I admit that I have read this report and in my opinion this report is sufficient from the perspective of the scope and quality for awarding purposes Bachelor of Mechanical Engineering (Thermal Fluid)

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TO IDENTIFY ON THERMODYNAMIC STEAM TRAP FAILURE MECHANISM ON HORIZONTAL INSTALLATION.

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I hereby declare that the word or the sentences in this thesis is of my own except for quotations and summarize which have been acknowledge.

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ABSTRACT

After finishing the industrial training in Petronas Penapisan Melaka Sdn Bhd (PPMSB), writer found that steam trap is a very important device used in steam system. Steam trap population in PPMSB is approximately 5800 plus. Great numbers of steam trap used in plant but small in size, make them as though they were neglected. Steam traps frequently fail but they were not noticed except when they are leaking. Different brands and types of steam trap being used by different units and areas in PPMSB plant. For industrial use, every steam trap was designed for designated reasons but usually being replaced blindly when they failed. Steam traps affect steam balance, product's temperatures and reduce of water hammering risk. Due to steam trap failures, PPMSB are losing more than 100 tonnes per day of steam, hence losing more than RM100,000 per month. For that reason, deep research should be done to identify the steam trap failure and try to find the solution because from the research result, it can help industrial especially have an involvement with steam generation to increase their profit and reduce operation cost in providing steam.In order to do that, early study and literature review of the related field is needed in order to accomplish this goal. After this step is done, we have to learn how the internal part of steam trap fail and make comparison the failure of actual steam trap and simulation sample of steam trap using CFX 5 Simulation Software. This software is one of the frequently used software in research industry for Computational Fluid Dynamic (CFD). In addition, we have to find a solution how to overcome this failure by doing the analysis and give a suitable recommendation.

ABSTRAK

Setelah menjalani latihan industri di Petronas Penapisan Melaka Sdn Bhd, penulis mendapati bahawa perangkap stim adalah satu peralatan yang amat penting digunakan di dalam sistem stim. Populasi untuk perangkap stim di PPMSB menjangkau sehingga lebih 5800 buah. Satu jumlah yang begitu banyak digunakan di dalam loji tetapi sering diabaikan kerana saiznya yang kecil. Perangkap stim juga sering mengalami kerosakan tetapi tidak diketahui melainkan setelah ianya bocor.Pelbagai jenama dan jenis perangkap stim digunakan di dalam pelbagai unit dan kawasan loji PPMSB. Setiap perangkap stim direka bentuk dengan fungsi tersendiri tetapi apabila ia mengalami kerosakan, selalunya diganti dengan begitu sahaja tanpa meneliti keadaan sistem yang digunakan. Perangkap stim juga mempengaruhi keseimbangan stim di dalam sistem, suhu produk dan juga menurunkan risiko penukul air.Disebabkan oleh kegagalan perangkap stim, PPMSB mengalami kehilangan stim sehingga 100 tan sehari menyebabkan kerugian menjangkau sehingga RM 100,000 sebulan.Oleh sebab itu, kajian yang lebih mendalam perlu dijalankan untuk mengenal pasti punca sebenar kegagalan perangkap stim dan mencari langkah yang sesuai untuk mengatasinya kerana dengan hasil kajian yang diperolehi ianya dapat membantu pelbagai pihak terutamanya yang terlibat di dalam penjanaan stim untuk meningkatkan keuntungan syarikat dan menurunkan kos operasi menghasilkan stim.Untuk melaksanakannya, pencarian maklumat terhadap bidang yg berkaitan perlu dilakukan. Setelah itu, kajian bagaimana perangkap stim rosak perlu dilakukan dan membuat perbandingan antara contoh sebenar perangkap stim dengan contoh simulasi dengan menggunakan perisian simulasi CFX 5. Perisian ini merupakan perisisian yang sering digunakan di dalam bidang Dinamik Bendalir Berkomputer. Selain itu, kita juga perlu mencari penyelesaian untuk mengatasi masalah ini dan memberikan cadangan yang sesuai.

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NOMENCLATURE	DEFINITION
HP	High Pressure
MP	Medium Pressure
LP	Low Pressure
LLP	Low Low Pressure
PERMATA	Petronas Management Training
CFD	Computational Fluid Dynamic
OK	Normally Operating
FO	Failed Open
FC	Failed Close
FOP	Failed Open Partial
OS	Out of Service
OFF	Off
UNK	Unknown
N/A	Not Accessible
PPMSB	Petronas Penapisan Melaka Sdn Bhd

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CHAPTER 1

INTRODUCTION

1.1 Introduction of Project

Condensate is formed whenever steam gives up its enthalpy of evaporation (latent heat). The proper removal of condensate from steam plant of all types is vital if the plant is to work efficiently and this operation is commonly performed by a steam trap.

Frequent causes of unsatisfactory condensate drainage include the choice of the wrong type of steam trap for the application, the use of a trap that is incorrectly sized for the load and pressure conditions and bad installation. Because any of these factors can seriously reduce plant output, it is worth spending some time studying how steam traps work and their application.

A steam trap is a self-contained automatic valve which automatically drains the condensate from a steam-containing enclosure while remaining closed to live steam. Some traps pass live steam at a controlled rate. Most traps also pass air and other non condensate gases while remaining closed to live steam.

The difference between condensate and steam is sensed in several ways. One group of traps detects the difference in density, another group reacts to a difference in temperature, and a third relies on the difference in flow characteristics.

Efforts and methods implementation needs to be considered are; study on the steam trap characteristics, design and how it works in real application in industry. The methodology uses are theoretical and simulation. The role of theoretical method in this study is to get the beginning data of steam system used in industry, frequent used of steam trap in industry and also type of failure happen on steam trap in industry. Meanwhile, the simulation method is to see the change and to compare result with theoretical method. The type of simulation use is CFX-5 to get the beginning result.

1.2 Purpose of the Study

The purpose of this study is to learn how the internal parts of thermodynamic steam trap fail. CFX-5 simulation software is used in order to implement the task. Steam trap internal part needed to be emphasis with perfect sizing to investigate the part that gives an effect on steam trap efficiency.

1.3 Problem Statement

Thermodynamic steam trap have a frequent failure in the horizontal position. This failure applies to all type of pressure; High Pressure Steam (HP Steam), Medium Pressure Steam (MP Steam) and Low Pressure Steam (LP Steam).

1.4 Focus

The focus of this study is at the internal part of thermodynamic steam trap. The component need to be emphasis is when steam flow into inlet of thermodynamic steam trap and moving around the steam trap, critical point of steam trap should be analyzed in order to increase its efficiency.

1.5 Objectives

The objectives of this study are as follows:

1. To learn how the steam traps functioning and operate in steam system.
2. To learn how the internal parts of thermodynamic steam trap fail
3. To compare the failure of actual sample and simulation sample of steam trap
4. To find a solution how to overcome the failure of steam trap.

In order to complete the task, need to study on thermodynamic steam trap internal part and doing simulation by using CFX-5 Simulation Software. It is intended to know the involved basic principle such as principle of steam trap, how it works and early study on steam system used in industry.

1.6 Scope

The scope of this thesis is to learn how steam trap functioning and operational in steam system. To do that, early study and literature review of the related field is needed in order to accomplish this thesis. After this step is done, we have to learn how the internal part of steam trap fail and make comparison the failure of actual steam trap and simulation sample of steam trap using CFX 5 Simulation Software. This software is one of the frequently used software in research industry for

Computational Fluid Dynamic (CFD). In addition, we have to find a solution how to overcome this failure by doing the analysis and give a suitable recommendation.

1.7 Outline Thesis

In chapter 2, it is explained about the literature review that has been done. There are many title of thesis by earlier researcher on how to improve the performance of steam trap. Within this research, there are many factors that influence the steam trap efficiency such as quality of steam used, maintenance of steam trap and type of steam trap used in industry.

In chapter 3, this part explains about method used in order to solve the problem that involve in this research. Simulator program is used to get the result on the experiment. The type of simulator used is CFX-5. Meanwhile, steam trap used is thermodynamic steam trap and the research is on the internal part of thermodynamic steam trap. It also explains about expected result that can be achieved. The result possibility is the critical point in internal part of steam trap when steam is flowing through it can be found.

In chapter 4, the result and discussion of overall simulation will be explained in full detail about the main founding during simulation.

In chapter 5, the conclusion and recommendations of this thesis will be explained in order to finalize this thesis. As a conclusion, this research will give big impact to industry that is using steam trap in order to increase the profit of company and reduce of steam loss.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction of Steam System

There are three principal forms of energy used in industrial processes: electricity, direct-fired heat, and steam. Electricity is used in many different ways, including mechanical drive, heating, and electrochemical reactions. Direct-fired energy directly transfers the heat of fuel combustion to a process. Steam provides process heating, pressure control, mechanical drive, component separation, and is a source of water for many,process reactions.

Steam has many performance advantages that make it an indispensable means of delivering energy. These advantages include low toxicity, ease of transportability, high efficiency, high heat capacity, and low cost with respect to the other alternatives. Steam holds a significant amount of energy on a unit mass basis (between 1,000 and 1,250 Btu/lb) that can be extracted as mechanical work through a turbine or as heat for process use. Since most of the heat content of steam is stored as latent heat, large quantities of heat can be transferred efficiently at a constant temperature, which is a useful attribute in many process heating applications.

Steam is also used in many direct contact applications. For example, steam is used as a source of hydrogen in steam ethane reforming, which is an important process for many chemical and petroleum refining applications. Steam is also used to control the pressures and temperatures of many chemical processes. Other significant applications of steam are to strip contaminants from a process fluid, to facilitate the fractionation of hydrocarbon components, and to dry all types of paper products. (Bloom.D. et al, 2001),

2.2 Types of Steam

There are four types of steam systems:

1. High Pressure Steam (HP)
2. Medium Pressure Steam (MP)
3. Low Pressure Steam (LP)
4. Low Low Pressure Steam (LLP)

TYPE	DESCRIPTION
HP Steam	• Generated by boilers • Used to drive steam turbines • Provide heat for Heat Exchangers • Temperature range 375-395 degree C
MP Steam	• Produced by passing the HP steam through Desuperheater • Temperature range 207-220 degree C • Used by Reboilers
LP Steam	• Produced by flashing condensate from Reboilers that used MP steam • Used in other Reboilers, Deaerator and cold flare stack
LLP Steam	• Produced by flashing condensate from Reboilers that used LP steam • Used in different heaters, vaporizer and other Reboilers

Table 1-2: Types of Steam

(Table is courtesy of PERMATA (2002), Basic Utilities Operation)

2.3 Steam System Operation

Four important categories need to be discussing in steam system components and ways to enhance steam system performance: generation, distribution, end use, and recovery. These four areas follow the path of steam as it leaves the boiler and returns via the condensate return system. (Marina L.D. et al, 2002)

2.3.1 Generation

Steam is generated in a boiler or a heat recovery steam generator by transferring the heat of combustion gases to water. When water absorbs enough heat, it changes phase from liquid to steam. In some boilers; a superheater further increases the energy content of the steam. Under pressure, the steam then flows from the boiler or steam generator and into the distribution system. (Bloom D. et al, 2001)

2.3.2 Distribution

The distribution system carries steam from the boiler or generator to the points of end use. Many distribution systems have several take-off lines that operate at different pressures. These distribution lines are separated by various types of isolation valves, pressure regulating valves, and, sometimes, backpressure turbines. A properly performing distribution system delivers sufficient quantities of high quality steam at the right pressures and temperatures to the end uses. Effective distribution system performance requires proper steam pressure balance, good condensate drainage, adequate insulation, and effective pressure regulation. (Bloom D. et al, 2001)

2.3.3 End Use

There are many different end uses of steam. Examples of steam's diverse uses include process heating, mechanical drive, moderation of chemical reactions, and fractionation of hydrocarbon components. Common steam system end-use equipment includes heat exchangers, turbines, fractionating towers, strippers, and chemical reaction vessels. In a heat exchanger, the steam transfers its latent heat to a process fluid. The steam is held in the heat exchanger by a steam trap until it condenses, at which point the trap passes the condensate into the condensate return system. In a turbine, the steam transforms its energy to mechanical work to drive rotating machinery such as pumps, compressors, or electric generators. In fractionating towers, steam facilitates the separation of various components of a process fluid. In stripping applications, the steam pulls contaminants out of a process fluid. Steam is also used as a source of water for certain chemical reactions. In steam methane reforming, steam is a source of hydrogen. (Bloom D. et al, 2001)

2.3.4 Recovery

The condensate return system sends the condensate back to the boiler. The condensate is returned to a collection tank. Sometimes the makeup water and chemicals are added here while other times this is done in the deaerator. From the collection tank the condensate is pumped to the deaerator, which strips oxygen and non-condensable gases. The boiler feed pumps increase the feed water pressure to above boiler pressure and inject it into the boiler to complete the cycle. Figure 2-1 provides a general schematic description of the four principal areas of a steam system. (Bloom D. et al,2001)

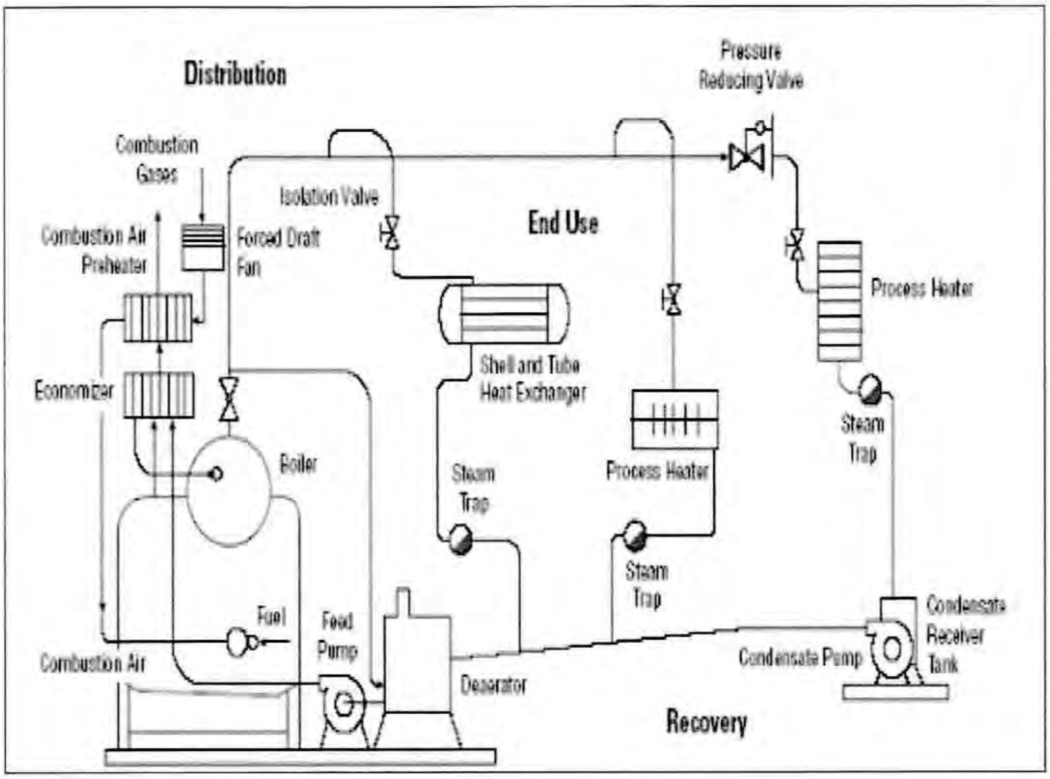

Figure 2-1: Steam System Schematic
(Illustration Courtesy of Bloom D. et al, 2001)

2.4 The Need for Steam Trap in Steam System

Humankind has developed an almost insatiable thirst for energy especially the demand for fossilized fuels that can be burned in boilers to produce heat and then indirectly power.

Heat is required for warmth and also for processing many types of products. This heat is transported from the boiler to the point of use by a heat transfer medium such as water, high temperature oil or steam. The latter is in fact the most versatile medium and for that reason is widely used throughout the world.

Steam is generated in the boiler and conveyed through piping to the steam using equipment. However in spite of the fact that the steam pipe work is usually well insulated to prevent the loss of heat, some heat will be radiated from the piping. Steam traveling along the pipe work will transfer some of the heat is carrying to the wall of the pipe to make up the losses due to radiation and in so doing some of the system will condense forming condensate (hot water) in the bottom of the pipe.

If this condensate were allowed to remain in the pipe, it would both extract more heat from the steam and also gradually fill up the pipe, blocking the passage of steam with disastrous consequences. What is therefore required is a simple automatic device that will allow such condensate to drain from the pipe without allowing steam to escape.

Such a device is known as a steam trap and its importance in maintaining the safety and efficiency of the steam system should not be underestimated. Similarly when steam finally enters the equipments, heat is transferred through the wall to the fluid or product being heated. As the steam is gives up its heat it condenses, the condensate so formed beginning to collect within the steam space of the equipment. Like the steam pipe work, this condensate should not be allowed to remain, otherwise the process of heat transfer would slow down and eventually cease altogether.

Once again, therefore, the simple automatic steam trap must be used to drain away the condensate without any steam escaping. Steam traps are however required to carry out one further function that is not at first apparent. When a steam system is shut down air enters the pipe work to occupy the space left by the condensing steam. Upon start up this air is pushed ahead of the steam to the far point of the pipe work system and also into the steam using equipment. It therefore reaches the drain outlets to which the steam traps are connected. Steam trap must also then be capable of discharging air and non-condensable gases for otherwise if these were allowed to