Journal of Civil Engineering and Management, Vol. 14, Number 4, pp 277–285, 2008
[14] Louangrath, P.T.I. Sample Size Determination for Non-Finite Population. International Conference on Discrete Mathematics and Applied Sciences (ICDMAS), University of Thai Chamber of Commerce Conference Proceedings, Applied Science Section, 2014, Article No. 2.
[15] Shapiro, H., Shapiro, J., & Shapiro, K. Cranes and Derricks, McGraw-Hill, New York, 2000.
[16] Construction Plant Hire Association (CPA). The climbing of tower cranes CPA Best practice guide, Published by tower crane interest group (TCIG), London, United Kingdom, 2011
[17] National Bureau of Statistics (NBS). Labour Force Statistics Vol:1 Unemployment and Underemployment Report. Q1 – Q3, 5. Nigeria, 2017
[18] Mbamali, I. The impact of accumulation of deferred maintenance on selected buildings of two federal universities in the northwest zone of Nigeria. Journal of Environmental Sciences. Vol. 5, Number 1, pp 77-83, 2003
[19] Kadiri, Z.O., Nden, T., Avre, G.K., Oladipo, T.O., Edom, A., Samuel, P.O., & Ananso, G.N. Causes and Effects of Accidents on Construction Sites (A Case Study of Some Selected Construction Firms in Abuja F.C.T Nigeria), IOSR Journal of Mechanical and Civil Engineering, Vol.11, Number 5, pp 66-72, 2014.
[20] Safework. Erection, climbing and dismantling tower cranes. Industry plant consultative committee, New South Wales, Australia, October 31, 2016
[21] Occupational Safety and Health Administration (OSHA). Region 6 News Release: 12-2231- DAL, United States, November 20, 2012
[22] Ting, F. "The promotion strategy of occupational health and safety by government." Annual meeting of Hong Kong Construction Association Limited, Hong Kong, 2007
[23] Zhao, Q. Cause analysis of US crane-related accidents, MSc Dissertation, Graduate School of the University of Florida USA, 2011