International Journal of ChemTech Research
CODEN (USA): IJCRGG, ISSN: 0974-4290, ISSN(Online):2455-9555
Vol.11 No.08, pp 134-140, 2018

Control System Review and Hazop Study of a Crude Visbreaking Plant

Zeyad M. Ahmed

Jazan University, Faculty of Science and Engineering, Saudi Arabia

Abstract : The chemical and process industries have been using a variety of hazard and operability problems identification techniques for many years, the most well-known of which is HAZOP.Hazop is a structured and systematic examination of a planned or existing process or operation in order to identify and evaluate problems that may represent risks to personnel or equipment, or prevent efficient operation In this paper the process control review and Hazop study has applied for a Visbreaking plant. Before applying Hazop technique for the visbreaking unit, the plant process control was reviewed to identify design intents for all equipment in the plant,then the Hazop study for the Visbreaking Plant has conducted. The result of hazop study shows that there is no deviation from the design intents for all nods (equipment) in the plant; and hence there are no Hazard or operability problems in the plant.
Keywords : *Hazop, Visbreaking, Nods,Soaker, Intention, Deviation.*

1. Introduction

1.1 Visbreaking Operation

Visbreaking operation is a relative mild thermal cracking operation mainly used to reduce the viscosities and pour points of heavy crude oil. There are two types of visbreaker operations, coil and furnace cracking and soaker cracking. Coil cracking uses high furnace outlet temperature885-930^{0}Cand reaction times from one to three minutes while soaker cracking uses lower furnace outlet temperatures (800-830^{0}C) and longer reaction times. The product yields and properties are similar, but the soaker operation with its lower furnace outlet temperatures has the advantages of lower energy consumption and longer run times before having to shut down to remove coke from the furnace tubes. Run times of 3–6 months are common for furnace visbreakers and 6–18 months for soaker visbreakers. This apparent advantage for soaker visbreakers is at least partially balanced by the greater difficulty in cleaning the soaking drum.[1]

1.2Hazop Technique

The technique of Hazard and Operability Studies, or HAZOPS, has been used and developed over approximately four decades for 'identifying potential hazards and operability problems' caused by 'deviations from the design intent' of both new and existing process plants. The HAZOP method (Hazard Operability study)

DOI= http://dx.doi.org/10.20902/IJCTR.2018.110814

was developed by ICI in the early70s. In the 1980s risk studies gradually came into use in petrochemicals, oil, chemicals, rail transport, automobiles and other industries. [2]

The HAZOP technique was initially developed to analyze chemical process systems, but has later -been extended to other types of systems and also to complex operations such as nuclear power plant operation and to use software to record the deviation and consequence.[3]

HAZOP can be used in the various stages of the plant design, operation and maintenance. HAZOP study at the design stage is the most ideal. The drawings are checked for correctness and the questions regarding the design in a particular way are answered readily. At this stage it is possible to study the section of the plant, the designs of which are established and should be taken to review this later to ensure that interactions have not introduced new hazards. It is also possible to incorporate necessary changes during the design stage. [4]

The main advantage of this technique is its systematic thoroughness in failure case identification.

1.2.1 Terminology used for Hazop

Study Node: Section of equipment with definite boundaries within which process parameters are investigated for deviations such as Heat exchangers, Reactors, Distillation tower ….ect

The location on P&ID's (Process and Instrumentation Diagram) at which process parameters are investigated for deviations.

Intention: Definition of how plant is expected to operate in the absence of deviations. It can be either descriptive or diagrammatic.

Guide Words: Simple words that are used to qualify/quantify the design intentions and to guide and stimulate the brainstorming process.

Process parameters: Physical or chemical property associated with the process.

Deviations: Departure from the design intentions that are discovered by systematically applying suitable guide words.

Causes: Reasons why deviations might occur.

Consequences: Results of deviations

Safeguards: Engineered systems or administrative control designed to prevent causes.

Recommendations: Suggestions for design.

2. Hazop Methodology

Essentially, the HAZOP examination procedure systematically questions every part of a processor operation to discover qualitatively how deviations from normal operation can occur and whether further protective measures, altered operating procedures or design changes are required.[6]

The examination procedure uses a full description of the process which will, almost invariably, include a P&ID or equivalent, and systematically questions every part of it to discover how deviations from the intention of the design can occur and determine whether these deviations can rise to hazards.

The questioning is sequentially focused around a number of guide words which are derived from method study techniques. The guide words ensure that the questions posed to test the integrity of each part of the design will explore every conceivable way in which operation could deviate from the design intention.

Some of the causes may be so unlikely that the derived consequences will be rejected as not being meaningful. Some of the consequences may be trivial and need be considered no further. However, there may be some deviations with causes that are conceivable and consequences that arc potentially serious. The potential problems are then noted for remedial action. The immediate solution to a problem may not be obvious and could need further consideration either by a team member or perhaps a specialist. Alldecisions taken must be recorded.

3. Results and Discussion

3.1 Control system review

General

Crude visbreaking plant is controlled mainly by the operator at the existing control room. Process set point can be varied in DCS as required, but it just be varied by the authorized person, like process manager or instrument engineer who have the control system password.

Control system

DCS and ESD

3.2 Main equipment and main process

Operating and control philosophy for main equipment and main process are following.

3.2.1 Desalter Operation and Control

Each desalter has two oil & water interface transmitters. When interface is high, the water injection control valve must be closed. Each desalted inlet has one differential pressure control loop. Normally, the set point of the differential pressure is 50kPa, it can be adjusted according to process and operating requirement in a low range

3.2.2 Flash Drum Operation and Control

Flash drum has a level control loop cascade with flash drum feed loop.

3.2.3 Furnace Operation and Control

Furnace has a outlet temperature control loop (cascade with fuel gas flow loop, a flue oxygen component control loop, and a furnace pressure control loop. The furnace feed has single control loop.

Fuel gas loop is used to control the temperature of furnace outlet temperature.. Flue oxygen component control loop controls opening of flue damper to keep appropriate oxygen percentage in the furnace and this for high burning efficiency.

Pressure control loop is used to control the furnace pressure and to insure furnace being in a good operating condition.

3.2.4 Soaker Operation and Control

Soaker has a overhead pressure control loop which control and monitor the pressure of the control valve.

3.2.5 Fractionator Operation and Control

Fractionator has an overhead oil and gas temperature control loop (cascade with overhead reflux control loop. A bottom oil temperature control loop (cascade with quenching loop of fractionator). A mid stage oil & gas temperature control loop (cascade with mid stage reflux loop) A reflux loop to control reflux oil flow to down collector. A bottom oil level control loop, and a collector oil level loop (cascade with flow loop).

3.2.6 Overhead Oil & Gas Separator Operation and Control

Overhead oil & gas separator has inlet temperature control loop, a level control loop and a gasoline & water interface control loop .

3.2.7 Heat Exchanger Operation and Control

Heat exchanger has a outlet visbroken oil temperature control.

3.2. Hazop Study of a Crude Visbraking Plant

3.3.4 Viscosity of visbroken oil

Intention: at 80^0C the viscosity of visbroken oil must be less than 35.64 mm^2/s.
Relevant parameters:furnace outlet temperature, soaker overhead pressure.
Control mode: manually adjust the set points of temperature at outlet of furnace and soaker overhead pressure.

Table 1.Solution to abnormal conditions for Viscosity and Stability of visbroken oil

Deviation	Causes	Solutions
Viscosity of visbroken oil is greater than design value	a. lower outlet temperature. b. shorter retain time in soaker due to lower pressure c. soaker heat insulation is damaged d. heavier crude oil	a. adjust raise temperature set point b. adjust raise pressure set point c. change damaged heat insulation

3.3.2. Control of Critical Process Parameters

3.3.2.1.Desalter Feeding Temperature

Control objective: 120 - 140^0C

Relevant parameters: Inlet crude oil temperature, flow rate and temperature of visbroken oil which is exchange heat with crude oil.

Control mode: manually adjust

Table3. Solution of abnormal conditions for Desalter Feeding Temperature

Deviation	Causes	Solutions
The desalter Inlet temperature is lower than 120^0C	a. low temperature or flow rate of visbroken oil. b. higher water content of inlet crude oil. d. high flow rate of crude oil.	a. raise temperature of inlet crude oil. braise temperature or flow rate of visbroken oil. d. adjust flow rate of crude oil.
The desalter Inlet temperature is higher than 140^0C	a.high temperature or flowrate of visbroken oil b. low flowrate of crude oil	a. reduce visbroken oil temperature b. Reduce flow rate of visbroken oil c. adjust flowrate of crude oil .

3.3.2.2 Desalter Operation Pressure

Control objective: Control pressure is 0.9±0.1 Mpa.
Relevant parameters: discharge pressure of crude oil pump, open inlet valve.
Control mode: manually/ automatically adjust.

Table 4. Solution to abnormal conditions for Desalter Operating Pressure

Deviation	Causes	Solutions
Pressure higher than 0.9+0.1MPa	a. high flow rate of inlet crude oil. b. high water content of crude oil. c. blockage in piping system after desalter. d. pressure set point is too high.	a. decrease inlet crude oil flow rate set point. b. check pipe and equipments after desalter. c. reduce pressure set point.
Pressure is lower than 0.9-0.1MPa	a. low flow rateof inlet crude oil. b. pressure set point is too low	a. increase inlet crude oil flowrate set point. b. raise pressure set point.

3.3.2.3 Furnace Outlet Temperature

Control objective: 425 - 435^{0}C

Relevant parameters: heat-exchanger outlet temperature,feed of furnace.

Control mode: manually set, automatically adjusted.

Table 5. Solutions to abnormal conditionsof Furnace Outlet Temperature

Deviation	Causes	Solutions
Furnace outlet temperature is lessthan 425^{0}C	a. heat exchanger outlet temperature is low b. furnace feed flowrate is above than 1.2 times of design intent. c. incorrect set point of furnace	a. adjust heat-exchanging system b. reduce furnace feed flow rate to design range. c. reset set point of furnace outlet temperature.
Furnace outlet temperature is greater than 435^{0}C	a. furnace outlet temperature set point is incorrect	a.reset set point of furnace outlet temperature

2.5.3.2.4 Soaker Overhead Pressure

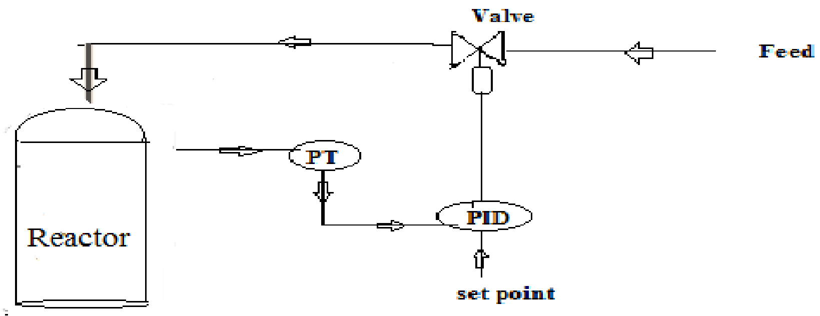

Figure 1. Process control Diagram for Soaker Overhead Pressure

Control objective: 0.4±0.05MPa
Relevant parameter: furnace outlet temperature
Control mode: manually/automatically adjust

Normal adjustment:

(1) Adjust pressure set point.

(2) Check if pressure gage and control system is working normally.

Table 6. Solutions to abnormal conditionsfor Soaker Overhead Pressure

Deviation	Causes	Solutions
High overhead pressure	Dehydration during start up stage is not complete	Separation of water from soaker crude oil feed.

2.5.3.2.5 Fractionator Overhead Temperature

Control objective: 140-180^{0}C
Relevant parameter: overhead pressure
Control mode: manually/automatically adjust

Table 7. Solution to abnormal conditions of Fractionator Overhead Temperature

Deviation	Causes	Solution
Sharp increase of overhead temperature and pressure	1- Water content of reflux is high. 2- high feedspecific gravity 3-Dehydration during start up stage is not complete.	Check parameters (Pressure and Temperature) one by one and adjust relevant parameters if necessary to decrease overhead temperature and pressure eventually.

2.5.3.2.6 Fractionator Overhead Pressure

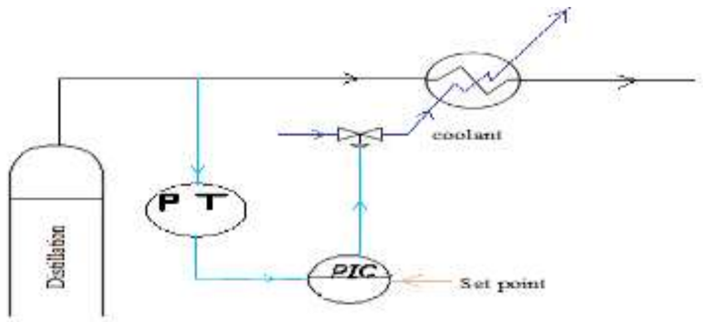

Figure 2.Process control Diagram for Fractionator Overhead Pressure

Control objective: 0.28±0.05MPa
Relevant parameter: overhead temperature
Control mode: manually/automatically adjust

Table 8. Solution to abnormal conditionFractionator Overhead Pressure

Deviation	Cause	Solution
high increase of overhead temperature and pressure	1-Water content in reflux is higher, 2-feeding gravity is lighter, 3- Dehydration during start up stage is not completed.	Check parameters (Pressure and Temperature) one by one and adjust relevant parameters if necessary to decrease overhead temperature and pressure eventually.

2.5.3.2.7 Fractionator Bottom Temperature

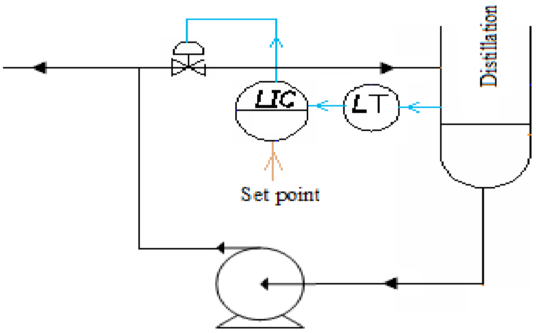

Figure 3. Process control Diagram for Fractionator Bottom Temperature

Control objective: 340 – 350^{0}C
Relevant parameters: temperature and flow rate of quenching oil
Control mode: manually/automatically adjust.

Table 9. Solution to abnormal condition for Fractionator Bottom Temperature

Deviation	Causes	Solution
Bottom fluid temperature is greater than 350^{0}C	malfunction of instrument control. failure of heat Exchanger	Check all instrument control

4. Conclusion

The systematic qualitative study namely hazard and operability study can be carried out at the design stage which would help to identify the hazard and operability problems and thus contributes to plant safety. This qualitative study helps in building fault trees and for further quantitative risk analysis like consequence.

Acknowledgements

First of all, my thanks to Allah for giving me health and luck to complete this study. I would like to express my deep gratitude and my sincere thanks to Visbreaking Plant staff .With special mention to Engineers, Tarig and Waleed. It was fantastic to have the opportunity to work majority of my research in your plant.

References

1. Gary JH, Handwerk G E. Petroleum refining technology and economics. Fourth edition: Marcel Dekker publisher; 2001.
2. Solomon CH. The Exxon Chemicals Method for Identifying Potential Process Hazards:I Chem E Loss Prevention Bulletin No. 52; 1983.
3. Knowlton RE. Creative checklist hazard and operability studies.Chemical manufacturers association: Process Safety Management Workshop, Arlington, Virginia;1985.
4. House A. A guide to hazard and operability studies: chemical industries association. London; 1977.
5. Kletz TA. Hazop and hazan: Institution of Chemical Engineers, UK; 1986.
6. Knowlton RE. An introduction to hazard and operability studies:Chemetics International Ltd.; 1981.
7. Lawley HG. Operability studies and hazard analysis: Chem. Eng. Prog. ; 1974.
8. H Heinemann H. The chemistry and technology of petroleum. Fourth edition: Taylor & Francis Group; 2006.

*****