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FACULTY OF ENGINEERING

DEPARTMENT CHEMICAL AND PROCESS ENGINEERING

AGRO-PROCESSING ENGINEERING PROGRAMME
FINAL YEAR PROJECT REPORT

Design and simulation of a vacuum insulation tube for steam pipes

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ABSTRACT

An industrial steam boiler is a closed vessel which is used to heat up water into vapour (steam). Steam is a colorless, odorless gas with the ability to transfer large amounts of thermal energy due to its high enthalpy. This high enthalpy makes steam an excellent candidate for a wide variety of applications such as heat treatment, sterilization, pharmaceuticals, energy production, and drying (Kandel, 2010). During the transfer of steam through the steam pipes, the temperature of steam heats up the interior of the steam pipe creating a temperature gradient between the interior and the exterior of the pipe. This temperature gradient causes heat to flow from the interior of the pipe to the exterior thus heating up the surface of the pipe. This results into skin burn accidents and heat losses due to condensation of the steam among other problems.

On noticing this, many researchers have tried to come up with possible solutions to these problems by designing insulators like Asbestos insulation, Fiberglass Blanket Insulation, Calcium Silicate Insulation, among others. However, these insulations are not efficient in the long run because they heat up and expand creating gaps within the insulator which leads to accidents. Furthermore, these insulators are designed with a very thick material leading to wastage of resources.

Therefore, this project is aimed at designing vacuum insulation tubes (VIT), so as to solve problems of the previous insulations.VIT technology is an insulating method designed with concentric tubes separated by an insulator, and a vacuum to prevent heat loss from the steam pipes by conduction. This technology is able to achieve the surface touch temperature thus eliminating skin burn accidents, reducing heat losses and keeping the steam pipes warm. The technology is also easy to install, has a longer lifespan and requires negligible maintenance. The VIT technology design is able to keep the surface touch temperature below 60°C for more than 36 hours in the simulated environment. The VIT design is simulated with matlab and solid works. matlab simulation is a 2D model and solid works simulation is a 3D model.

DEDICATION

I dedicate this project to my beloved parents who are always around whenever I need them and they always advise me, which has enabled me to reach where I am with the help of Allah.

DECLARATION

I NAJJEMBA Leilah declare that this project report is entirely my work carried out under supervision. It has never been submitted to any institution for any academic award.

Signature: .....

Date : 24th / May / 2016

APPROVAL

This project report was compiled and submitted to the department of Agro-processing engineering of Busitema University by Najjemba Leilah under the supervision and approval of;

Main supervisor

NAME: Mr. OKETCHO Yoronimo

SIGNATURE: .....

DATE:.....

CO-supervisor

NAME: Mr. MUGISHA Moses

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1 Introduction

This chapter consists of the background of the study, problem to be addressed, justification of the study, objectives and scope of study.

1.1 Back ground of the study

Steam is a colorless, odorless gas with the ability to transfer large amounts of thermal energy due to its high enthalpy. This high enthalpy makes steam an excellent candidate for a wide variety of applications such as heat treatment, sterilization, pharmaceuticals, energy production, and drying, (Kandel, 2010).The mention of steam conjures up the thought of days gone by when steam was used to power Engines, to pump water for mines and replaced the muscle power of men and animals. In reality, steam, which powered the industrial revolution of yesterday, is still the most popular heat transfer medium in many industries. Steam continues to be an efficient heat source for industries throughout the world. However, it's most important priority remains as source of power for the production of electricity (Shabrulnitzam, 2007).

The steam plants of today are a combination of complex engineered systems that work to produce steam in the most efficient manner that is economically feasible. However, there are much heat loses in the boiler system that in turn lead to overall financial loses. Research shows that steam at 700kpa flowing through $1m^2$ of un-insulated surface will lose approximately 0.225Gj through a 24 hour period equating to approximately 81Gj per year of nature gas or 2 tons of fuel oil (wiley, 2006). According to the article published by biomass magazine (2012), every ton of wood pallet goes for up $600 which equates to $1,200 per a year lost for just $1m^2$ steam pipe. In addition to loss of heat, the pipes become inconvenient to work with since they usually heat up and exceed the surface touch temperature which is 60°C (ASTM, 2015).

Therefore this project is aimed at designing and simulation of a vacuum insulation tube (VIT) for steam pipes so as to minimize such losses. VIT technology is an insulating method designed with concentric tubes separated by an insulator, and a vacuum to prevent heat loss from the steam pipes by conduction.

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