"I confess that have been read this outstanding piece of works and at my this piece of work is acceptable from the scope and the quality for the awarded Bachelor of Mechanical Engineering (Thermal-Fluids)"

Signature : ……

Name : En. Mohd Haizal Bin Mohd Husin

Date :…….

© Universiti Teknikal Malaysia Melaka

STUDY OF NOZZLE INTERNAL DESIGN

SITI RABI'AH BT HAMZAH

This report is submitted
in partial fulfillment for Bachelor of Mechanical Engineering (Thermal-Fluids)

Faculty of Mechanical Engineering
Universiti Teknikal Malaysia Melaka

APRIL 2009

© Universiti Teknikal Malaysia Melaka

"I declare that all parts of this report are the result of my own work, except a few sections which were extracted from other resources as being mention"

Student's Signature: .....

Name: .....

Date: .....

© Universiti Teknikal Malaysia Melaka

Special for my mom and dad, Amrah Bt. Abu Bakar and Hamzah B. Arasad….
My dear friends……

© Universiti Teknikal Malaysia Melaka

ACKNOWLEDGEMENTS

In the begininng, I would like to express my thankful to God for giving the chances to fulfill my Projek Sarjana Muda (PSM). I would like to say thanks to En. Mohd. Haizal B. Mohd Husin for his guidance and concern in helping me to completed this task, also as my supervisor for this project.

Special thanks go to Fakulti Kejuruteraan Mekanikal, Universiti Teknikal Malaysia Melaka and the staffs for a teamwork and guide along my project. I'm also gratitude to my family for a moral support and to all my friends.

I would like to say thanks to my family for given me encouragement to complete my study in UTeM and surely all the mankind involved.

I am grateful to be here, to learn and create what I learn. Thanks to my beloved family and friends for all theirs' support since I have started this project until I have finished ……..

© Universiti Teknikal Malaysia Melaka

ABSTRAK

Nozel mempunyai pelbagai kegunaan dalam kehidupan seharian. Kegunaanya telah berkembang dengan pesat seperti nozel untuk mencuci kereta, mencuci pinggan (terutama di hotel), semburan pam racun (bidang pertanian) dan sebagainya. Keberkesanan nozel terbukti dan berfungsi dalam pelbagai bidang. Kepelbagain rekabentuk nozel dilakukan dengan menggunakan perisian '*Solidwork*' manakala proses larik dilakukan bagi menghasilkan nozel. Terdapat empat jenis rekaan dalaman dihasilkan berdasarkan nozel rekaan dalaman tirus. Cirri-ciri rekabentuk yang bersesuaian juga dititikberatkan supaya nozel yang akan dihasilkan dapat memenuhi piawaian yang ditetapkan. Oleh itu, kajian terhadap kadar alir, halaju, corak semburan dan masa cucian dilakukan dengan membuat perbandingan antara nozel yang direka. Nozel yang dibangunkan berjaya menghasilkan corak semburan di dalam ujian corak semburan.

© Universiti Teknikal Malaysia Melaka

ABSTRACT

Nozzles are useful for a daily life today. The usages of nozzle were spread out such as for car wash, dishwasher spray (usually at hotel), poison pump (in agriculture field) and others. The effectiveness of nozzles were prove and functions for apply in all field. Variety shapes with internal design of nozzles are made by using Solidwork software hence and lathe process to be used to fabricate the nozzle. There are four types of internal nozzle have been design. Appropriate designs characteristic also needs to emphasize to make sure that the designs of nozzle are fulfill the standard. From that, research about the spray pattern, flow rate, water velocity, and dishwasher time are made from the nozzles by comparing the different between the nozzles. Developed nozzle successful is for produce the spray pattern needed in spray test.

© Universiti Teknikal Malaysia Melaka

TABLE OF CONTENTS

© Universiti Teknikal Malaysia Melaka

© Universiti Teknikal Malaysia Melaka

© Universiti Teknikal Malaysia Melaka

LIST OF TABLE

© Universiti Teknikal Malaysia Melaka

LIST OF FIGURE

© Universiti Teknikal Malaysia Melaka

© Universiti Teknikal Malaysia Melaka

LIST OF SYMBOL

SYMBOL	DEFINITON
Q	Flow Rate
A	Area
V	Water Velocity

© Universiti Teknikal Malaysia Melaka

CHAPTER 1

INTRODUCTION

1.1 Project Background

A spray nozzle is a device that facilitates the formation of spray. When a liquid is dispersed as a stream of droplets (atomization), it is called a spray.A nozzle is a mechanical device or orifice designed to control the characteristics of a fluid flow as it exits (or enters) an enclosed chamber or pipe. A nozzle is often a pipe or tube of varying cross sectional area and it can be used to direct or modify the flow of a fluid (liquid or gas). Nozzles are frequently used to control the rate of flow, speed, direction, mass, shape, and/or the pressure of the stream that emerges from them. Many other factors can impact the spraying system. To achieve long-term, efficient, optimal performance it is need to consider the spray system in its entirety and develop a plan for evaluating, monitoring and maintaining it.

Nozzles can be described as convergent (narrowing down from a wide diameter to a smaller diameter in the direction of the flow) or divergent (expanding from a smaller diameter to a larger one) or de Laval nozzles/convergent-divergent (CD nozzles). A wide variety of nozzles are available for different applications. Application rate, spray pattern, and droplet size requirements may all influence nozzle type selection. The type

© Universiti Teknikal Malaysia Melaka

of nozzle must include a specific nozzle that is able to provide the flow rate needed to achieve the desired application rate with the selected equipment settings.

The design objective for a spray nozzle is to create a pattern of spray drops of a specific size distribution and spray distribution pattern. With a new nozzle, the application pattern from a series of nozzles in a row is evenly distributed across the spray path if the nozzles are set at the recommended height above the crop canopy. The nozzle orifice is a precisely engineered device that creates the drops of a certain average size at a specific pressure and with a designed spray distribution pattern, such as a flat fan spray.

A variety of spray nozzles are available to provide the applicator with a means of getting the right size spray drops to reduce spray drift, and to deliver the appropriate liquid flow rate so that the field application speed can be maintained. By designing the internal design of nozzle will produced the flow pattern. Some parameters involved to produce the nozzle are diameter of nozzle, design of nozzle, flow rate, and the spray pattern. The appropriate nozzle will be shown the efficiency as a dishwasher.

1.2 Objectives

The aim of this project is to study the spray pattern based on internal design influences of nozzle. To achieve this target need to design a different internal design of nozzle that satisfied and needed. Determined the spray pattern achieved from the different internal design of the nozzle. Fabricate the satisfied nozzle with different spray pattern.

© Universiti Teknikal Malaysia Melaka

1.3 Scope

This project focuses on the spray pattern of nozzle. To achieved the project need to design internal nozzle design using the software Solidwork. Design the nozzles with different internal design that can satisfy.) To determine the spray pattern which is produce by the nozzle using the practical method or simulate by software CFX. The nozzle will be test as dishwasher spray to know the effectiveness.

The scope of this study is to :

1. Study of design on spray pattern nozzles
2. Fabricate the nozzles with different internal design
3. Testing the fabricate nozzles for dishwasher spray

1.4 Problem statement

This study refers to an internal design of spray, which the spray pattern produce is based on the internal design of nozzle that created. To investigate the problem, need to study the design and spray pattern for available nozzle that use in marketing. In nozzle the most important thing that had to be alert are the design of the nozzle and the spray pattern produce by.

To design the nozzle the factors and characteristics such as the shape, diameter, and dimension should satisfied. Take the nozzle as a dishwasher spray, the aspects that should be taken is the material used. Some of nozzles use has made from copper and it takes high cost to produce also the price. The best spray pattern can give a good dishwasher and can save the cost.

© Universiti Teknikal Malaysia Melaka

To observe the spray pattern from the nozzle use the practical method or simulation by software CFX. The testing for the fabricate nozzles also can commit to show the result for the suitable dishwasher spray.

1.5 Limit of Research

There were some of benefits from this studied which is to design variety spray pattern based on internal design of the nozzle. The different internal design of nozzle can produce different spray pattern. The application of nozzle is for the dishwasher. The suitable nozzle and spray pattern can be applied for dishwasher spray to show the benefits of safety and washing based on the internal design of nozzle. The customer also can reduce a cost for nozzle and safe the water after using it. The standardize nozzle also can be applied for industrial and daily used.

© Universiti Teknikal Malaysia Melaka

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Based on previous research and observation by Spraying Systems Co., there were some types of nozzle and flow pattern obtained. Some information and reference how to produce the nozzle depends on the design to produce different flow patterns. From this research by Spraying Systems Co. was find many types of nozzle examples Hollow cone nozzle (whirlchamber-type), Hollow cone nozzle (deflected-type), Hollow cone nozzle (spiral-type), Full cone nozzle, Full cone nozzle (spiral-type), Flat spray nozzle (tapered), Flat spray nozzle (even), Flat spray nozzle (deflected-type), Hydraulic atomizing nozzle (fine mist), Two-fluid and air assisted nozzles, and Solid stream nozzle.

Spray nozzles are precision components designed to yield very specific performance under very specific conditions. Just because a nozzle is spraying doesn't mean that it is working properly. And it certainly doesn't mean that the spray system performance is optimal. Many other factors can impact the spraying system. To achieve long-term, efficient, optimal performance you need to consider the spray system in its entirety and develop a plan for evaluating, monitoring and maintaining it.

© Universiti Teknikal Malaysia Melaka

The result from the company research also based on the applications, flow rate cost, the problems of available nozzle, spray pattern quality, Spray nozzle maintenance, material, and it is also include The Value of Spray System Optimization, Setting Optimization Strategies for Your Application, Detecting Spray Nozzle Problems, Solving Spray Nozzle Problems, Automating The Spray System for Peak Performance, and Preventing Spray System Problems Before They Occur.

© Universiti Teknikal Malaysia Melaka

2.2 The Standard Work and Factors

According to ASTM (American Society Testing & Material) with code F23424-03 for Prerinse Spray Valves as the standard work for maximum flow rate is 1.2 gpm (6 lpm) while the maximum time taken is limited to 30 second per plate. The water pressure is 60 psi (414 kpa). The PG&E's Food Service Technology Service is stated the standard work and pass the test by ASTM. Some factors should be taken to produce the nozzle based on ASTM are:

i. Flow rate, $Q = AV$ (2.1)

Which is,

Q= flow rate (m^3/s) or (lpm)

A = area (m^2)

V = water velocity (m/s^2)

ii. Spray pattern

iii. Hygiene

iv. Standard Water pressure (414 kpa)

Figure 2.1 : Example of nozzle by Encore

The characteristics obtained from the test :

i. Rated spec : 1.2 gpm (6 lpm)

ii. Water Pressure : 60psi (414 kpa)

iii. Water temperature :120 F (49^oC)

© Universiti Teknikal Malaysia Melaka

2.3 The Research

Indicates the application of nozzle as a dishwasher spray, according to ASTM (American Society for Testing and Material) and code F2324-03 shows the testing for a Prerinse Spray Valves by the manufacture Encore. This project was tested by Food Service Technology Center and decide a standardize for a qualify nozzle as a dishwasher.

This test method covers the water consumption flow rate and hygiene of prerinse spray valves (here after referred to as spray valves). The food service operator can use this evaluation to select a spray valve and understand its water consumption and cleaning effectiveness.

This is the result shows after the tested:

Table 2.1 : The test result nozzle of Encore

Nozzle # 1

Test	Water Flow (gpm)	Cleanability (seconds)
1	1.17	19.54
2	1.16	21.20
3	1.17	19.94
Average	1.17	20.23

Nozzle #2

Test	Water Flow (gpm)	Cleanability (seconds)
1	1.18	21.10
2	1.18	21.40
3	1.18	20.57
Average	1.18	21.02

Nozzle # 3

Test	Water Flow (gpm)	Cleanability (seconds)
1	1.21	24.10
2	1.20	22.71
3	1.20	23.95
Average	1.20	23.59

Average Results:

	Average Water Flow (gpm)	Cleanability (seconds)
Nozzle #1	1.17	20.23
Nozzle #2	1.18	21.02
Nozzle #3	1.20	23.59
Overall Average	**1.18**	**21.61**

Testing in Accordance with ASTM F2324 - 03

© Universiti Teknikal Malaysia Melaka

2.4 Type of nozzle

This is some of sample of nozzles produce by Spraying Systems Co. for marketing. Each nozzle has it own functions and uses. For example:

a) Full cone nozzle

b) Flat Spray Nozzle

c) Hollow Cone Nozzle

Figure 2.2 : Sample of nozzles

(Source: Spraying Systems Co.,)

2.4.1 Full Cone Spray Nozzles

As a sample for this nozzle it is consisting of a nozzle body and spray tip, quick-connect nozzles can reduce maintenance time and lower costs. The spray tips can be removed for cleaning and/or replacement while the nozzle body remains on the pipe or spray header.

© Universiti Teknikal Malaysia Melaka

2.5 Detecting Spray Nozzle Problems

From the research by Spraying Systems Co. some spray nozzle problems are easy to detect. For example, quality control issues and increased maintenance time will become apparent quickly. But, there are several less noticeable symptoms that indicate your nozzles are not performing optimally. It's important to remember that visual inspection alone doesn't tell the full story. Some symptoms can't be seen and require special testing to detect

2.5.1 Flow rate change

In all nozzles, the flow rate will increase as the surfaces of the orifice and/or internal vane or core begin to deteriorate. In applications using positive displacement pumps, which provide the same capacity regardless of pressure, the spraying pressure will decrease as the nozzle orifice enlarges. Lower spray velocities and spray impact will result. Increased flow rates or lower spraying pressures may also result in larger drop sizes.

2.5.2 Deterioration of spray pattern quality

Hollow cone nozzles: As orifice wear occurs, the spray pattern uniformity is destroyed as streaks develop and the pattern becomes heavy or light in sections of the spray. Full cone spray nozzles: The spray pattern distribution typically deteriorates as more liquid flows into the center of the pattern. Flat fan sprays: Streaks and heavier flows in the center of the pattern, accompanied by a decrease in the effective spray angle coverage typify deterioration.

© Universiti Teknikal Malaysia Melaka