INCREASING EFFICIENCY OF PASTEURIZE MACHINE IN BAEL DRINK PRODUCTION BY CLEAN TECHNOLOGY

JARIYAPORN PUNKKOM

A THESIS SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR
THE DEGREE OF MASTER OF SCIENCE
(APPROPRIATE TECHNOLOGY FOR RESOURCES AND ENVIRONMENTAL DEVELOPMENT)
FACULTY OF GRADUATE STUDIES
MAHIDOL UNIVERSITY
2004

ISBN 974-04-4935-2

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ACKNOWLEDGEMENTS

I would like to express my sincere gratitude and deeply thank to my major advisor, Lect. Sanchai Sutipanwihan for his guidance, invaluable suggestion, supervision and encouragement throughout the study.

I am grateful to Lect.Chitima Singhavanich my co-advisor for her kindness ,supervision, great guidance , constructive and patient proof writing my thesis and I would like to thank Assist.Prof. Acharaporn Kumsopa and Assist.Prof. Nuttawan Yoswathana for their comments and suggestion

I would like to thank Dr. Sarasin Kittiphovanon, for his kindness, and note book.

I wish to thank my friends, Mr.Suwat Limjamroonrat, Mr.Jukkrit Wonglangka, Mr.Atthawit Wipatanawin for their supports, friendships and several helps.

Finally, I am grateful to my parents for their financial support, facilities, entirely care and love. I also thank to my brother for his suggestion

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INCREASING EFFICIENCY OF PASTEURIZE MACHINE IN BAEL DRINK PRODUCTION BY CLEAN TECHNOLOGY

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ABSTRACT

In this study, the Cleaning Technology concept which emphasises reusing reducing and recycling materials and making many small technological adjustment has been applied in order to increase the efficiency of the pasteurization and cooling system for the beverage industry. In the first part of experiment, bael juice was the sample and an old design 55 liter pasteurizing machine was used. The standard holding time for pasteurization is 15 seconds and the standard temperature is 85 ^{O}C . At these levels, holding time is sufficient to destroy any pathogenic bacteria. The first objective was check the machine's performance against these standards. All samples don't met the holding time standard, however most(83.3 %) did not meet the temperature pasteurized standard. Microbial quality analysis indicated contamination through aerobic bacteria and yeast and mould in all samples .In the second part of the experiment, the cleaning technology concept was applied. The medium of heat transfer was changed, the machine's height was raised and an improved cleaning procedure was instituted. Increasing holding time practical follow by operating manual. The analyses undertaken in the first part of the experiment were repeated. The improved system reduced the number of samples that did not meet the temperature standard from 83.3% to 58.33%. All of the samples met the holding time standard. There was less aerobic bacteria contamination and less yeast and mould contamination than previous but these were still at 16% and 41.6% about the standard respectively. Incidental calculations established that the pasteurization process used 2,432 - 2,500 liters of waste water per 1,000 kg. of product and solid waste of 204 – 210 kg . per 1,000 kg . of finished product was generated. In conclusion applying cleaning technology concept can improve the process to some extent for this machine still not have enough efficiency for using in plant and it is not the total answer to the problem.

KEY WORDS : CLEAN TECHNOLOGY /MICROBIOLOGICAL QUALITY PASTEURIZATION
99 pp. ISBN. 974-04-4935-2

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การเพิ่มประสิทธิภาพของการพาสเจอร์ไรซ์ ในกระบวนการผลิตเครื่องดื่มโดยประยุกต์ใช้หลักการของเทคโนโลยีสะอาด (INCREASING EFFICIENCY OF PASTEURIZE MACHINE IN BAEL DRINK PRODUCTION BY CLEAN TECHNOLOGY)

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บทคัดย่อ

ในการศึกษาได้นำเอาหลักการของเทคโนโลยีสะอาดเข้ามาประยุกต์ใช้ในการเพิ่มประสิทธิภาพของการพาสเจอร์ไรซ์และการหล่อเย็นในกระบวนการผลิตเครื่องดื่มเพื่อลดการสูญเสียผลิตภัณฑ์ที่เกิดจากการปนเปื้อนของแบคทีเรียที่ก่อให้เกิดโรค ในการศึกษาใช้เครื่องพาสเจอร์ไรซ์ รุ่น 55 ลิตร เป็นตัวแทนเครื่องพาสเจอร์ไรซ์ในการทดลอง และตัวอย่างที่ใช้ในการทดลองได้แก่ น้ำมะตูม ที่มีค่า pH 4.3 ผลจากการเก็บข้อมูลพื้นฐานด้านประสิทธิภาพในการฆ่าเชื้อของเครื่องพาสเจอร์ไรซ์ซึ่งเทียบได้จากเกณฑ์ของอุณหภูมิในการฆ่าเชื้อของผลิตภัณฑ์ที่85องศาเซลเซียสโดยมีระยะเวลาที่ผลิตภัณฑ์สัมผัสกับความร้อน ณ.อุณหภูมินั้นนาน 15 วินาที ซึ่งเป็นเกณฑ์ของระยะเวลาในการฆ่าเชื้อที่นานพอจะฆ่าเชื้อแบคทีเรียที่ก่อให้เกิดโรคในผลิตภัณฑ์ ผลจากการเก็บข้อมูลเพื่อศึกษาและวิเคราะห์หาปัญหาและการสูญเสียจากการทดลองก่อนการแก้ปัญหาพบว่า อุณหภูมิที่ใช้ในการฆ่าเชื้อไม่ผ่านตามเกณฑ์ที่กำหนดร้อยละ 83.3 และเวลาที่ใช้ในการฆ่าเชื้อไม่ผ่านตามเกณฑ์ที่กำหนดทั้งหมดร้อยละ 100 ผลวิเคราะห์ทางด้านจุลินทรีย์ของผลิตภัณฑ์ที่ผ่านการพาสเจอร์ไรซ์ พบการปนเปื้อนของเชื้อจุลินทรีย์ ชนิด แอโรบิค และ ยีสต์ โมลด์ เกินกว่าค่ามาตรฐานร้อยละ100 ทั้งสองชนิด ทำให้ผลิตภัณฑ์ทั้งหมดร้อยละ100 เกิดการสูญเสียทั้งหมด เมื่อวิเคราะห์หาวิธีการแก้ไขปัญหาตามหลักการของเทคโนโลยีสะอาดในการทดลองได้เลือกใช้ วิธีการเปลี่ยนตัวกลางนำความร้อนจากน้ำเป็นป็อบปารีน, ปิดฝาbalance tank และวางเครื่องไว้บนโต๊ะเพื่อเพิ่มความสูงจากปากก็อกถึงพื้นอย่างน้อย 50 เซนติเมตร และควบคุมวิธีการเปิด-ปิด วาลว์บรรจุผลิตภัณฑ์ เพื่อเพิ่มเวลาที่ผลิตภัณฑ์สัมผัสความร้อนณ.อุณหภูมิที่ใช้ฆ่าเชื้อ ได้นำมาใช้ในการทดลองพบว่าอุณหภูมิที่ใช้ในการฆ่าเชื้อของผลิตภัณฑ์ไม่ผ่านตามเกณฑ์ที่กำหนดลดลงจากร้อยละ83.3ของจำนวนการทดลองทั้งหมด เป็นร้อยละ 58.33 และเวลาที่ใช้ในการฆ่าเชื้อผลิตภัณฑ์ผ่านตามเกณฑ์ที่กำหนดเพิ่มขึ้นร้อยละ 100 ผลวิเคราะห์ทางด้านจุลินทรีย์ของ ผลิตภัณฑ์ที่ผ่านการพาสเจอร์ไรซ์พบการปนเปื้อนของเชื้อจุลินทรีย์ชนิดแอโรบิคเกินกว่าค่ามาตรฐาน (>500 cfu/ml.)ร้อยละ 16 และ ยีสต์โมลด์ ร้อยละ 41.6 ตามลำดับ ซึ่งเมื่อเปรียบเทียบการสูญเสีย ผลิตภัณฑ์ก่อนการแก้ปัญหาและหลังการแก้ปัญหา พบว่า เครื่องพาสเจอร์ไรซ์ที่ใช้เป็นตัวแทนในการทดลองยังไม่มีประสิทธิภาพเพียงพอในการฆ่าเชื้อจนถึงระดับที่ทำให้ผลิตภัณฑ์ปลอดภัยต่อการบริโภค ถึงแม้ว่ามีการสูญเสียของผลิตภัณฑ์ลดลงจากร้อยละ 58.4เป็นร้อยละ 41.6 ผลกระทบจากการผลิตต่อสิ่งแวดล้อมพบว่าเกิดปริมาณน้ำเสียโดยรวมของกระบวนการผลิตโดยรวมทั้งหมด 2,432 - 2,500 ลิตรต่อผลิตภัณฑ์ 1 ตัน และมีปริมาณของเสียที่เกิดขึ้นในกระบวนการผลิตโดยรวม 204 – 210 กิโลกรัม ต่อผลิตภัณฑ์ 1 ตัน

99 หน้า ISBN 974-04-4935-2

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LIST OF ABBREVIATIONS

CT	Clean Technology
CFU/ml	Colony-forming units per milliliter
MPN	Most Probable Number
PCA	Plate Count Agar
^{o}C	Temperature in degree Celsius
ml	Milliter
s.	Secound
min.	Minute
h.	Hour
Temp	Temperature
STD	Standard
FDA	Food and Drug Administration

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CHAPTER 1
INTRODUCTION

1.1 Background and significance of the study

There have been substantial changes in food consumption habits and safety requirements in recent years. These changes have acted as a "driving force" advancing food preservation and increased knowledge for alerting the consumer to food quality and safety. Local manufacture of fruit juice processing has increased continuously. When you go to the market you can notice an increase in the varieties and number of fruit juice brands. The fruit juice industry will continue to grow with demand as more Thai people consume fruit juice in their daily food intake. One of the problems found in fruit juice processing was the presence of contaminating microorganism. The report study of development HACCP (Hazard Analysis Critical Control Point) model for pasteurized fruit juice manufacturing in small scale industries indicated that the process which not also reduces pathogenic bacteria but also inhibits pathogenic bacteria are the pasteurizing process and cooling process . Pasteurized machine was apply to a small industry which was inexpensive and popular among consumers. The pasteurizing efficiency of the pasteurizing machine was major factor which needs to develop and improve by following standards for the most value and safety for consumer which is the direct benefit, indirect benefit was accepted among consumer. The general purpose of pasteurization is to deliver a mild thermal process. It preserves foods by inactivating enzymes with heat (for example non-sporing bacteria , yeast and molds)

In the fruit juice pasteurization process, hot juice is bottled and immediately lidded. The juice is then cooled by either placing them in a spin cooler in which they revolve under sprays of water, or by being placed in crates and into tanks of running water. The cooling process can shock bacteria and preserve product. This process should be continued until product temperature is approximately $4\ ^{0}C$. There are only two processes which can both reduced and inhibited the growth rate of pathogenic

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bacteria in fruit juice . The pasteurization machine which were distributed in Bangkok and the metropolis are a favorite for use among small fruit juice manufacturing companies . Most of them applied pasteurizing technique and have many of limited in term of cost and effective . There is still a problem with some small fruit juice manufacturers that are using pasteurization. They still have some contamination in their product which shows that the process of pasteurization and cooling is not effective enough.

Environmental pollution is a subject of intensive debate and deliberation all over the world these days. Each and every activity is being scrutinized in terms of environmental impact. One of the concepts of clean technology is to reduce waste at the source in process which have many technical for practical and one of them is improving efficiency of technology. Researchers apply this concept to solve the problem appropriately in order to reduce contamination and re- contamination in the pasteurized process and cooling process.

1.2 Purpose of study

The purpose of this research is

1. To study the efficiency of pasteurized machine that are used to reduce pathogenic bacteria in fruit juice either before and after implementing the machine by applying clean technology options.
2. To evaluate the proposed Clean Technology options in term of technical, economical and environmental impacts for the implemented plan
3. To make environment index of fruit juice process.

1.3 Profit of study

1. Have CT options which used for reduce pathogenic bacteria in fruit juice after implementing the machine.
2. Reduce lost at source of fruit juice process.
3. Have environment index of fruit juice process.

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1.4 Conceptual frame work

Case study on pasteurized machine which measured in term of physical and microbiology quality each pasteurize process for evaluated problems and selected CT options for solve that problems

1.5 Scope of study

Case study on pasteurized machine size 55 litre. This is a pasteurization machine for small fruit juice manufacturing .

Population top sale of pasteurized machine used bael fruit juice product sample.

Independent factor pasteurizing effectiveness (retention time and temperature of pasteurization)

1.6 Definition of terms

1. Clean technology is a concept and a way of thinking rather than a technology. Clean technology involves an on going effort to reduce the environmental impact of industrial activities by minimizing the consumption of raw materials and auxiliaries and/or emissions and waste.

2. Pasteurization machine is a machine which is used by small industries that is inexpensive and popular among consumers and has a capacity to pasteurize 55-300 liters per day.

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CHAPTER 2
LITERATURE REVIEW

2.1 Clean Technology

As environmental concerns become more importance to the public and this is reflected in the cost of disposal, it will become increasingly importance to minimize the waste produced by any process plant. It is thus important to understand the processes which are taking place during cleaning so that the environmental impact of the effluent is minimized and the time which plant is not operating is minimized.

2.1.1 Concept of Clean Technology

Industrial pollution is regarded as an accepted phenomenon in Thailand. There are about 90,000 registered industrial establishments in the country one-third of which are located in Bangkok Metropolitan area . Among the pollutants generated from industries. As for biological oxygen demands, major sources of industrial pollution include pulp and paper mills, textile mills, food industries. In Thailand, end-of –pipe treatment to conform to effluent standards in the norm. Such practice, however, cannot reduce the volume of waste water, only control its degree of pollution. Clean technologies refer to technologies designed specifically to prevent waste emissions at the source of generation, as opposed to treating them at the end of production process. Thus, clean technologies are designed to generate less pollution and waste than conventional technologies while saving raw materials and conserving energy whenever possible. Clean Technology includes recycling, process and production reformulation installation of more efficient equipment. (1)

Definition of Clean Technology

Clean technology is a new way of thinking to solve problems for improves better life and social living by concentrating on conserve the environment, efficiency

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and economy. Clean technology has defined in several means as follow : Clean technology was described as that pollution and waste related to the production , use and disposal of products is eliminated or minimized as much as possible and as close to the source as possible. This implies that the product or the production process is changed in such a way that the total pressure on the environment from circulation of materials and substance of a society is reduced as much as possible.(2)

Clean technology means to improve or adjust production processes or product so that to consumption of raw material, energy and natural resources is accomplished efficiently with minimum waste or none at all. It reduce pollution at source .(3)

Clean technology has defined the continuous application of an integrated preventive environment strategy to processes, product, and serviced to improve eco-efficiency and reduce risk to human and the environment.(4)

Clean technologies means proper technology and efficient management to product environmental, friendly product and simultaneously increase the profits. Principally. It is pollution reduction at source, decreases used toxic and simultaneously reduces production costs.(5)

The concept of clean technology goes beyond “clean production” which has been defined by the United National Environment Programmed (UNEP) as:

a conceptual and procedural approach to production that demands that all phase of the life cycle of a product or of a process should be addressed with the objective of prevention or minimization of short-and long-term risk to human health and to the environment.(6)

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Clean Technology Techniques

Clean Technology techniques encompass a variety of actions that are useful and beneficial in ways that go beyond waste minimization

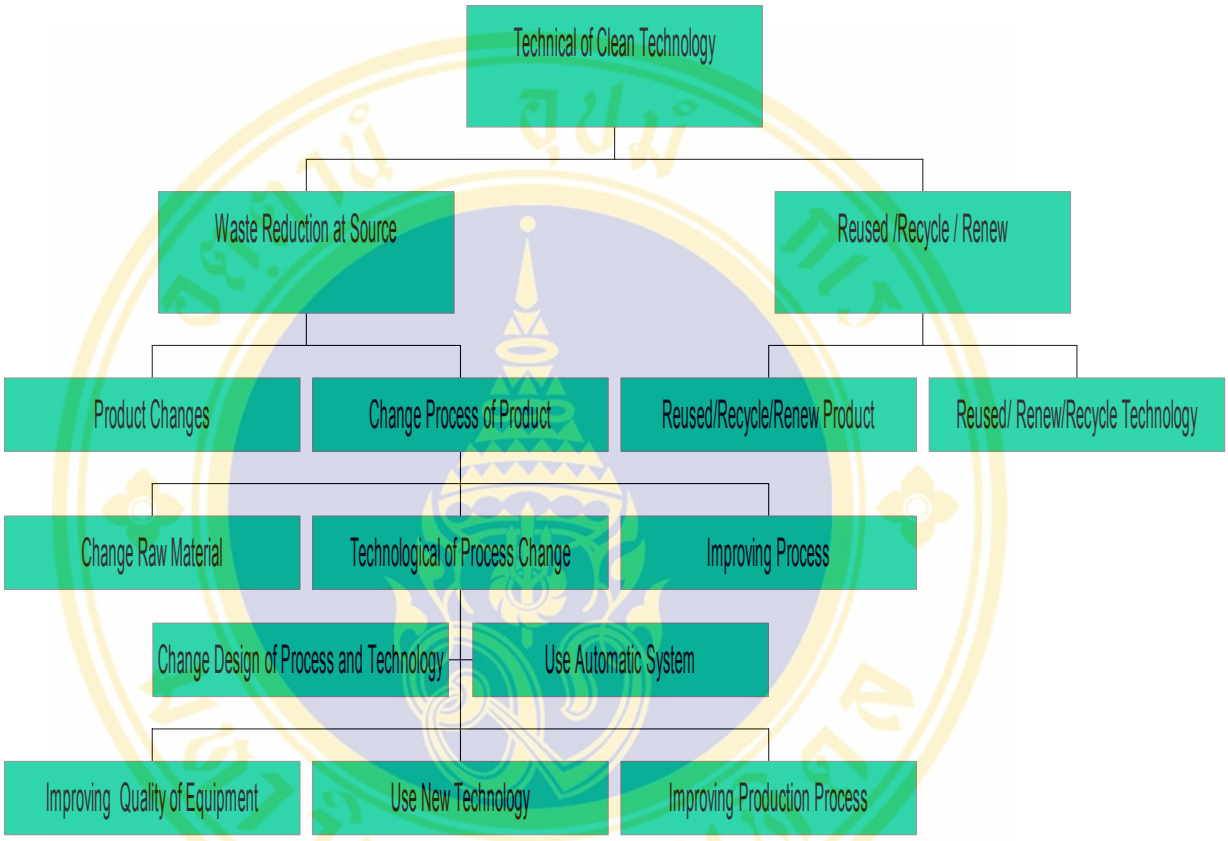

Figure 2.1 presents the components and hierarchy of Clean Technology Techniques**.** (5)

2.1.2 Clean Technology principle

The concept of clean technology was consist of 6 principles as follow :

Principle 1 Planning and Organization

Purpose: The executive and employees should be awareness for necessary of clean technology. Assemble the clean technology team. The aims were scoped.

Consequence of principle 1: The executive was promoted and supported the clean technology program, The executive and team known about clean technology concept.

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The clean technology team was assembled. Has clearly scoped of the aims.

Task of principle 1 Made understanding with the executive for supporting and promoting the clean technology program cause they can push program to success. Assemble the clean technology team. Scoped the aims. Identifying and scoping the aim of clean technology program, which can be directed team to reach the success. The aim should be possible foe action either short- and long-term and measurably. Planning for task, time table . The plan should be flexible and suitable. Find the barrier and strategy to defeat it.

i. Identify problem and barrier .Sample of problem and barrier: wrong attitude, no information, economical, technique

ii. Solve the problem .Sample the way to solve the problem: present positive thinking of clean technology concept, present the result and benefits of clean technology.

Principle 2 Pre – Assessment

This step will be done through the common sense, not deep down in detail. The result from this step will guide the next more concentrated assessment. This step is to evaluated overall impact of lost and explore for the location.

Purpose: Selected the project to the next step.

Consequence of principle 2 :

i. The processing flow chart was constructedm,ii. Prefer information for comparison before and after, iii. Clean technology option was cleared, iv. Has topic for assessment.

Task of principle 2 : Construct process flow chart

The process flow chart should be constructed by the clean technology team. The flow chart should cover all either step in the operation and data.

i. Collected information and data. plan of factory , number of employee , organization scope, processing flow chart, information of energy used , raw material , water , waste and treatment, plan of close area around factory.

ii. On – site data. The clean technology team was confirmed the process flow chart during all of operation and explore every step of process. Record on – site data.

iii. Construct the process flow chart. The process flow chart should be exactly.

Has more detail in every step.

Estimate all masses and energy loss in process by comparison (input - output)

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i. Evaluated not deep down., I. Has too enough data for evaluated input – output. Choose area for assessment as follow :i. Source of maximize waste,ii. High cost of loss,iii. Low cost for solve the problem and simplify to practical.,iv. The impact is dangerous. The member of team accepted for the way to solve.

It can be possible in term of law and future trend or increase capacity of competitive.

Principle 3 Assessment

Purpose: To evolve the clean technology options , group of alternatives of them to 2 groups that clean technology options which can be done immediately. clean technology options which need more detail for analysis.

Consequence of principle 3 :i. to develop mass balance.,ii. Can detect source and cause of loss.,iii.Ordinary of clean technology options in priority.

Task of principle 3 Derive balance

purpose of mass balance :To account for the use of raw material and cost.,Cost of raw material, product and waste.,Cost of energy used.,Cost of transportation of waste and pollution management., Cost of maintenance.

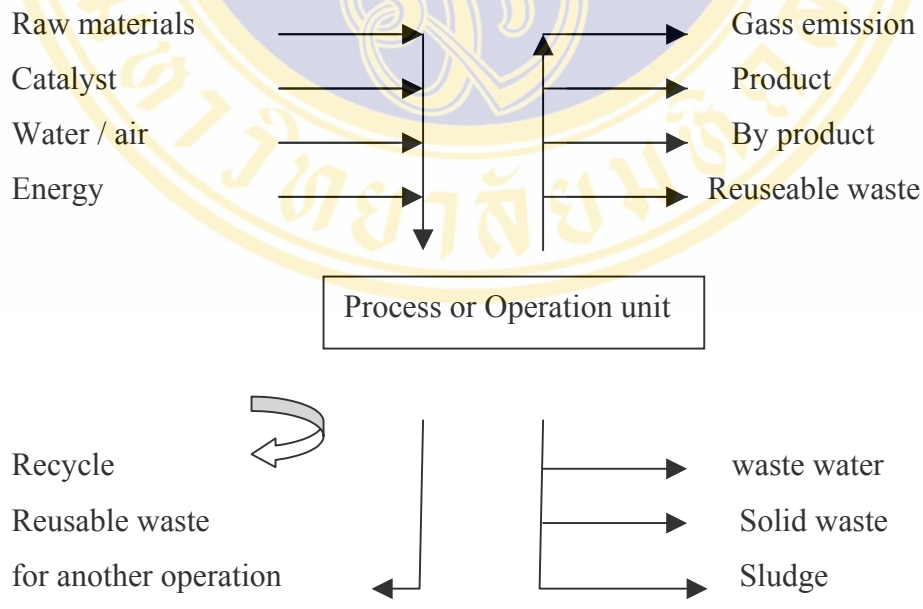

Figure 2.2 Sample of components of mass balance.(6)

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Fundamental rule

Input = Output + Accumulation

Input = Raw materials , water , energy ,etc.

Output = Products , waste solid , waste water , pollution , energy ,

stream , heat in product and wasteScope mass balance. Input mass was verified. Usually , input mass divided to raw material , chemical , water , energy , which can identify to quantity , cost , impact to human an environment. Particularly mass balance and energy balance can do it both but should be separate clearly in calculation step. Output mass was verified. Usually , output mass divided to products , by product , waste water , solid waste , and energy , which can identify to quantity , cost ,source , impact to human an environment . in term of waste should be identify of law regulation , recycle , cost of treatment and management etc.Used mass balance work sheet for unit operation. Work sheet of cost for management divided to products and has identify in put and out put follow by items such as raw material , chemical , energy used , catalyst , water air , date for begin . Input and solid waste , waste water ,sludge .heat,productand by product , energy .For out put and each issue have detail of cost (bath/ year and quantity per year.

Conduct a cause assessment

purpose : To focus the source and cause of energy and mass losses.

Strategy of conduct a cause assessment , focus on five main features involved in process.

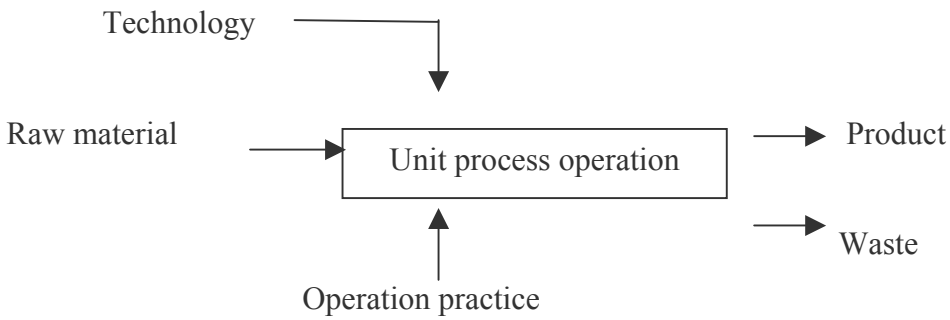

Figure 2.3 five main feature in process

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Identify the focus source loss such as:

i. Cause from raw material, low quality,unsufficient material, purchasing method unsuitable, storage method unsuitable

ii. Cause from product, too high standard, packaging design is unsuitable(contaminate with toxic substance)

iii. Cause from waste, no separate type of waste., no reuse and recycle system.,tranferring system is unsuitable., no reuse from energy loss.

iv. Cause from procedure and practical., lack of operation skill., Over responsibility., No training employee to develop their skill.

v. Cause from technology, use equipment unsuitable for capacity., Equipment be cause contaminate to product., In appropriated material transport., Use low technology.

Generate clean technology options.

List of alternatives for clean technology options for solving the problem. From production process chart , the problem including cause and effect will be received. The clean technology working team will meet to find way to solve problems. The alternatives possible are :

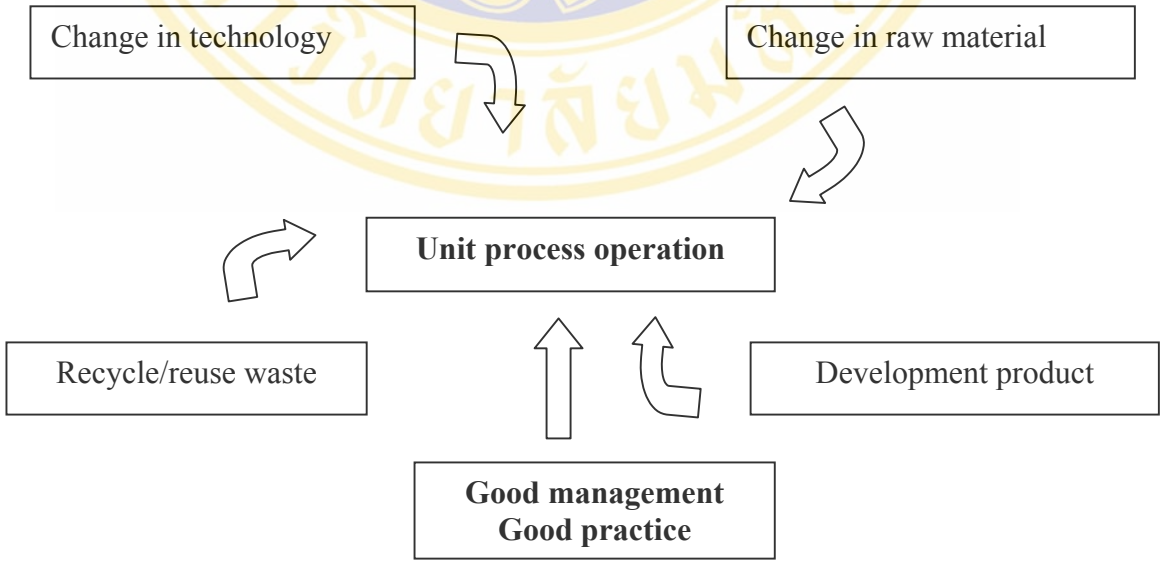

Figure 2.4 factor for selected clean technology option. (5)

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Sample of alternatives for clean technology options.

i. Change in raw materials such as : used high quality , low risk of pollution.
ii. Change in product such as : change in standard of product , composition .
iii. Good management / good practice such as : low cost to refine the process
iv. Change in technology such as : improve efficiency of equipment./ improve in technique, condition in process for control temperature , pressure , flow rate , etc.

Clean technology options are selected.

i. Classification of clean technology options.
ii. Clean technology are ordered for simply to action . Consideration of choice by factor such as : possible for action , suitable , impact in environment and human , possible in term of economical

Principle 4 Feasibility Study

Purpose : to select clean technology options for implementation

Consequence of principle 4 : Practical options are selected.,Anticipately options are recorded.

Task of principle 4 Pre-evaluation : evaluated each clean technology options that need more detail or data to decide .

Technical evaluation : to determine the clean technology options which can be possible in term of technical and economical.

i. identification of clean technology options : cost.
ii. Side effect of process : quality , production rate , delay time , risk
iii. Regulation law : occupational health , environment.

economical evaluation : to evaluate the cost – effectiveness of a clean technology options. collect data for calculation of investments and operating cost.

The total investment is the sum of the fixed capital cost for design , procurement and installation equipment such as cost for working capital , licensing , training starting-up and financing.

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i. Analysis of profit :

Payback period (years) = $\frac{\text{Total capital investment}}{\text{Total average profit per year}}$

This method is recommended for quick assessments of profitability.

Improving quality of product = $(P_1-P_0)Q_0+P_1Q_1$

Q_1 = the number product after used clean technologyoption .

Q_0 = the number product before used clean technologyoption .

P_1 = the cost of product after used clean technology option .

P_0 = the cost of product before used clean technology option .

Added number of product = $P(Q_1- Q_0)$

Q_1 = the number product after used clean technologyoption .

Q_0 = the number product before used cleantechnology option .

P = products cost.

Longer shelf-life = $(P_1-P_0)\ Q_0 +P_1Q_1$

Q_1 = the number product after used clean technology option .

Q_0 = the number product before used clean technology option .

P_1 = products cost after used clean technology option .

P_0 = products cost before used clean technology option .

15.Environmental evaluation : to evaluated the impacts of each options for environment.

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three levels for environmental evaluation

i. Simple evaluation which concentrate on quantity of waste , emissions and energy loss.

ii. Profound evaluation which concentrate on result of input and output of each selected options .

iii. Simple life cycle assessment.

16. Select options : to record result of each selected options .

i. Result of practical options and impractical options are recorded

ii. Select practical options and impractical options.

iii. Prioritize practical options.

Principle 5 Implementation

Purpose : implementation of practical options

Consequence of principle 5 : Practical options was simulated

Principle 6 Follow up Evaluation

Purpose : evaluating the performance and operation And continue the operation

2.1.3 Clean Technology in Thailand

Content of master plan ,which play a major role in supporting Clean Technology in Thailand such as :Government revise or improve about involved law Factory Act ,1992 / National Promotion and Environmental Conservation Act ,1992 /Industrial Estate Authority of Thailand Act ,1979/ Public Health Act ,1992 / Dangerous Substances Act , 1992.

The need for implementation of clean technology concepts has accepted widely , not only government but also many organizations have been awake to increase apply using clean technology concept to reduce risk to human and the environment .

Clean technology concept was promoted by Department, Organization both of central and local government ,beside that clean technology was included in the country's major planning such as: National Economic and Social, Industrial Restructuring plan,Agricutural Restructuring plan, Educational Restructuring plan,Reseach and Development Master plan, Tourism Development Master plan

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2.1.4 Clean Technology in The Food Industry

The aim of the food industry is the efficient production of safe food ,food must been shown not to be harmful to the consumer. The scope of the industry is wide and extends from the farm ,where food is grown ,to the factory where it is processed ,and then to the shops where it is sold . Each of these stages involves an environmental cost.(6) The food processing industry used many of the chemical solvent and raw material which produces a significant amount of waste water . Three types of waste water are produced by any food process.

Process waste. Produced by leaks, product washing and equipment cleaning.

Cooling and heating waters. Thermal processing requires cooling; in the case of canning ,or pasteurization ,very large amounts of water are involved

Domestic waste. These are produced by the plant operators ;it is vital that they are kept separate from other plant waste ,as mixing would make it impossible to ensure hygienic conditions for water reuse and / or product recovery.(6)

A number of specific types of food effluent can be identified as causing particular problems, as follows

Meat and poultry Slaughtering and subsequent processing release considerable amounts of organic waste ,ca . 5 m^3/kg. of carcase produced during meat processing and 8m^3/kg. of car case produced in poultry processing. This waste has a very high BOD. I deals to reduce waste to quickly apply and carry out the process of production by the clean technology.

Dairy Most (up to 90 %) of the waste produced from a diary plant arises due to dilution of the milk. The BOD of raw milk is ca. 1000,000 mgl^{-1} , approximately 250 times that of sewage ,so dilution will still produce a highly active effluent . Wide ranges in the characteristics of the effluent can be found ; as discussed above, the use of highly alkaline cleaning solutions is commonplace , and so high pH waste can be produced. This can obviously cause problems in the process control of waste treatment plants.

Brewing The drinks industry is highly complex and difficult to generalize. However ,a number of waste components ,such as steep liquor and fermented effluent ,have a high BOD. These component may be a small part of the total effluent ,as significant waste are also generated in cooling and washing ;this is one area where it is

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important to keep the waste streams separate . Recovery of solids such as excess yeast is common ; these can be sold as animal feeds.

Solid processing Industries such as cereals and baking involve the processing of solid rather than liquids. These create special cleaning problems ; it may be acceptable to hose down a diary to remove waste, but it is much less acceptable to wash a bakery .By contrast with liquids processing , solids waste handing is poorly understood ;whilst it is known how to keep a surface clean by washing with chemicals , to keep a dry surface clean is much more difficult .It is ,however, imperative to keep liquid and solids waste apart to minimize subsequent problems.

Food waste tends to be treated either by (i) direct discharge (ii) land application , or (iii) treatment However ,the major of waste are combined and then treated together.

(6) Organic waste comprise domestic sewage, farm waste including those arising from the intensive farming of pigs, cattle and chickens . Also include are food processing waste, e.g. from abattoirs , meat processing , canneries , distilleries , breweries and vegetable processing factories. Although organic waste very enormously in composition they all share one particular characteristic in that they are 'biodegradable' that is to say that they contain organic compounds. Some waste such as raw sewage already contain large numbers of bacteria while other rapidly acquire and build up the necessary specialist aerobic bacteria to break down fats, starches , proteins , amino acid , alcohols , cellulose and other substances of varying degrees of complexity into ammonia , nitrates , phosphates , sulphates and carbon dioxide. In these processes large amounts of oxygen are consumed and therefore, if large amount of untreated or poorly treated organic waste are discharge, eventually total de- oxygenation of the receiving water may take place. Once de-oxygenation is complete heterotrophic aerobic bacteria are replaced by anaerobic bacteria which can produce methane , sulphuretted hydrogen, ammonia and black iron sulphide, these processes are particularly evident where discharges contain high levels of organic solid which settle out on the bed of the river ,lake or coastal water producting conditions which are highly offensive to the eyes and the nose .(7)

Fruit and vegetable processing_ Liquid waste can arise during vegetable processing , such as 15–20 m^3 of liquid/tone processed generated during washing and peeling of foods such as potatoes ; this waste can have a high pH and suspended

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solids content. The preparation of fruit juices also involves the generation of both liquid and solid waste , and their thermal processing may involve a heavy cleaning duty.

Apply of Clean Technology Concepts, the logical solution is to minimize the amount of organic waste and others. Clean Technology Concept are

Source reduction .Any activity that reduces or eliminates the generation of a waste in process. Input material changes. These can be considered where it is possible to substitute a material which provides the required function but results in reduced environmental load . Examples are the replacement of chlorinated organic solvents by non-chlorinated or aqueous media in cleaning operation ; the replacement of chemical biocides or oxidants by ozone or hydrogen peroxide, which decompose to leave no residues or emission. Product Change. These include changes in final or intermediate products to reduce waste generation and other environment loads arising else where in the life cycle. Technology Change and modification. Change in the technology and equipment of production including modernization ,modification ,or better control of process equipment may result in reduction of waste . Technology and process modification techniques can be separated into the following components: process changes ,equipment modifications ,change in operational setting, process automation, Equipment modifications can sometimes be introduced to perform existing operations more efficiently in order to eliminate or reduces waste generation.(7).Good Operating Practice .This includes preventing unnecessary releases ,and therefore merges into on-site recycling.(6) Recycling and Reuse. Recycling refers to processing a waste for reuse, whereas reuse refers to recycling without any processing.

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2.2 Fruit Juice Industry

Consumption behavior of Thai people particularly those who live in urban and suburban area change the style of eating from home-cooking food into ready-to-eat foods. fruit juice have become more popular among the urban population. Moreover , the local manufacture of fruit juice processing has increased continuously . This can be noticeable in an increase in varieties and a number of fruit juice brands in the markets. Fruit juice industries continue to grow as the increasing demand for these products and may become one of daily food for consumption of Thai people.

2.2.1 Definition and Classification of Juice

Juice can be classified as the liquids or pulpy material in relatively homogenous form , derived from fruits and vegetables. The juice are, in the most case, entirely free of seeds and tough fibers , and of smooth consistency. For purposes of classification , the juices are divided first into three broad classifications. Reference is made to these groupings in the manner of their thermal processing to render them commercially sterile for preservation. Methods of preparation prior to extraction are also by groups. Finally , methods of extraction and treatment prior to thermal processing are described by groups.(2)

i. High acid juices

This classification includes fruits which produce juice in the pH range of 3.90 or lower which include apricots , barbodos cherries , blackberry , carambola , cherries(practically all types) , citrus fruits(except sweet lemons , sweet limes , certain of the mandarin family) , crab apple , grapes , guava , naranjila , pineapple , pomegranate , quince , rasberry , strawberry , tamarindo . etc.

ii Medium acid juices

This classification includes fruits and vegetable which produce juice in the pH range above 3.90 but lower than 4.80 which include anona , apples , banana , blue berries , cantaloupes , currants , lemons and limes (sweet) , mango , papaya , passion fruit , peaches , pears , plums , beal fruit , sapodilla , tomatoes , watermelon etc.

iii Low acid or non-acid juices

This classification includes fruits and vegetable which produce juice in the pH range of 4.80 or higher which include avocado , bael fruits , beets , broccoli , cabbage , carrots , celery ,cucumbers , garlic , lettuce etc.

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2.2.2 Fruit Juice Processing

The operations described in this report are , where possible , performed by mechanical equipment , however , substitution of hand operations is not precluded if the same principles are followed.(2)Raw material preparation

At the time of harvest or slaughter , most foods are likely to contain contaminants , to have components which are inedible or to have variable physical characteristics (for example sharp , size or color). It is therefore necessary to perform one or more of unit operations of cleaning sorting , grading or peeling to ensure that foods with a uniformly high quality are prepared for subsequent processing . these are mechanical separation procedures which are applied near the beginning of a process to up grade the quality of the raw material. They are a highly cost-effective method of improving the overall quality of batches of food. (8)

Cleaning

Cleaning is the unit operation in which contaminating materials are removed from the food and separated to leave the surface of the food in a suitable condition for further processing. Type of contaminant found on raw foods such as Metals always found ferrous and non-ferrous metal, bolts , filings. Mineral always found Soil , engine oil , grease , stone. Plant always found Leaves , twigs , weed seeds , pods and skins. Animal always found Hair , bone , insect , larvae. Chemical not to be confused with adulterants(chemicals intentionally added to food which are forbidden by law) or additives(chemicals added to food to improve eating qualities or shelf-life) always found Fertilizer , pesticides , herbicides. Microbial cells always found Soft rots , fungal growth , yeast (7) Wet cleaning is more effective than dry cleaning to removes soil or earthy substances. Removes mold , yeast , bacteria or spores of these microorganisms The following washing procedures apply to the fruits and vegetables listed under the various washing methods Washer fruit or vegetable is now ready for final inspection and trimming.(8) In the case of small scale manufacture washing as soak fruit or vegetable in the sink which products were washed by hand(9)

Sorting and trimming

The sorting and trimming operations remove whole units by sorting or portions of units by trimming with knives for any one or more of the following

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reason; insect damage or insect removal ,pathological damage , imbedded roots or earthy substances , roots or other tough , inedible portion of the fruit or vegetable , a typical color and mechanical injury.

Extraction of juices

Washed , sorted and trimmed fruit or vegetables drop into a tubular chopper-crusher which reduces the unit size by rupturing the skin and internal structure in the case of small scale manufacture are extract by use the grinder and filtrating with the cotton filter , or use a juice extractor where paddles or brushes revolving inside a circular , perforated screen separate juice and pulp(which flow through the screen) from the seeds , skins and tough tissue. The waste material is discharged from the end of the juice extractor.

Blending of juices

Juices are frequently packed with added sugar , salt , spices , harmless food colors , vitamins and citric or other fruit acids. It is also desirable at times to blend juices from several varieties of fruits to produce pleasant flavors or colors. The blending is normally accomplished in open kettles. The kettles may contain steam coils or be steam jacketed. Generally , they are equipped with mechanical agitators which thoroughly mix the contents without incorporating air into the product. All types of juices which require this treatment are handled in exactly the same manner. Usually a minimum of two kettles are used, one to be blending while the other is used for filling , after which the juice continues through the regular processing steps.

Preheating

This step is performed in the blending kettles. Juices of fruits and vegetables contain enzymes and viable microorganism of all types. The purposes of preheating are to ;render enzymes inactive to prevent them from developing off-flavors in the juice and reduce the danger of their destroying pectin and related substances that aid in suspending the pulpy portions in uniform distribution throughout the juices, kill large numbers of the microorganism in the juice and prevent many of them from forming spores. Since spores are much more difficult to kill than microorganism themselves, preheating is a very important operation. Juice must be heated to a minimum temperature of 82 ^{0} C and held at this temperature for 3 – 4 minutes to

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accomplish the purpose of preheating. Many of small scale manufacture have not this operation

Pasteurization

The general purpose of pasteurization is to deliver a mild thermal process, usually performed below 100 ^{0} C ,which is used to extend the shelf life of foods for several day (for example milk) or for several months (for example bottled fruit) . It preserves foods by inactivation of enzymes and destruction of relatively heat – sensitive microorganism (for example non-sporing bacteria , yeast and molds), all pathogenic bacteria

Filling

Hot juice is filled immediately into containers ,the lids are applied for a minimum of four minutes

Cooling

After hot juice is filled immediately and was lided. They are then cooled by either placing them in a spin cooler in which they revolve under sprays of water to cool rapidly, or by being placed in crates and into tanks of running water. Cooling should be continued until product temperature is approximately 4 ^{0} C for a maximum of 4 hours.(2)

Storage

All packed foods are subject to loss of flavor , color and vitamins during storage. The most acceptable storage is that in which the temperature remains nearly constant at about 4 ^{0} C – 8 ^{0} C. These conditions should be maintain within commercial practicability. For small scale manufacture they store product in the ice box and add ice for control the temperature.

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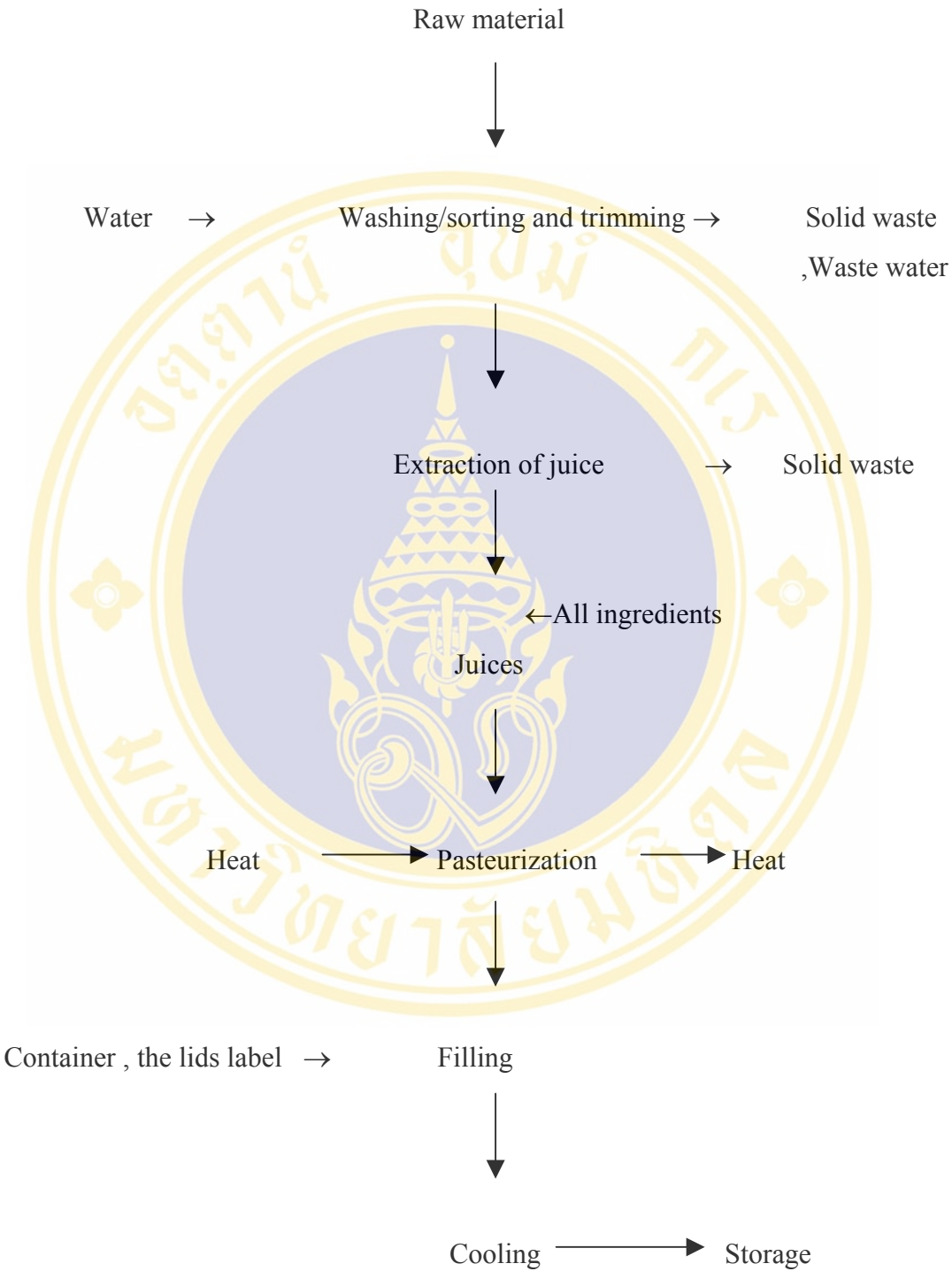

Figure 2.5 Fruit Juice Processing

Cleaning of food process plant

It is vital that food process plant be clean and hygienic. During operation, food plant gradually becomes contaminated. Many of the components of foods ,such

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as starches and milk proteins, are highly temperature – sensitive, and thus tend to form solid fouling deposits on heat transfer surfaces during thermal processing. These deposits require removal if they are not to become the focus for corrosion and microbial contamination. The removal of solid deposits, together with the requirements of product sterility and safety, means that food process plant requires frequent and expensive cleaning. The cleaning of food surfaces is a familiar process, but one which is not well understood, and the fouling and cleaning of surfaces in contact with foods remains one of the major processing problems in the food industry. In many industry, such as in diary processing , complex cleaning – in – place (CIP) techniques have been developed. CIP requires a series of stages ; a pre-rinse step to remove product and poorly bound deposit, followed by cleaning steps , each followed by a rinsing stage. Industrially ,two types of cleaning treatment are used to remove deposits from food plant :

Two - stage cleaning using both acid and alkali, commonly sodium hydroxide , followed , after rinsing , with nitric or phosphoric acid.

Single - stage cleaning with formulated detergents , which contain compounds to enhance cleaning , such as surface active and chelating agents.

The costs of cleaning are significantly greater than the cost of the chemicals . extra cost arise in a number of area:

Capital cost of CIP system , energy cost , labor cost and effluent costs will be significant, cleaning effluent is often voluminous, contains high BOD waste and will often be at alkaline pH . they are thus potentially hazardous and expensive to dispose

Cleaning equipment

Cleaning of dairy facilities involves removing soil from all surfaces that come in contact with food products and using a sanitizer after each processing period. Surfaces that do not touch food products also need to be cleaned. Food plant use different cleaning system, depending on their size. A cleaning – in – place system is used. Special considerations for cleaning plant equipment such as Batch pasteurizes and heated product surfaces has Recommended cleaning procedures as follow Lower temperature below 49 ^{0} C immediately after emptying product; immediately rinse , with brushing to loosen burned – on products ; if the vat cannot rinsed, fill with warm(32^{0}C–38^{0} C)water until cleaning , and then cleaning using both acid and alkali

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and every weeks cleaning with formulated detergents , which contain compounds to enhance cleaning. (3)

2.2.3 Clean Technology in Fruit Juice Process

Many of fruit juice industries apply of used Clean Technology Concept to minimize a mount of organic waste and others. Case study in this industries as follow : In the early 1990 s ,an orange juice manufacturer in Victoria had a waste problem with orange peel but with some creative thinking, the orange- peel problem was turn in to an asset. Clean production is most often applied to manufacturing process. Cleaner production offers rewords increased profits and enhanced environment image to those who can reduce their overall level or waste. Redefining waste reducing disposal fees.(9)

In Vietnam have many project support from government about information and know how to manufacturing to quickly apply and carry out the process of production by the clean technology the advanced and modern technology of watering and draining , preservation and apply to clean technology concept to many project , vegetables and fruits of Vietnam may catch up with that of the other countries in the region.(10)

In many fruit juice manufacture management looked for simple ideas to reduce waste and came up with the following initiatives: Reusing tank rinse- water for cleaning in less critical area, reusing pasteurize cleaning water and chemical for the first rinse on tanks, recovering the energy from steam condensate to pre-heat cleaning solutions, recycling of packaging materials.(11)

In lime economic plants have production process of complete range of lime powder products is a production process in which clean technology is applied in the design, aiming to make the most of the waste produced during the production process cause no impact on the environment and incur no additional costs and reduce losses. Clean technology technical which implemented in fruit juice process has shown in figure 2.6

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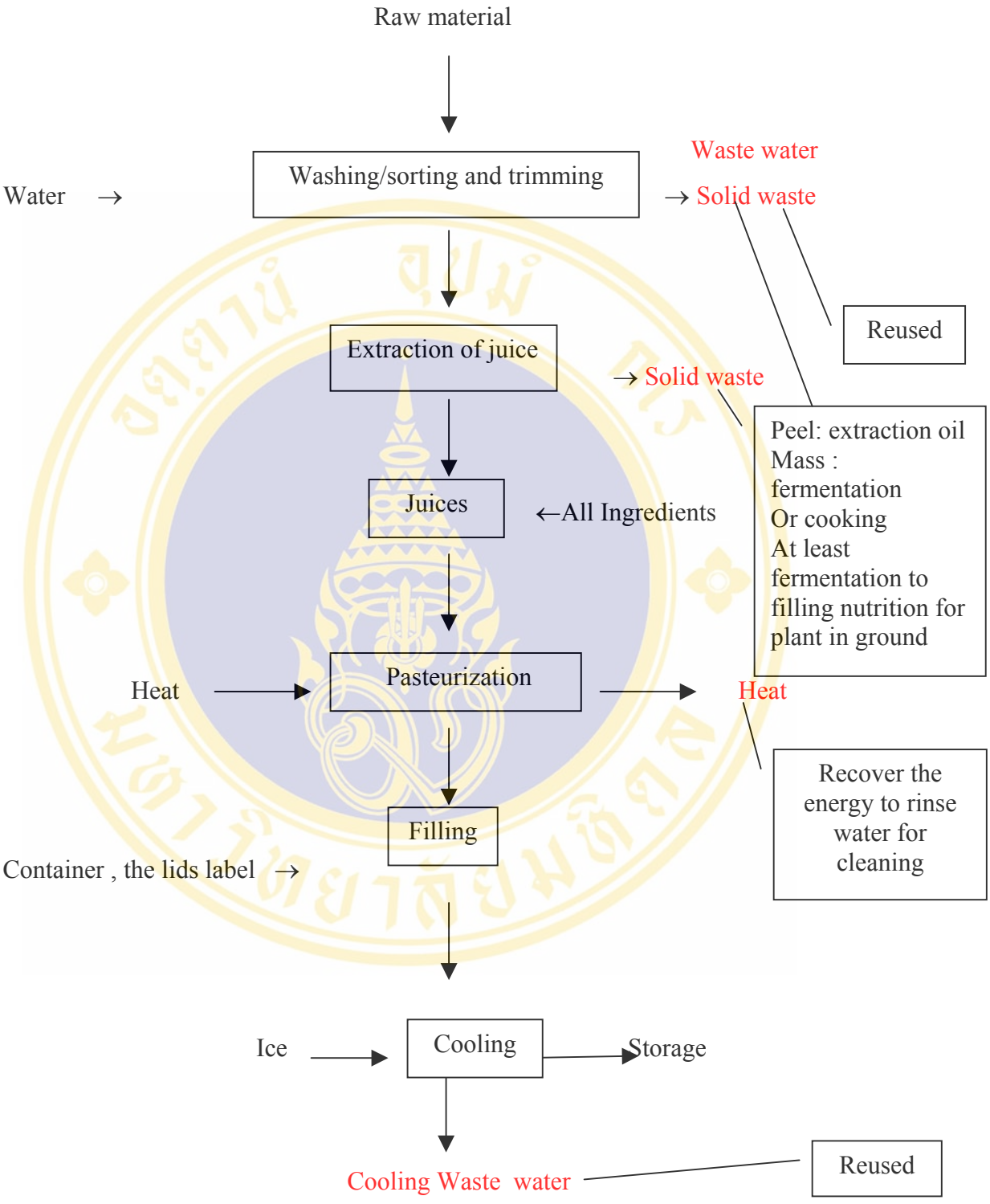

Figure 2.6 Clean technology which action in fruit juice processing

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2.3 Factor involve

For this study has many factor involve which importance and controlled for study as follow

2.3.1 Bael Fruit

Description

The bael occupies an important place among the indigenous fruits of India It is a woody and smooth food which is 5 to 15 cm in diameter. It has numerous seeds, which are densely covered with fibrous hairs and are embedded in a thick aromatic pulp. The flesh is either eaten fresh or dried.

Food Value

An analysis of the bael fruit shows it is rich in mineral and vitamin contents. The sherbet made out of this fruit has all the important nutrients and health growing ingredients. It should be thick and syrupy enough to be taken with spoon and it should be thoroughly masticated. The bael fruit should also not be taken in excess at a time as excessive intake of bael may produce a sensation of heaviness in the stomach and may cause gastric discomfort.

An analysis mineral and vitamin contents of the bael fruit (25)

Food Value Per 100 gm. edible portion of the bael fruit Food energy 133 calories, A.I.U. 92, Calcium 85, Moisture 61.5, Phosphorus 50, Carbohydrates 31.8, Vitamin C 8, Fibre 2.9, Protein 1.8, Vitamins B1 1.30 , Vitamins B2 1.19, Niacin 1.1, Iron 0.6, Fat 0.3

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The bael tree is one of the most useful medicinal plants of India Its medicinal properties have been described in the *ancient medical* treatise in Sanskrit, *Charaka Samhita. All* the parts of this tree *including stem,* bark, root, leaves and fruit at all stages of maturity has medicinal virtues and has been used as traditional medicine for a long time.The fruit is of considerable medicinal value Diarrhoea and Dysentery, Peptic Ulcer, Respiratory Affections

2.3.2 Pasteurization

Pasteurization have 2 types as LTLT (low temperature long time) this system are under 60 ^{0} C for 30 minutes and cool down immediately and HTST (high temperature short time) operate under 72 ^{0} C for 15 minutes and cool down immediately. The general purpose of pasteurization is to deliver a mild thermal process, usually performed below 100 ^{0} C ,which is used to extend the shelf life of foods for several day (for example milk) or for several months (for example bottled fruit) . It preserves foods by inactivation of enzymes and destruction of relatively heat – sensitive microorganism (for example non-sporing bacteria , yeast and molds), all pathogenic bacteria such as *Mycobacterium tuberculosis , Salmonella spp.* And *Brucella spp.*

The most well known pasteurization process is associated with fluid milk , where the minimum process is that necessary to eliminate human health concerns associated with brucellosis and / or tuberculosis. Pasteurization is also a process used to inactivated enzyme in fruit juice and reduce the population of spoilage microorganism in beer. A more recent application of pasteurization is to remove the potential health concerns in liquid whole eggs by destruction of microorganism such as *Salmonella* and *Listeria*. Note that the magnitude of the pasteurization process

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does depend on the pH of the product ; high pH products require somewhat of the more severe thermal process.(11)

The severity of the heat treatment and the resulting extension of shelf life are determined mostly by the pH of the food. In low – acid foods (pH > 4.5),the main purpose is destruction of pathogenic bacteria whereas ,below pH 4.5 , destruction of spoilage microorganism or enzyme inactivation is usually more important. (12)

Batch pasteurization

One of the earliest and simplest methods of effectively pasteurizing liquid foods such as milk ,is to heat the food in a vat with mild agitation .Raw milk commonly is pumped into a stream-heated jacketed vat, brought to temperature , held for the prescribed time, and then pumped over a plate-type cooler prior to bottling or cartooning. Batch pasteurization also know as the holding method of pasteurization is still widely practiced in some parts of the world but it has largely given way to high-temperature-short-time continuous pasteurization.(3)

Purpose of pasteurization for different foods

Food which pH < 4.5 such as fruit juice which include apples , banana , blue berries , cantaloupes , currants , lemons and limes (sweet) , mango , papaya , passion fruit , peaches , pears , plums , bael fruit , sapodilla , tomatoes , watermelon has main purpose of pasteurization is Enzyme inactivation (pectinesterase and poly galacturonase) and has Subsidiary purpose is Destruction of spoilage microorganism (yeast , fungi) usually pasteurization process for this group has Minimum processing conditions [a] 65 ^{0} C for 30 min;77 ^{0} C for 1 min.;88 ^{0} C for 15 s

For other group such as Beer has main purpose of pasteurization is Destruction of spoilage microorganism (wild yeasts, lactobacillus species),and residual yeast(saccharomyces species) usually pasteurization process for this group has Minimum processing conditions [a] 65 ^{0} C – 68 ^{0} C for 20 min. (in bottle);72 ^{0} C – 75 ^{0}C for 1 – 4 min. at 900 –1000 Kpa. Food which pH > 4.5 such as milk has main purpose of pasteurization is Destruction of pathogens: *Brucella abortis ,Mycobacterium tuberculosis, Coxiella bernettiib* and has Subsidiary purpose is Destruction of spoilage microorganism and enzymes usually pasteurization process for this group has Minimum processing conditions [a] 63 ^{0}C for 30 min.71.5 ^{0}C for 15 s

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For Ice cream has main purpose of pasteurization is Destruction of pathogens and has Subsidiary purpose is Destruction of spoilage microorganism usually pasteurization process for this group has Minimum processing conditions [a] 65 ^{0}C for 30 min.; 71 ^{0} C for 10 min.; 80 ^{0} C for 15 s(3)

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Table 2.1 Classification of foods on basis of processing requirements .(3)

Acidity Classification	pH value	Food Item	Food Groups	Spoilage Agents	Heat and Processing Requirements
Low acid	7.0	Lye hominy ,ripe olive , crabmeat , eggs, oyster , milk , corn , duck , chicken , codfish , beef , sardines. Corned beef, lima beans , peas , carrots , beets , asparagus , potatoes. Pigs , tomato soup.	Meat Fish Milk Poultry Vegetable Soup	Mesophillic spore- forming anaerobic bacteria.	High temperature processing 116 ^{0}C- 121 ^{0}C
	6.0			Thermophiles naturally occurring enzymes in certain process.	63 ^{0}C 30 min. 71.5 ^{0}C 15 min.
	5.0			-	-
Medium acid	4.5	Ravioli , pimientos	Manufactured foods	Lower limit for growth of *C. botulinum*	-
Acid	3.7	, pears , apricots , peaches , orange , sauerkraut , pine apple , apple , strawberry , grape fruit	Fruit Berries	Nonspore-forming aciduric bacteria Aciduric spore-forming bacteria Naturally occurring enzymes	Boiling water processing 100 ^{0}C
High acid	3.0	Pickles Relish Cranberry juice Lemon juice Lime juce	Hight acid foods(pickles) High acid-high solids foods (jam-jelly) Very acid foods	Yeast Molds	65 ^{0}C 30 min. 77 ^{0}C 1 min. 88 ^{0}C 15 s.
	2.0	-			

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Pasteurization machine

Equipment

Pasteurization of unpackaged liquids ; open boiling pans are used for small-scale batch pasteurization of some liquid foods. However , the large-scale pasteurization of unpackaged low viscosity (for example milk, milk products , fruit juices ,liquid egg , beer and wines) usually employs continuous equipment, and plate heat exchangers are widely used.

Thai machine was used concept of pasteurization and apply for producting pasteurization machine for small-scale manufacture, which distribute all apart of Thailand. This will show data in chapter 4

Material of equipment for food processing

Stainless steels are selected as food processing materials mainly because of their excellent corrosion resistance in many environments. The corrosion resistance of stainless steels is due to their high chromium contents. Alloy number 304 and 304L have trypical applications to used for Chemical and food processing equipment

Low carbon for welding chemical tank

Establishment of the pasteurization process

The impact of pasteurization is defined by the time/temperature relationship. pasteurization have 2 types as LTLT (low temperature long time) this system are under 60 ^{0} C for 30 minutes and cool down immediately and HTST (high temperature short time) operate under 72 ^{0} C for 15 minutes and cool down immediately.

The first is necessary time/temperature to achieve the desired result of the process. The second is the configuration of the equipment required to achieve the established process. Both of these considerations must be evaluated in order to understand the significance of pasteurization and its application.

Schematic illustration of individual batch pasteurization

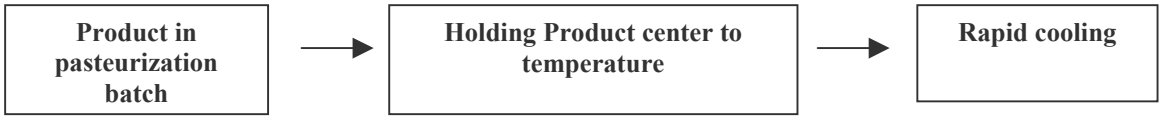

Figure 2.7 Schematic illustration of individual batch pasteurization.

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2.3.3 Microbiological quality

Microbial contamination associates with both sensory and safety properties. Juice contain not only their natural flora but also microorganism from soils , animals and / or sewage. The kind of bacteria in juice are chiefly species of *E.coli*. coliform bacteria , *Clostridium perfringens , Staphylococcus aureus , Bacillus cereus , Salmonella spp. ,* Mold and Yeast.

Food – Born Disease

A special kind of food deterioration that may or may not alter a food's organoleptic properties has to do with food-born disease. Food –born disease are commonly classified as food infections or food intoxication. Whereas the distinction is sometimes imperfect , foods infections involve microorganisms present in the food at time of consumption which then grow in the host and cause illness and disease. Food intoxication involve toxic substances produced in foods as by-product of microorganism prior to consumption and cause disease upon ingestion .where the toxin producer is a microorganism ,it need not grow in the host to produce disease or even be present in the food.

Staphylococcus aureus and *Clostridium botulinum* produce bacterial food poisoning by toxication through the production of specific bacterial toxins. In fact , the toxin produce by *C.botulinum* is one of the most toxic substance known. Certain molds produce mycotoxins , the best known being the alflatoxins of Aspergillus flavus . Unlike the toxin of *S.aureus* and *C.botulinum* ,which are highly toxic to man , alflatoxins may be more toxic to domestic animals than to man. When such product occur in feeds alflatoxins may subsequently be detected in the milk of animals consuming the feed and in cheese made from such milk.

Manybacteria can transmit food –born infections capable of causing human disease , these include *Clostridium perfringens* , numerous members of the genus *Salmonella , Shigella dysenteriae , Vibrio parahaemolyticus ,Steptococcus pyogens , Bacillus cereus , Campylobacter jejuni* and others . Microorganism which cause disease in human are known as pathogenic or pathogens.(3)

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Table 2.2 Major Food–Born Pathogenic Microorganism causing Food–Born Illness.(3)

Microorganism	Source in Nature	Characteristics of Illness	Association Foods
Clostridium botulinum	Soil ,sediment intestinal tracts of fish, mammals, gills , viscera of fish crabs , seafood	Neurotoxicity ; shortness of breath , blurred vision ;loss of motor capabilities ; death ;onset ranges between 12 and 36 h.	Low – acid foods ,especially home canned ; meats,fish, smoked/fermented fish, vegetables, other marine products
Clostridium perfingens	Soil and sediment(wind - spread) water, intestinal tracts of humans and animals.	Nausea , occasional vomiting , diarrhea and intense abdominal pain; onset range from 8 to 22 h. short duration (24h.)	Improperly prepared roast beef, turkey , pork , chicken , cooked ground meat and other meat dishes , gravies , soups and sauces.
Salmonella spp.	Water , soil , mammals , birds , insects, intestinal tracts of animals, especially poultry and swine.	Nausea , vomiting , abdominal cramps , diarrhea , fever and headache; normal incubation period 6 – 48 h.	Beef, turkey, pork , chicken eggs and products, meat salads, crabs, shellfish, chocolate, animals feeds, dried coconut, baked goods and dressing.
Listeria monocytogens	Soil, silage, water and other environmental sources, birds , mammals and possible fish and shellfish	Healthy individuals generally have mild flulike symptoms ;severe forms of listeriosis include septicemia, meningitis , encephalitis and abortion in pregnant women.	Raw milk, soft cheese ,Cole slaw, ice cream, raw vegetables, raw meat sausage, raw and cooked poultry, raw and smoked fish.
Campylobacter jejuni	Soil,sewage, sludge, untreated waters, intestinal tracts of chickens, turkeys , cattle, swine, rodents and some wild birds	Fever, headace, nausea , muscle pain and diarrhea (some times watery, sticky or bloody) ; onset time 2 – 5 days and duration 7 – 10 day ; relapses common.	Raw milk, chicken, other meats and meat products.

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Table 2.2 Major Food – Born Pathogenic Microorganism causing Food – Born Illness. (cont.) (3)

Microorganism	Source in Nature	Characteristics of Illness	Association Foods
Stappylococcus aureus	Hands , throats and nasal passages of humans; common on animals hides	Nausea , vomiting , diarrhea , abdominal cramps and prostration . symptoms may be severe ; normal onset from 30 min. to 8 h; duration usually 24 – 48 h.	-
Shigella spp.	Polluted water ans intestinal tracts of human and other primates.	Diarrhea with bloody stools , abdominal cramps and fever ; severe cases caused by *S.dysenteriae* may result in septicemia , pneumonia or peritonitis ;onset averages 0.5 – 2 days but may be as high as 7 days; recovery is slow.	Milk and diary products , raw vegetable , poultry and salads (e.g. potatoes , tuna , shrimp , macaroni and chicken)
Bacillus cereus	Soils , sediments , dust , water , vegetation and variety of foods , notably cereals , dried foods , spices , milk and products and vegetable.	**Type 1** : diarrhea type food poisoning watery diarrhea , abdominal cramps , nausea usually no fever or vomiting ; onset time 6 – 15 h ;short duration (24 h.) **Type 2** : emetic type food poisoning nausea and vomiting within 0.5 – 6 h ;abdominal cramps and diarrhea occasionally occur ;short duration (less than 24 h.)	Meats , vegetable , dished milk , cream pastries soups and puddings. Fried , boiled ; or cooked rice and other starchy foods (e.g. potatoes and pasta)
Escherichia coli.(enterovirulent types)	Intestinal tracts of humans and animals	Mild to several bloody diarrhea , vomiting , cramping , dehydration and shock; can result in more serious symptoms; some illnesses may last up to 8 days.	Raw and rare meats and poultry , raw milk and milk products , unprocessed cheese ,salads

Molds

A wide variety of mold fungi take part in the rotting of fruit, and are therefore likely to appear in juices. Appreciable growth of such fungi on the fruit leads to defects in the juice:for example, off-flavors and sometimes difficulty in fermentation.

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Because they mostly require oxygen and are sensitive to carbondioxide, only a few this array of fungi occur significantly in the fruit juices. They are usually eliminated by heat treatments in factory procesing ; and the common cause of the growth of such molds in industrial juice is infection of the containers.When they occur in a juice , fungi usually produce deleterious changes in addition to a moldy taste. They may attack pactin,and cause clarification of the juice. Also, they often change the acid composition, introducting new acids or destroying those already present (e.g., citric,malic , or ascorbic) . some mold also produce pigment which discolor the juice . It must ,however be remembered ,in descriptions of the activities of mold, that they occur comparatively rarely in juices. In large scale industry, they are troublesome only where juices are stored without CO_2 : with an atmosphere of CO_2 , especially under pressure, mold development is likely. In farmers'and small-scale production,on the other hand , infections and acid change by mold are more frequent .(3)

Yeast

The important property of the yeast is that carry out alcoholic fermentation, producing ethanol and carbon dioxide from sugars ; many , however , are only feebly or not active in this way. Most yeast produce appreciable quantities of organic acids, especially acetic. Some are capable of breaking down fruit acids ,bur this is seldom important in practice. They often produce esters with fruit-like odors. Particular yeast tend to be found on a given kind of fruit and, to some extent,in a given climate and season; though much more information on these topics is desirable. Further, or the yeast occuring on the fruit, only a minor proportion are active in the juices. This selection occurs because different yeast has different properties. Many of the wild yeast occuring on fruit resemble the molds in being"aerobic,"requiring oxygen for growth;and these mostly have weak powers of fermentation and do not form spores. The yeast, which are capable of vigorous growth and fermentation in juice in the absence of air, are mostly species of *Saccharomyces* which do form spores.(3)

Clostridium

Members of genus *Clostridium* are Gram-positive, spore-forming rods that are anaerobic. These motile bacteria are ubiquitous in nature and are especially fond of soil. Under the microscope, they appear as long drumsticks with a bulge located at their terminal ends. A Gram-stain is a good method for identifying *Clostridium*

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because the cell incorporates the dye while the spore remains unstained. *Clostridium* shows optimimum growth when plated on blood agar at human body temperatures. When the environment becomes stressed, however, the bacteria produce **spores** that tolerate the extreme conditions that the active bacteria cannot. In their active form, these bacteria secrete powerful exotoxins that are responsible for such diseases as tetanus, botulism, and gas gangrene. The four clinically important species of *Clostridium* will be discussed here: *C. tetani*, *C. difficile*, *C. perfringens*, and *C. botulinum*.

Clostridium botulinum

Clostridium botulinum is an anaerobic, Gram-positive, spore-forming rod that produces a potent neurotoxin. The spores are heat-resistant and can survive in foods that are incorrectly or minimally processed. Seven types (A, B, C, D, E, F and G) of botulism are recognized, based on the antigenic specificity of the toxin produced by each strain. Types A, B, E and F cause human botulism. Types C and D cause most cases of botulism in animals. Animals most commonly affected are wild fowl and poultry, cattle, horses and some species of fish. Although type G has been isolated from soil in Argentina, no outbreaks involving it have been recognized. Foodborne botulism (as distinct from wound botulism and infant botulism) is a severe type of food poisoning caused by the ingestion of foods containing the potent neurotoxin formed during growth of the organism. The toxin is heat labile and can be destroyed if heated at 80^{o}C for 10 minutes or longer. The incidence of the disease is low, but the disease is of considerable concern because of its high mortality rate if not treated immediately and properly. Most of the 10 to 30 outbreaks that are reported annually in the United States are associated with inadequately processed, home-canned foods, but occasionally commercially produced foods have been involved in outbreaks. Sausages, meat products, canned vegetables and seafood products have been the most frequent vehicles for human botulism.

The organism and its spores are widely distributed in nature. They occur in both cultivated and forest soils, bottom sediments of streams, lakes, and coastal waters, and in the intestinal tracts of fish and mammals, and in the gills and viscera of crabs and other shellfish.

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Associated Foods: The types of foods involved in botulism vary according to food preservation and eating habits in different regions. Almost any type of food that is not very acidic (pH above 4.6) can support growth and toxin production by *C. botulinum*. Botulinal toxin has been demonstrated in a considerable variety of foods, such as canned corn, peppers, green beans, soups, beets, asparagus, mushrooms, ripe olives, spinach, tuna fish, chicken and chicken livers and liver pate, and luncheon meats, ham, sausage, stuffed eggplant, lobster, and smoked and salted fish.

Clostridium perfringens

This non-motile bacterium is an invasive pathogen that can be contracted from dirt via large cuts are wounds. C. perfringens cells proliferate after spore germination occurs and they release their exotoxin. The toxin causes necrosis of the surrounding tissue (Clostridial myonecrosis destroys muscular tissus). The bacteria themselves produce gas which leads to a bubbly deformation of the infected tissues. C. perfringens is capable of necrotizing intestinal tissues and can release an enterotoxin that may lead to severe diarrhea.

Salmonella

Salmonella is a rod-shaped, motile bacterium -- nonmotile exceptions *S. gallinarum* and *S. pullorum*--, nonsporeforming and Gram-negative. There is a widespread occurrence in animals, especially in poultry and swine. Environmental sources of the organism include water, soil, insects, factory surfaces, kitchen surfaces, animal feces, raw meats, raw poultry, and raw seafoods, to name only a few.

S. typhi and the paratyphoid bacteria are normally caused septicemic and produce typhoid or typhoid-like fever in humans. Other forms of salmonellosis generally produce milder symptoms.

Acute symptoms - Nausea, vomiting, abdominal cramps,minal diarrhea, fever, and headache. Chronic consequences -- arthritic symptoms may follow 3-4 weeks

Associated Foods: Raw meats, poultry, eggs, milk and dairy products, fish, shrimp, frog legs, yeast, coconut, sauces and salad dressing, cake mixes, cream-filled desserts and toppings, dried gelatin, peanut butter, cocoa, and chocolate.

Staphylococcus aureus

S. aureus is a spherical bacterium (coccus) which on microscopic examination appears in pairs, short chains, or bunched, grape-like clusters. These organisms are

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Gram-positive. Some strains are capable of producing a highly heat-stable protein toxin that causes illness in humans. .

Foods Incriminated: Foods that are frequently incriminated in staphylococcal food poisoning include meat and meat products; poultry and egg products; salads such as egg, tuna, chicken, potato, and macaroni; bakery products such as cream-filled pastries, cream pies, and chocolate eclairs; sandwich fillings; and milk and dairy products. Human intoxication is caused by ingesting enterotoxins produced in food by some strains of *S. aureus*, usually because the food has not been kept hot enough (60°C, 140°F, or above) or cold enough (7.2°C, 45°F, or below).

Campylobacter jejuni

Campylobacter jejuni is a Gram-negative slender, curved, and motile rod. It is a microaerophilic organism, which means it has a requirement for reduced levels of oxygen. It is relatively fragile, and sensitive to environmental stresses (e.g., 21% oxygen, drying, heating, disinfectants, acidic conditions). Because of its microaerophilic characteristics the organism requires 3 to 5% oxygen and 2 to 10% carbon dioxide for optimal growth conditions. This bacterium is now recognized as an important enteric pathogen. Before 1972, when methods were developed for its isolation from feces, it was believed to be primarily an animal pathogen causing abortion and enteritis in sheep and cattle. Surveys have shown that *C. jejuni* is the leading cause of bacterial diarrheal illness in the United States. It causes more disease than *Shigella* spp. and *Salmonella* spp. combined.

Although *C. jejuni* is not carried by healthy individuals in the United States or Europe, it is often isolated from healthy cattle, chickens, birds and even flies. It is sometimes present in non-chlorinated water sources such as streams and ponds. Because the pathogenic mechanisms of *C. jejuni* are still being studied, it is difficult to differentiate pathogenic from nonpathogenic strains. However, it appears that many of the chicken isolates are pathogens.

Major Symptoms: *C. jejuni* infection causes diarrhea, which may be watery or sticky and can contain blood (usually occult) and fecal leukocytes (white cells). Other symptoms often present are fever, abdominal pain, nausea, headache and muscle pain. The illness usually occurs 2-5 days after ingestion of the contaminated

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food or water. Illness generally lasts 7-10 days, but relapses are not uncommon (about 25% of cases). Most infections are self-limiting and are not treated with antibiotics.

Associated Foods: *C. jejuni* frequently contaminates raw chicken. Surveys show that 20 to 100% of retail chickens are contaminated. This is not overly surprising since many healthy chickens carry these bacteria in their intestinal tracts. Raw milk is also a source of infections. The bacteria are often carried by healthy cattle and by flies on farms. Non-chlorinated water may also be a source of infections. However, properly cooking chicken, pasteurizing milk, and chlorinating drinking water will kill the bacteria.

Listeria monocytogenes

This is a Gram-positive bacterium, motile by means of flagella. Some studies suggest that 1-10% of humans may be intestinal carriers of *L. monocytogenes*. It has been found in at least 37 mammalian species, both domestic and feral, as well as at least 17 species of birds and possibly some species of fish and shellfish. It can be isolated from soil, silage, and other environmental sources. *L. monocytogenes* is quite hardy and resists the deleterious effects of freezing, drying, and heat remarkably well for a bacterium that does not form spores. Most *L. monocytogenes* are pathogenic to some degree.

Associated Foods: *L. monocytogenes* has been associated with such foods as raw milk, supposedly pasteurized fluid milk, cheeses (particularly soft-ripened varieties), ice cream, raw vegetables, fermented raw-meat sausages, raw and cooked poultry, raw meats (all types), and raw and smoked fish. Its ability to grow at temperatures as low as 3^{o}C permits multiplication in refrigerated foods.

Vibrio cholerae

This bacterium is responsible for Asiatic or epidemic cholera. No major outbreaks of this disease have occurred in the United States since 1911. However, sporadic cases occurred between 1973 and 1991, suggesting the possible reintroduction of the organism into the U.S. marine and estuarine environment. The cases between 1973 and 1991 were associated with the consumption of raw shellfish or of shellfish either improperly cooked or re-contaminated after proper cooking. Environmental studies have demonstrated that strains of this organism may be found in the temperate estuarine and marine coastal areas surrounding the United States.

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Associated Foods: Cholera is generally a disease spread by poor sanitation, resulting in contaminated water supplies. This is clearly the main mechanism for the spread of cholera in poor communities in South America. The excellent sanitation facilities in the U.S. are responsible for the near eradication of epidemic cholera. Sporadic cases occur when shellfish harvested from fecally polluted coastal waters are consumed raw. Cholera may also be transmitted by shellfish harvested from nonpolluted waters since *V. cholerae* O1 is part of the autochthonous microbiota of these waters.

Shigella spp.

Shigella are Gram-negative, nonmotile, nonsporeforming rod-shaped bacteria. The illness caused by *Shigella* (shigellosis) accounts for less than 10% of the reported outbreaks of foodborne illness in this country. *Shigella* rarely occurs in animals; principally a disease of humans except other primates such as monkeys and chimpanzees. The organism is frequently found in water polluted with human feces.

Associated Foods: Salads (potato, tuna, shrimp, macaroni, and chicken), raw vegetables, milk and dairy products, and poultry. Contamination of these foods is usually through the fecal-oral route. Fecally contaminated water and unsanitary handling by food handlers are the most common causes of contamination.

E.coli

E.coli is generally regarded as part of the normal flora of the human intestinal tract and that of many animals. Serotypes of E.coli which have been implicated in human diarrheal diseases or food – poisoning out brake have been designted enterpathogenic E.coli (EEC). The human disease syndromes resulting from the ingestion of EEC have been devided into two main groups. The first group consists of strains which produce an enteroxin and result in a choleralike or enterotoxigenic illness in human. These enterotoxigenic atrain usually produce two enterotoxins a heat- stable (ST) and a heat-labile(LT) toxinand are thought to be responsible for infantile diarrheal diseases and teavelers diarrhea. The secound major group consist of invasive strains which produce a cytotoxin and result in the invasive illness, colitis,or dysentery like syndrome .These serotypes are noneterotoxigenic grow in the colon and invade or penetrate the enithelial cells of colonic mucosa, resulting in the signs and symptoms outline .A larg infective case of EEC is required for either

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the enterotoxigenic or invasive illness to occur.There fore, foods must be highly contaminated or refrigerated to allow for prolific growth. The optimal temperature for growth is 37ºC,with a temperature rage for growth of 10 to 40ºC. The optimal pH for growth is 7.0 to 7.5, with the minimum at pH 4.0 and the maximum at pH 8.5. The organism is relatively heat sensitive and can readily be destroyed at pasteurization temperatures and by the proper cooking of foods. Some of the foods implicated in EEC outbreaks and some methods of prevention. In addition to the above strains,there is a group referred to as hemorrhagic E.coli . These strains can result in illness in humans as manifested by bloody diarrhea and severe abdominal pain .

Bacillus cereus.

Report of outbreak of B. cereus food gastrogenteritis are quite uncommon in the United states; however many European countries report frequent implication of this organism in food born illness. B..cereus is a gram-positive,aerobic,spore-forming rod. It's optimal temperature for growth is 30 C , with a minimal temperature for growth at 10 ºC and maximum of 49 ºC . The pH range for growth is 4.9 to 9.3 .Numerous surveys on foods and ingredients have indicated a high percentage of samples containing B.cereus .It is undoubtedly widely distributed in nature and our food supply .Extremely large numbers (108 per gram) of viable cells of B.cereus must be ingested to develop signs and symptoms of the syndrome.Two syndromes are recognized: the diarrhea syndrome and the emetic syndrome.

2.3.4 Spoilage and shelf life of bottled pasteurized fruit juice

Pasteurized food is food that been subjected to a process of sufficient energy or effect to reduce only the vegetative pathogenic microorganisms to a safe level, spore forming pathogens(except Clostridium botulinum type E which can destroy at 180 ^{0}C) are not assume to be controlled by a pasteurization process. Therefore ,the food must be refrigerate after thermal processing. If process procedure have not include sufficient thermal processing or other berries (i.e., pH, or addition of chemical) for controlling Clostridium botulinum typ E, F and non proteolytic B stain,then the food must be store at refrigeration temperatures of less than 3.3 ^{0}C.(18) The approximate shelf life of pasteurized juice is highly dependent on the initial spoilage microorganism load of the product. And the shelf life is dependent on distribution temperatures. The distribution system has many potential irregularities in

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time- temperature control. Distribution tempertures should be maintained at or below –1.1 ^{0}C.(17)

2.3.5 Pasteurizing machine

The Pasteurized machine was apply pasteurize concept to design machine. This machine favorite to used among small fruit juice manufacturing .The part of balance tank and pasteurizing tank made from stainless steel for cooking pot size 40 inches . Methods for used machine which was advise to buyer is fill water in balance tank and warm the machine until temperature which hight to reach 95^{0}C and pressure hight to 4 bar and then drain all water in balance tank and fill product which need to pasteurized

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CHAPTER 3
METHODOLOGY

3.1 Study Design

The purpose of this study were focused on pasteurizing machine and cooling process for reduce pathogenic bacteria and evaluate the purpose clean technology options in term of technical , economical and environmental impact for implement plan.

3.2 Study Population

The study using pasteurizing machine series 55 liters which favorite among of small fruit juice manufacturing. This machine distributed in Bangkok and metropolis .

3.3 Planning for data collection

Three methods are used to collect data as below

(1) Documents: This method is used to collect data from general information in book, report thesis and other information about clean technology, bael juice, fruit juice process, pasteurizing machine and pathogenic bacteria which contaminated in fruit juice.

(2) Interview : This method is used to collect data by interviewing the factory manager and other person who involve the process. This method will be give the general information of process and pasteurizing machine, flow chart of fruit juice process.

(3) Experiment : This method is used to collect data from experimental in lab and in line process by checking and measuring the microorganism contaminated in product and inner surface of machine, measuring structure of machine, measuring temperature and timing with involve.

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3.4 Experimental design This study design to collecting data of microbial quality comparison with standard from Thai FDA which have aerobic plate count not over 500 cfu/ml, yeast and mold should not be found.

Machine' information (physical) in term of temperature, time comparison with and standard for pasteurized process follow text book reference which have temperature for pasteurized at 85 ^{o}C and holding time 15 s.

All of CT options should be Economical analysis as below

(1) Analysis of profit : Payback period (years)

(2) Improving quality of product

(3) Longer shelf-life

3.5 Equipment and instrument

Equipment and instrument which used in experiment was shown as below Equipment and instrument used in cleaning process has Physical checking using Tank, flash measurement volume of waste water. Trimming process has Physical checking using Weight scale measurement volume of waste water. Extraction Process has Physical checking using Weight scale measurement volume of waste water. Beal juice before pasteurize has Microbial quality checking using Microbial quality equipment check number of microorganism by BAM 8 Biological analysis version 8. Balance tank has Physical checking using Thermometer Clock check relation of temperature and time. Pasteurized process has Microbial quality checking using Microbial equipment check number of microorganism by BAM 8 (shown in appendix A) and weight scale, thermometer, Clock ,Tank , flask measurement volume of product, relation of temperature and time. Filling &close ,sealing process has Microbial quality checking using Microbial equipment check number of microorganism by BAM 8 (shown in appendix A). Cooling process has Physical checking using Weight scale, thermometer, clock, tank. Storage process has Microbial qualitychecking using microbial equipment check number of microorganism by BAM 8 (shown in appendix A).

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3.6 Physical Analysis

Physical information : Measurement structure of machine, characteristic, material, cost

Physical experiment : Checking temperature and time of product in balance tank, checking time using in pasteurize process(holding time of product),check volume of product, gas using, waste water, solid waste

3.7 Microbiological Analysis

Microbiology experiment: Microbiological analysis quality checking by microbiological analysis by BAM 8 (shown in appendix A) . Sampling bael juice before and after passes pasteurization process and swab test at critical surface of pasteurization machine such as input and output point, curve tube, bottom of boiling pot, plastic tube, pipe in order to analytical criteria point where total plate count were collected.

3.8 Planning for experiment

3.8.1 Control factor in Physical experiment and Microbiology experiment

(1) Using pasteurize machine size 55 lites only 1 machine for all experiment.

(2) Control method for cleaning machine is shown in Appendix B.

(3) Control sample for microbial analysis .This study selected bael juice for sample. Method to prepare bael juice shown in 3.8.2 as below

(4) Set up the range of cost to define CT option in 3 level as high cost , medium cost , low cost as high cost used budget about > 5000 baht, medium cost used budget about 500-5000 baht , low cost used budget about 0-500 baht.

(5) Control method for micro analysis .This study referance method of BAM version 8 which is shown in Appendix A.

3.8.2 Prelimary preparation

(1) Prepare bael juice

Preparation beal juice sample

- Using dry bael fruit 50-100 g. per water 5 lites and sugar 1 kg.
- Filling dry bael fruit in boiling water about 5 minites fill sugar and close gas separate bael fruit and bael juice storage in tank .

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(2) Prepare equipment and instrument as table 3.1

(3) Warm machine fill bael juice in balance tank waiting until temperature and pressure of machine which shown on machine reach to accepted limit. Checking temperature and time of bael juice in balance tank which separated to 3 deep level for awareness a risk for bacteria growth between production.

(4) Check flow rate by open all valve and checking volume of bael juice which drained per unit time .Checking temperature of bael juice in the end of pipe which sampling between batch ,Relation between temperature and time which holding of bail juice in prepare pot before pasteurization. Checking temperature of finish product either left and right pipe of pasteurization machine. Measurement waste water and solid waste from all productivity.

(5) Filling bael juice in bottle and put it down in rack inner cooling tank , control level of cooling water and bael juice's temperature from high to 4 degree within 2 hours and selected finish product for microbial quality checking , expire date testing every 3 days include 9 days

(6) Efficiency energy using of pasteurization machine and cost before implement CT options which were selected. Information were collected from experimentation including volume of energy using per times, volume of finish product per times, relation between holding time and heat in pasteurization process, volume ability in process

(7) Swab test after cleaning pasteurize machine

3.9 Experimental phase

This study have 2 phase of experiment .

3.9.1 Before implement CT options :

Preliminary information was collected before CT options were implemented Which can be classifier as follow:

Physical experiment : Measurement structure of machine, characteristic, material, cost, checking temperature and time of product in balance tank, checking time using in pasteurize process(holding time of product),check volume of product, gas using, waste water, solid waste

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Microbiology experiment: Microbiological quality checking by microbiological analysis . Sampling bael juice before and after passes pasteurization process and swab test at critical surface of pasteurization machine such as input and output point, curve tube, bottom of boiling pot, plastic tube, pipe in order to analytical criteria point where pathogenic bacteria were collected.Critical surface was shown in figure 3.1 as below

The microbiology check in order to quality and pathogens including Aerobic plate count, Yeast and Mold, MPN coliform, *E.coli, Salmonella spp*., *Staphylococcus aureu* , *Bacillus cereus* as analysis following the bacterial analysis method version 8 as described in Appendix A . Swab test before pasteurization ,before and after cleaning microbiology quality analysis and swab test method were shown in Appendix A. The microbial quality standard for swab test were carried on the precedence of the department of medical science (19) and for finish product analysis was followed the standard of Thai FDA.

(1) Record result and information from experimentation.

(2) Comparison result which separate to 2 phase.

Microbial quality comparison with standard from Thai FDA

Machine' information in term of temperature ,time comparison with and standard for pasteurized process follow text book reference.

(3) Conclusion result analytical problems and possibly CT option for solve problem.

(4) Implement possibly CT option which was selected.

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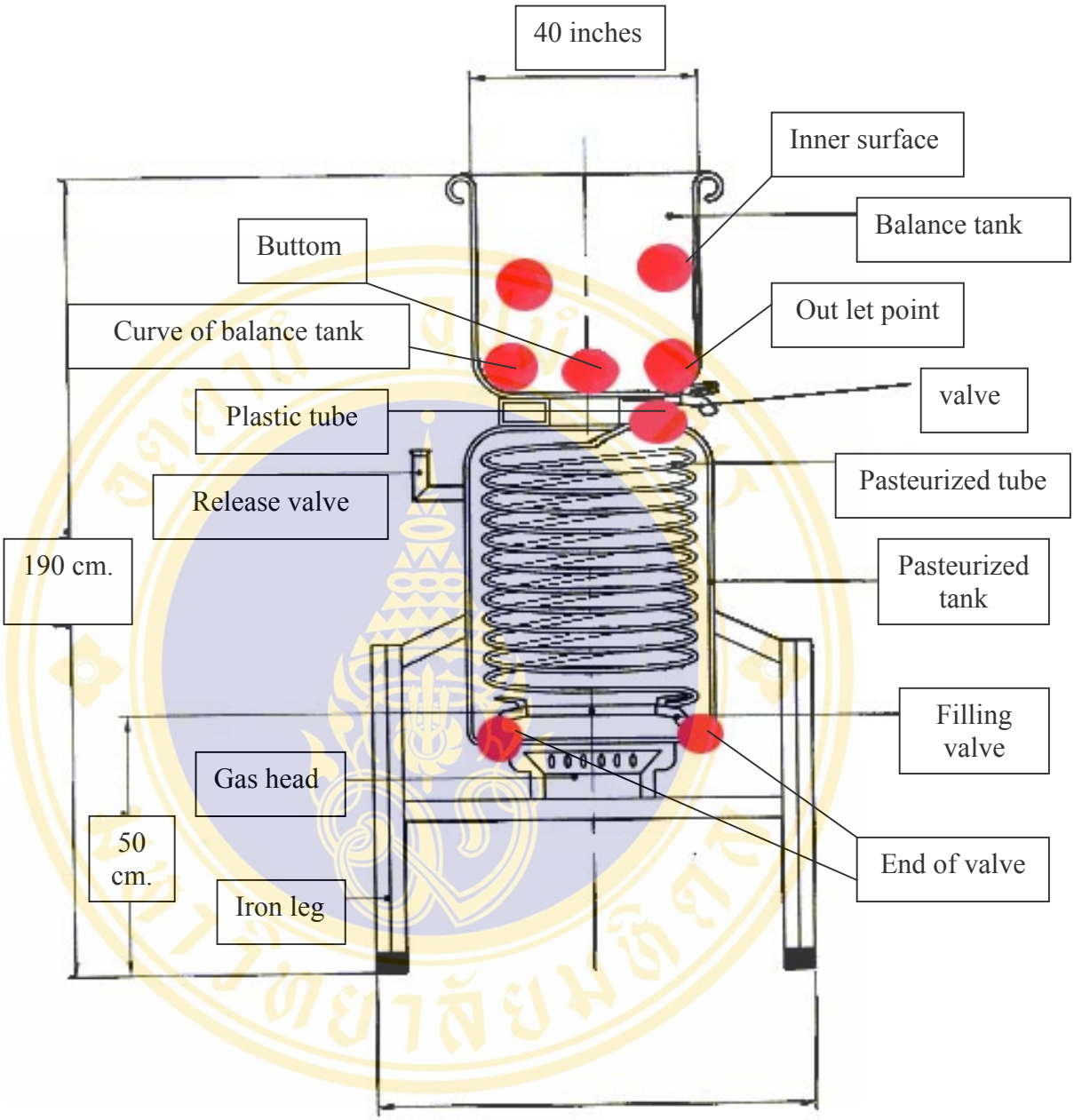

Figure 3.1 Sampling point for swab test

3.9.2 After implement CT options. Information was collected after CT options were implemented Which can be classifier as follow

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Physical experiment : Doing operating manual. The operating manual design to increasing holding time to meet standard for pasteurized by manual as follow

Operating procedure

(1) . Fill product which want to pasteurized after temperature and pressure of machine reach to 95 ^{o}C ,4 bar (avoid to storage product in balance tank longer 20-30 minutes) and always close lidded of balance tank .

(2) Close filling valve .

(3) Open out let valve from balance tank and open filling valve drain little product about 1-2 ml. And close valve immediately.

(4) Holding time at least 15-20 second.

(5) Filling finish product to bottle size 250 ml. Can be filling continue 20-25 bottle and do follow step (4)

(6) Person who filling product should not sitting when working in line production.

(7) Cleaning before and after used the machine.

(8) Manual checking temperature of finish product and holding time (85 ^{o} C, hold on 15 secound)

Measurement, cost,checking temperature and time of product , checking time using in pasteurize process(holding time of product),check volume of product , gas using , waste water , solid waste

Microbiology experiment: Microbiological quality checking by microbiological analysis . Sampling bael juice before and after passes pasteurization process and swab test at critical surface of pasteurization machine such as input and output point ,curve tube ,bottom of boiling pot ,plastic tube ,pipe in order to analytical criteria point where pathogenic bacteria were collected .

The microbiology check in order to quality and pathogens including Aerobic plate count , Yeast and Mold , MPN coliform , *E.coli , Salmonella spp. , Staphylococcus aureus , Bacillus cereus* as analysis following the bacterial analysis method version 8 as described in Appendix A .

(1) Collected information of pasteurization machine after implementations CT option as same as before implementation for comparison to differ result.

(2) Economical analysis : economical evaluation : to evaluate the cost – effectiveness of a clean technology options.

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collect data for calculation of investments and operating cost.

The total investment is the sum of the fixed capital cost for design, procurement and installation equipment such as cost for working capital , licensing, training starting-up and financing.

i Analysis of profit :

$$\text{Payback period (years)} = \frac{\text{Total capital investment}}{\text{Total average profit per year}}$$

This method is recommended for quick assessments of profitability.

Improving quality of product = $(P_1-P_0)Q_0+P_1Q_1$

Q_1 = the number product after used clean technology option.
Q_0 = the number product before used clean technology option.
P_1 = the cost of product after used clean technology option.
P_0 = the cost of product before used clean technology option.

Added number of product = $P(Q_1- Q_0)$

Q_1 = the number product after used clean technology option.
Q_0 = the number product before used clean technology option.
P = products cost.

Longer shelf-life = $(P_1-P_0)\ Q_0 +P_1Q_1$

Q_1 = the number product after used clean technology option.
Q_0 = the number product before used clean technology option.
P_1 = products cost after used clean technology option.
P_0 = products cost before used clean technology option.

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CHAPTER 4
RESULT

I. BEFORE CT OPTIONS IMPLEMENTATION

4.1 Pre-evaluation the efficiency of the pasteurization machine

Preliminary survey of pasteurization machine data .All of them were distributed in small-scale fruit juice manufacture which located in Thailand. The result of survey in term of characteristic for pasteurization machine from source as follow.

4.1.1 Characteristic of pasteurization machine

Table 4.1 Characteristic of pasteurization machine .

Product description			Cost (Bath)
	Composition	Data	
I.	Material		
	- Balance tank (stainless steel 304L)	Finished pot 40 "	
	- pasteurize tank (stainless steel 304L)	Apply from cooking pot	
	- tube sizeØ 5 /8 ", Ø ~ 1.5 cm.	Total 12 maters,flow rate	
	- plastic tube Ø	1.5 liter/ minites	14,000
	- 1 piece copper valve for draining	10-15 cm.	
	- 2 piece copper valve for filling	-	
	- stainless steel 304 L	-	
	- iron for legs	About 1,200 cm^3	
	- total weight	638 cm^3 (made of iron)	
	- total length	100-150 kg.	
	- total length between valve to floor	130 cm.	
		50 cm.	
II.	Energy consumption		
	- source of energy	Gas petroleum	
	- cost	210 bath/15kg.	210
	- consumption rate	Used 1 kg./1times	21 /batch
III.	Production rate of machine		
	- time	15 days	5,000
	- number of machine per time	10-20 units	
IV.	Temperature / pressure / time		
	- design pressure	Cover 4-6 bar	
	- design temperature	85-95 degree	
	- temperature lose	About 9-10 degree	

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Table 4.1 Characteristic of pasteurization machine (cont.)

V.	Production rate of juice (liter/times) (full scale of all three valves)	50 liters / 30 minuets	
VI.	Cost of labor	15 days/ 5,000 bath/person	333 bath/day
VII.	Environmental cost - solid waste - waste water - air pollution	 1.05 kg./ batch 12.50 liters/ batch -	

The machine was applied pasteurize concept ,According to their target focus on small manufacturing ,cost of machine in importance factor to apply some part of machine such as they using cooking pot apply to balance tank and pasteurized tank, and valve not property for pasteurize machine

4.1.2 Result of microbial quality analysis and physical experiment before implement CT options

Result of microbial quality analysis before implement CT options was shown in Table as below.

(1) Pasteurize process

Result of microbial quality of bael drink before and after pasteurization were collected for estimate efficiency of pasteurizing machine and quanity of spoilage finish product .

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Table 4.2 microbial quality of bael drink before and after pasteurization (before implement CT option)

Microorganisms	Standard Value (CFU/ml)	No.of Substandard Sample / No.of Sample		Range (CFU/ml)		Average (CFU/ml)	
		BF-PAS	AF-PAS	BF-PAS	AF-PAS	BF-PAS	AF-PAS
Aerobic plate count	<500	12/12	12/12	1,630-2,120	700-1,400	1,861.6	1,022
Yeast and Mold	None	12/12	12/12	230 - 340	120 - 220	293.6	174.8
MPN coliform	<2.2	0/12	0/12	0	0	0	0
E.coli	None	0/12	0/12	0	0	0	0
B.cereus	None	0/12	0/12	0	0	0	0
S.aureus	None	0/12	0/12	0	0	0	0
C.perfringens	None	0/12	0/12	0	0	0	0
Salmonella spp.	None	0/12	0/12	0	0	0	0

BF-PAS = Before pasteurized, AF-PAS = After pasteurized, Under condition : full scale of all three valves

Table 4.2 was shown ,most of finish product before pasteurization have microbial quality do not meet the standard value of Thai FDA such as Aerobic plate count and Yeast and Mold was over the accepted standard value. Even though bael drink was pasteurized but microbial quality was shown ,all of sample still have microbial quality do not meet the standard value of Thai FDA such as Aerobic plate count and Yeast and Mold that means 100% finish product was spoilage . Result of microbial quality found Aerobic plate count and Yeast and Mold only .

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(2) Cooling process

Result of microbial quality of bael drink after cooling process were collected for estimate efficiency for pasteurized machine and quantity of spoilage finish product .

Table 4.3 Microbial quality of bael drink after cooling process that sampling on 0 days 3 days and 6 days (before implement CT option)

Microorganisms	Standard Value	No.of sample			No.of Substandard sample		
		Time			Time		
	CFU/ml	0days	3days	6days	0 days	3days	6 days
Aerobic plate count	<500	12	-	-	12	-	-
Yeast and Mold	None	12	-	-	12	-	-
MPN coliform	<2.2	12	-	-	0	-	-
E.coli	None	12	-	-	0	-	-
B.cereus	None	12	-	-	0	-	-
S.aureus	None	12	-	-	0	-	-
C.perfringens	None	12	-	-	0	-	-
Salmonella spp.	None	12	-	-	0	-	-

Microbial quality of bael drink after cooling process shown that all of sample has substandard of microbial quality in some microorganism such as Aerobic plate count , Yeast and

Mold ,the other microorganism can not be found . This result shown that 100% of finish product were spoilage. Cooling process for this study control to protect cooling water leak in the finish product ,so design of cooling for this study was control the bottle's lid can not approach to cooling water which shown in Appendix B

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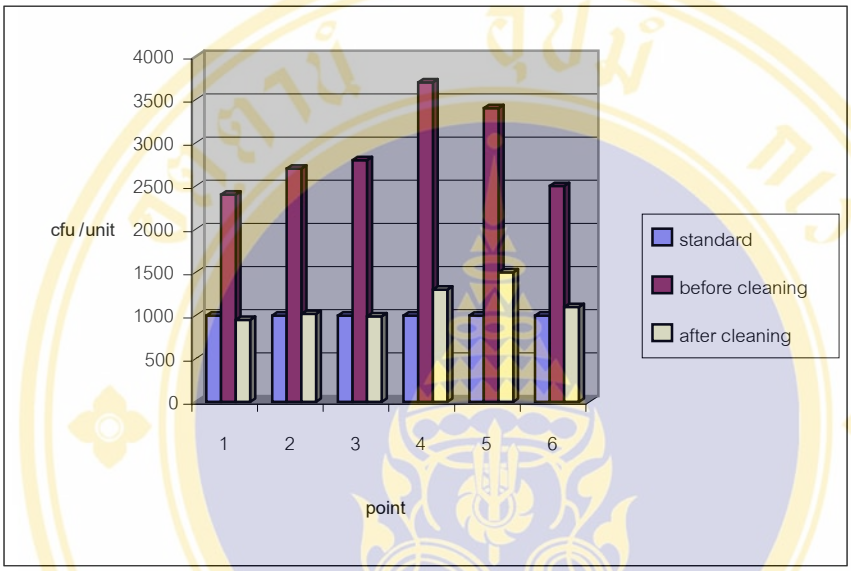
(3) Cleaning process

Result of microbial quality by swab test before and after cleaning shown that cleaning methods can be reduce volume of pathogenic bacteria which collected in any part of machine .The quantity of collected pathogenic bacteria on surface machine can caused cross contaminated in finish product.



1. Inner balance tank
2. Curve of balance tank
3. Bottom of inner balance tank
4. Out let point
5. The end of valve
6. Plastic tube

Figure 4.1 Aerobic plate count by swab test before and after cleaning (before CT option implementation)

Table 4.4 Aerobic plate count by swab test before and after cleaning (before CT option implementation)

Swab point	Standard Value CFU/unit *	Before cleaning CFU/unit	After cleaning CFU/unit
1. Inner balance tank	<1,000	2,400	950
2. Curve of balance tank	<1,000	2,700	1,020
3. Bottom of inner balance tank	<1,000	2,800	990
4. Out let point in balance tank	<1,000	3,700	1,300
5. The end of valve	<1,000	3,400	1,500
6. Plastic tube	<1,000	2,500	1,100

* comparison with thai FDA standard

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Before cleaning the machine : The result of microbial quality of swab test (Aerobic plate count)on surface of machine has bacteria collected over standard ,Therefore after cleaning the result of microbial quality of swab test shown that cleaning can be decrease collected bacteria but some swab point still has bacteria collected over standard. The collected pathogenic bacteria on surface of machine is one of factor which can be loaded efficiency of pasteurized process and can be cause cross contaminated to finish product.

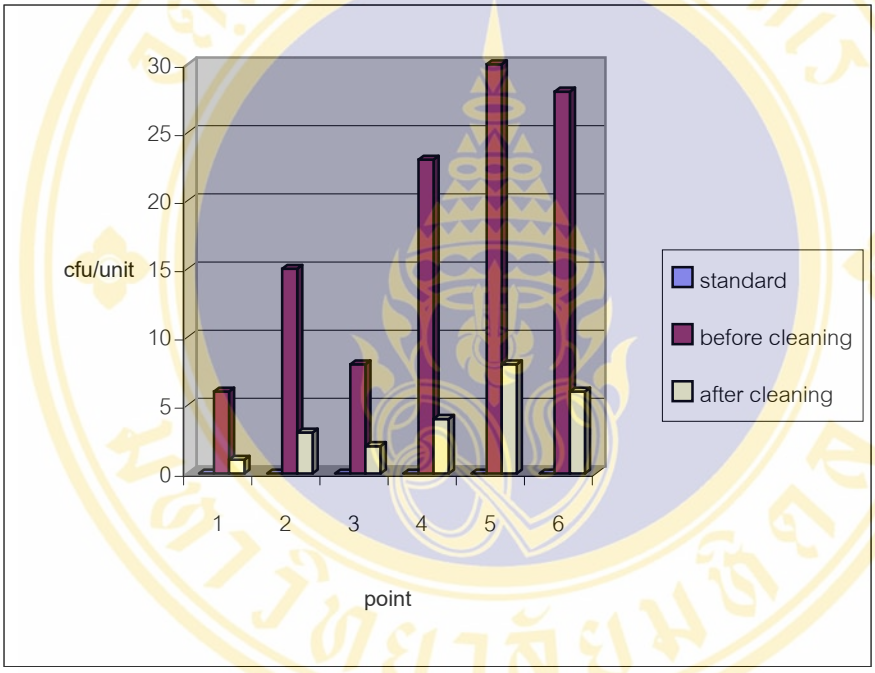

Figure 4.2 Yeast and Mold by swab test before and after cleaning (before CT option implementation)

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Table 4.5 Yeast and Mold by swab test before and after cleaning (before CT option implementation)

Swab point	Standard Value CFU/unit	Before cleaning CFU/unit	After cleaning CFU/unit
1. Inner balance tank	None	6	1
2. Curve of balance tank	None	15	3
3. Bottom of inner balance tank	None	8	2
4. Out let point in balance tank	None	23	4
5. The end of valve	None	30	8
6. Plastic tube	None	28	6

Before cleaning the machine : The result of microbial quality of swab test (Yeast and Mold) on surface of machine has bacteria collected over standard ,Therefore after cleaning the result of microbial quality of swab test shown that cleaning can be reduce collected bacteria but still has bacteria collected over standard.

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4.1.3 Physical collected data

This study design to collected physical property data for evaluated efficiency of pasteurize machine , physical property with concern as below

(1) Holding time and temperature of product

Data collected from experimental in temperature and holding time is importance to evaluated efficiency of pasteurize machine

Table 4.6 Relation between temperature and holding time (before implement CT option)

Batch no.	Temperature(^{0}C)		Holding * Time for pasteurize (Second)
	Machine (^{0}C)	Product (^{0}C)	
1	89	81	11
2	88	80	10
3	85	75	11
4	90	81	11
5	90	80	11
6	85	75	12
7	95	85	12
8	95	85	11
9	90	82	10
10	85	77	11
11	80	72	11
12	87	79	12
Average	88.25^{0}C	79.33^{0}C	11.08 second
Standard	90^{0}C/ 4 bar.	85^{0}C	15 second
No. of substandard sample	7 (58.33%)	10 (83.3%)	12(100%)

Under condition : full scale of all three valves *

Relation between temperature and time were shown that 83.3% of product do not meet the standard value of temperature(85^{0}C) and all of product (100%)do not meet the standard value of time (15 second). By average the product temperature is 79.33 ^{0}C at holding time 11.05 seconds.

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Temperature of machine and product should be the same or can be varies in acceptable value, for this study the result shown that each temperature differ average about 10 ^{0}C which be heat lost .

The major reason to design open full scale of all three valves of machine and collected data because prelimination data of machine should over all maximum efficiency of machine.

(2) Energy consumption

This pasteurization used gas power in process was shown in table 4.7 The data collecting of gas energy consumption in each batch was 1 kg. by average

Table 4.7 Energy consumption for pasteurization machine and cost before implement CT option.

No.	Gas using /batch		Temperature and time for pasteurize					
			Temperature			Time		
			Temp.	STD	Result	Time	STD	Result
	Weight (kg)	Cost* (bath)	(^{0}C)	(^{0}C)		(s)	(s)	
1	1.1	15.4	81	85	Not pass	11	15	Not pass
2	0.9	12.6	80	85	Not pass	10	15	Not pass
3	1.2	16.8	75	85	Not pass	11	15	Not pass
4	1.0	14	81	85	Not pass	11	15	Not pass
5	0.9	12.6	80	85	Not pass	11	15	Not pass
6	0.9	12.6	75	85	Not pass	12	15	Not pass
7	1.0	14	85	85	pass	12	15	Not pass
8	1.0	14	85	85	pass	11	15	Not pass
9	1.0	14	82	85	Not pass	10	15	Not pass
10	0.9	12.6	77	85	Not pass	11	15	Not pass
11	1.1	15.4	72	85	Not pass	11	15	Not pass
12	1.0	14	79	85	Not pass	12	15	Not pass
Average	1	14	79.33	85^{0}C	Not pass	11.08	15	Not pass

STD = Standard Temperature 85^{0}C, Time 15 s.,* Check cost on June 2002

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Temperature and time for pasteurization machine in process can not reach standard for pasteurize process, Even though some batch of experimental has temperature high enough for pasteurization but do not related with the holding time, holding time not enough for killing pathogenic bacteria. By average each batch using gas about 1 kg. and cost for energy is 14 baht per batch which was checked cost on June 2002.

(3) Temperature in balance tank

All process importance to quality of product when product storage in balance tank for flow to next step,either proper temperature and time can be factor to pathogenic bacteria growth ,for this reason researcher design to collected this data.

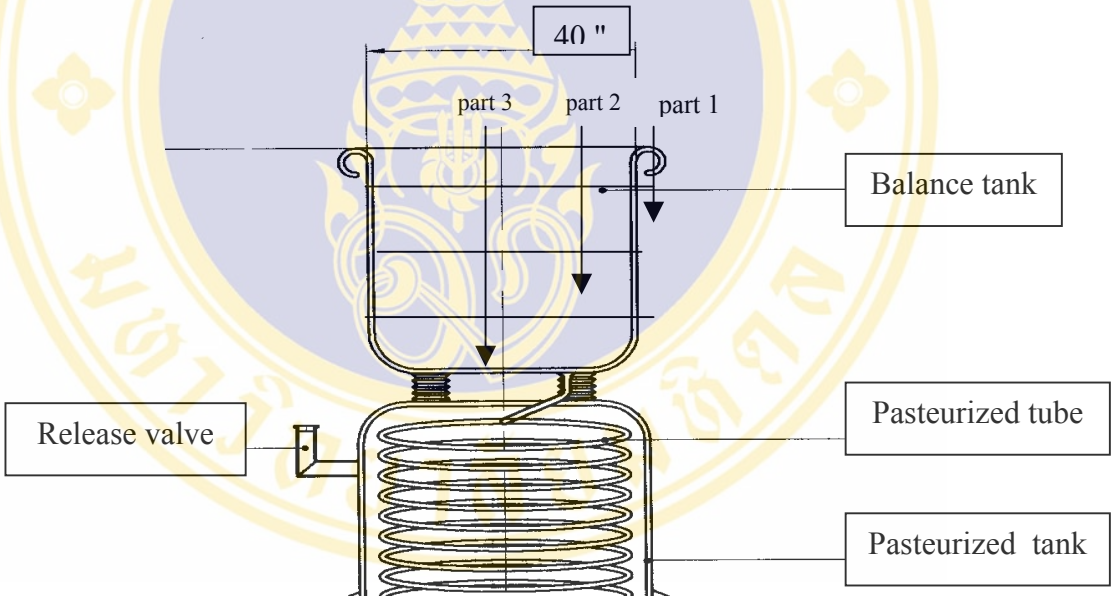

Figure 4.3 Picture of temperature checking point of balance tank.

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Table 4.8 Temperature of product in balance tank before pasteurize process

No.	Part 1		Part 2		Part 3		Total holding time (s)
	Temp (^{0}C)	Time (s)	Temp (^{0}C)	Time (s)	Temp (^{0}C)	Time (s)	
1	40	44	40	120	40	300	464
2	40	50	40	125	40	602	777
3	41	65	41	182	41	520	767
4	41	61	41	122	41	433	616
5	40	63	40	95	40	621	779
6	40	62	40	133	40	235	430
7	41	60	41	126	41	250	436
8	39	52	39	148	39	240	440
9	41	66	41	150	41	266	482
10	40	64	40	154	40	564	782
11	41	68	41	188	41	441	697
12	40	63	40	136	40	543	742
Average	40.33	59.8 =0.9 minite	40.33	139.91 =2.33 minites	40.33	417.91 =6.96 minites	617.66 =10.29 minites

Temp = Temperature, s = second

Temperature of product in balance tank before pasteurize process average 40.33 ^{0}C which can be importance factor for bacteria increasing but not related with time when not long enough for bacteria increasing. The dangerous zone of microorganism growth is wide range between 4^{0}C - 70^{0}C, more than 30 minutes(14) . This critical point can be ignore to after CT implemental experiment.

(4) Waste water and solid waste

Volume of waste water ,solid waste in production data can be estimate them per mass volume of finish product and used this data to evaluated environmental index in term of waste water and solid waste. This study not include data of cost in electric used and cost of personal

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Table 4.9 Volume of waste water ,solid waste and costing for production

No.	Waste water (lites/batch)	Solid waste (kg./batch)	Spoilage of product	No.of Labor	Chemical for cleaning (bath/batch)
1	12	0.5	5	2	30
2	13	1.2	5	2	30
3	15	0.9	5	2	30
4	14	1.1	5	2	30
5	12	1.3	5	2	30
6	14	0.9	5	2	30
7	13	1.0	5	2	30
8	10	1.5	5	2	30
9	12	1.2	5	2	30
10	11	1.0	5	2	30
11	11	0.9	5	2	30
12	13	1.2	5	2	30
Average	12.50	1.05	5	2	30

According to table 4.9 average volume of waste water per batch about 12.50 liters, volume of solid waste about 1.05 kg. For this study design to control cleaning method so chemical for cleaning have stable cost every batch.

(5) Mass balance (before implement CT options)

Input mass was verified, which can identify to quantity impact to human and environment. For this study can be identify quantity of spoilage product before implement CT options

Pasteurized process

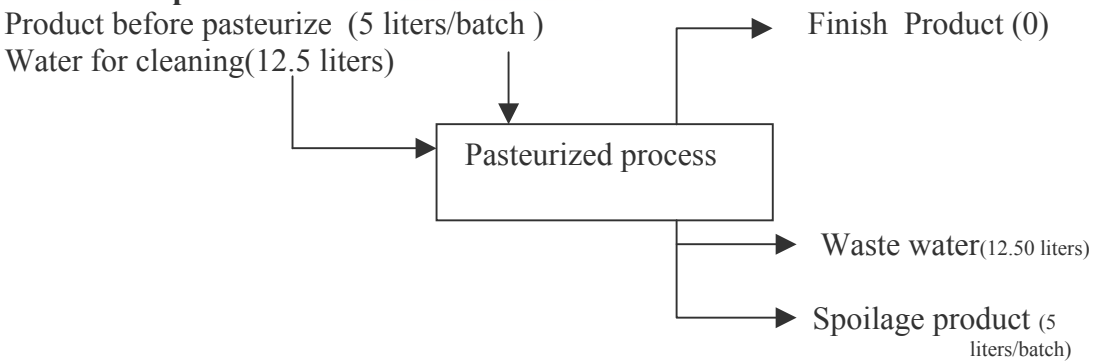

Figure 4.4 Mass balance of pasteurized process before implement CT options.

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4.2 Cause assessment

For focus to the source and cause of losses which on two features involved technological change and good operation practice

4.2.1 Evaluated cause and Source of lost

Cause assessment and the cause of lost characteristic can be identify as below

Table 4.10 Cause assessment and the cause of lost characteristic

Evaluated cause and Source of lost
Technology cause 1. Temperature and time for pasteurization lower than standard 2. Design of machine focus on junction and tube made pathogenic bacteria collected. 3. Balance tank can not be self draining from bad design. 4. No insulation for protection heat loss in pasteurize tank 5. Improper height of out let valve is too low which can cause cross contamination from the floor. 6. Inner surface of tube is not smooth from welding effect and the fixed tube was not easy for cleaning and sanitizing. 7. Filling valves can not control flow rate property 8. No lid of balance tank for prevention of cross contamination 9. Water media used cause uncontineus to heat transfer 10. Using insanities valves for food production 11. Not appropriate material used of stand for pasteurize machine 12. Improper diameter and length of pasteurized tube can not achieve the complete pasteurization

4.2.2 Classification of alternatives CT options

From this study found that one cause of losses can be solve by one or combine with many CT options, classification of alternatives CT options based on related cause of lost made clearly to selected proper CT options to implement.

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Table 4.11 Classification of alternatives CT options based on related cause of lost.

Options number	Cause of lost	CT options
1.	Temperature for pasteurization lower than standard	1. Change media for heat transfer from water to propylene 2.Change size ,diameter or length of pasteurize tube
2.	Pasteurization time cannot meet standard according to improper diameter and length of pasteurized tube	1. Prepare operation manual : hold bael juice in tube by closing the filling valve for 15 second .(per 25 bottle) 2. Change size ,diameter or distance of pasteurize tube
3.	Residues Finish product remained in balance tank	1.change design of machine for easy to separate for cleaning
4.	No insulation for protection heat loss in pasteurize tank	1.install insulation for protect heat losses 2.Put the machine in the place close from wind
5.	Improper height of machine cause cross contamination	1.Put the machine on the table which have total height 50 cm. 2.Made leg of machine longer 50 cm.
6.	Inner surface of tube fixed can not separate for cleaning	1.Change size ,diameter or distance of pasteurize tube 2. Train producer about cleaning methods the machine for decrease pathogenic bacteria collected inner machine
7.	Can not control flow rate property	1.Using temperature detected for double check inner of tube and show on gay 2. Prepare operation manual 3. Train the controller for control flow rate of production
8.	No lid of balance tank for prevention of cross contamination	1.Close prepare pot
9.	water media used cause uncontineus to heat transfer	1. Change media for heat transfer from water to propylene
10.	Using insanities valve for food production	1.Change kind of pipe from copper to stainless steel 2. Train producer about cleaning methods the machine for decrease pathogenic bacteria collected inner machine
11.	Not appropriate material used of stand for pasteurize machine	1.Used stainless steel for stand of pasteurize machine
12.	Design of machine focus on junction and tube made pathogenic bacteria collected	1.change design of machine for easy to separate for cleaning 2. Train producer about cleaning methods the machine for decrease pathogenic bacteria collected inner machine

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4.3 Generated and selection of CT options

The factor for selected clean technology options can be classified as

4.3.1 Technical change

The clean technology options can distinguish in to 3 levels high cost which cost in range > 5,000 baht, medium cost which cost in range 500-5,000 baht , and no or low cost options which cost in range 0-500 baht. The no or low cost options easy to implement and ready to do first. The medium cost options need some factor or cost for implement so pay back period is importance factor for applicants this options to do if pay back period will not be so long this options should be a good choice .The high cost options need to new design of machine and change main of structure which so complicated and need many cost ,therefore factory has many stock for raw material which using for built machine and can not change by now such as tube for pasteurize boiling pot ,pipe and iron leg of machine .So all investments require a technology evaluation , economical and environment evaluation. The CT options was selected to implement was in level medium cost options and no or low cost options which shown in table 4.12 as following

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Table 4.12 Generation of Alternatives CT-options base on technical change and The selected CT options classified by cost operatio

Factor for CT-options selection	Alternatives of CT-option And cause of problem	High cost	Medium cost	None or low cost	Selected CT option to implement
CT1 Technological change	1.1 Change media for heat transfer from water to propylene : cause CT options No.1,9 1.2 Change size ,diameter or length of pasteurize tube : cause CT options No.1,6,12 1.3 Close prepare pot : cause CT options No.8 1.4 Install insulation or protect heat losses: cause CT options No.4 1.5 Change type of pipe from copper to stainless steel : cause CT options No.10 1.6 Used stainless steel for stand of pasteurize machine : cause CT options No.11 1.7 Put the machine on the table which have total height 50 cm. : cause CT options No.5 1.8 Made leg of machine longer 50 cm. : cause CT options No.5 1.9 Using temperature detected for double check inner of tube and show on gay : cause CT options No.7 1.10 Change design of machine for easy to separate for cleaning : cause CT options No.2	● ● ● ● ● ● ●	● ● ● ●	● ●	● ●

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4.3.2 Good operating practices

This one of technical factor for CT options to solve the losses in process, for this study can be classified by factor good operating practices and cost as below

Table 4.13 Generation of alternatives of CT-options based on good operating practices and The selected CT options classified by cost operation.

Factor for CT-options selection	Alternatives of CT-option And cause of problem	High cost	Medium cost	None or low cost	Selected CT option to implement
CT 2 Good operating practices	2. 1 Prepare operation manual : cause CT options No.1,7,12 2.2 Train the controller for control flow rate of production : cause CT options No.7 2.3. Train producer about cleaning methods the machine for decrease pathogenic bacteria collected inner machine : cause CT options No. 2,6,10 2.4. Train producer about cooling process for decrease cooling water leak in the finish product 2.5. Check efficiency of machine every batch 2.6. Put the machine in the place close from wind : cause CT options No. 4		●	● ● ● ●	● ● ●

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CT options selected can be separate to two factor are technical change and good operating practices Each factor have many of alternatives of CT option ,finally proper CT options will be selected to implement

4.3.3 CT options which was implemented

CT options which was implemented in this study have detail for implement in experiment as below.

Table 4.14 Classifier Cause of problem related with CT options was selected to implemented

Cause of problem	Selected CT option to implement
1. Temperature for pasteurization lower than standard 2. Water media not proper to heat transfer	Change media for heat transfer from water to propylene .Usually in pasteurize machine used water from pipe to be media for heat transfer , Therefore many problem from media for heat transfer such as scale,slime, uncontinues to heat transfer. Propylene has quality to keep increase continues to heat transfer more than water raised temperature 79.33^{0}C to 83.25^{0}C. Cost of propylene is 80 baht per kg. for this machine used about 40-50 kg. so total cost for propylene about 3200-4000 baht which can be used 2-5 years.
3. Holding time for pasteurized not meet standard 4. Can not control flow rate property 5. No flow rate regulator	Prepare operation manual document of the pasteurize machine: hold bael juice in tube by closing the filling valve for 15 second .(per 25 bottle) The operation manual which shown in Appendix should be practical and easy for the operator and increasing holding time longer enough for pasteurization.
6. Improper height of machine cause cross contamination	Place the machine on the table which have total height 50 cm. Usually machine should be control hygienic position for working . The previous has too low out let which can cause cross contamination from the floor and the operator person. Cost for table about 500-1,000 baht.

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Table 4.14 Classifier Cause of problem related with CT options was selected to implemented (cont.)

Cause of problem	Selected CT option to implement
7. No lid of balance tank for prevention of cross contamination	Close lid of balance tank which apply for pasteurize machine is made from stainless steal . It's instant both tank body and lid . Machine was sold it both but do not used , this CT option just used cover to close the balance tank for protect dust, spore of any microorganism which cause to contaminate to bael juice when storage in balance tank before pasteurize process. No cost for this options.
8. Design of machine focus on junction and tube made pathogenic bacteria collected 9. Using insanities valve for food production	Prepare cleaning procedure manual (shown in Appendix B). The proper cleaning methods is importance to reduce pathogenic bacteria contaminated in product. The strictly practice on cleaning method not only reduce pathogenic bacteria contaminated in product but also maintenance the machine to long live. Cleaning procedure manual was shown in Appendix B: The seller should advise cleaning procedure manual to producer.

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Table 4.15 The result of implementation the CT options for increase effectively of machine .

No.	CT-Options	Capital Cost (Baht)	Total (Baht)
1.	Change media for heat transfer from water to propylene	80/ liters.	3,200-4,000
2.	Close prepare pot.	-	-
3.	Fill insulator for heat transfer.	180	180
5.	Change type of pipe from copper to stainless steel	1,500	1,500
6.	Put the machine on the table which have total height at least 50 cm.	-	500-1,000

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II. AFTER CT OPTIONS IMPLEMANTATION

4.4.1 Result of microbial quality analysis and physical experiment after implement CT options

Result of microbial quality of bael drink after pasteurization can be estimate that CT options was selected effective by comparison the result of microbial quality with before and after implement CT options .

(1) Pasteurize process

Result of microbial quality of bael drink before and after pasteurization were collected for estimate efficiency for pasteurized machine and quanity of spoilage finish product .

Table 4.16 Microbial quality of bael drink before and after pasteurization that sampling were pasteurized machine (after implement CT option)

Microorganisms	Standard Value (CFU/ml)	No.of Substandard Sample /No.of Sample		Range (CFU/ml)		Average (CFU/ml)	
		BF-PAS	AF-PAS	BF-PAS	AF-PAS	BF-PAS	AF-PAS
Aerobic plate count	<500	12/12	2/12	900-1,210	120 -650	1,050	322
Yeast and Mold	None	12/12	5/12	50-280	0 - 172	123	59
MPN coliform	<2.2	0/12	0/12	0	0	0	0
E.coli	None	0/12	0/12	0	0	0	0
B.cereus	None	0/12	0/12	0	0	0	0
S.aureus	None	0/12	0/12	0	0	0	0
C.perfringens	None	0/12	0/12	0	0	0	0
Salmonella spp.	None	0/12	0/12	0	0	0	0

BF-PAS = Before pasteurized, AF-PAS = After pasteurized

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Table 4.15 result of microbial quality was shown , all of finish product before pasteurized do not meet the standard value of Thai FDA such as Aerobic plate count and Yeast and Mold .The other pathogenic bacteria can not be found in finish product before pasteurized. After pasteurized 10 samples of total 12 samples or about 83.3% of sample has microbial quality (Aerobic plate count) was accepted standard value and 7 samples of total 12 samples or about 58.3 % of sample has microbial quality (Yeast and Mold) was accepted standard value.

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(2) Cooling process

Result of microbial quality of bael drink after cooling process were collected for estimate efficiency for pasteurized machine and quantity of spoilage finish product after CT implemented.

Table 4.17 Microbial quality of bael juice after cooling process that sampling 3 days, 6 day.9 days keep in refrigerator temperature (after implement CT option)

Microorganisms	Standard Value CFU/ml	No.of sample	No.of Substandard sample			
			Time			
			0days	3days	6days	9days
Aerobic plate count	<500	12	2	4	7	8
Yeast and Mold	None	12	5	10	0	0
MPN coliform	<2.2	12	0	0	-	-
E.coli	None	12	0	0	-	-
B.cereus	None	12	0	0	-	-
S.aureus	None	12	0	0	-	-
C.perfringens	None	12	0	0	-	-
Salmonella spp.	None	12	0	0	-	-

From table 4.17 MPN coliform, *E.coli ,B.cereus ,S.aureus ,C.perfringens and Salmonella spp.*Not detected in beal juice after cooling process .On 0 day and 3days have 2 substandard sample of Aerobic plate count ,after that on 6 days and 9 days have 3 and 1 substandard sample which shown that expired date of finish product longer than before implement CT option by not significant which all of sample were substandard value since 0 day

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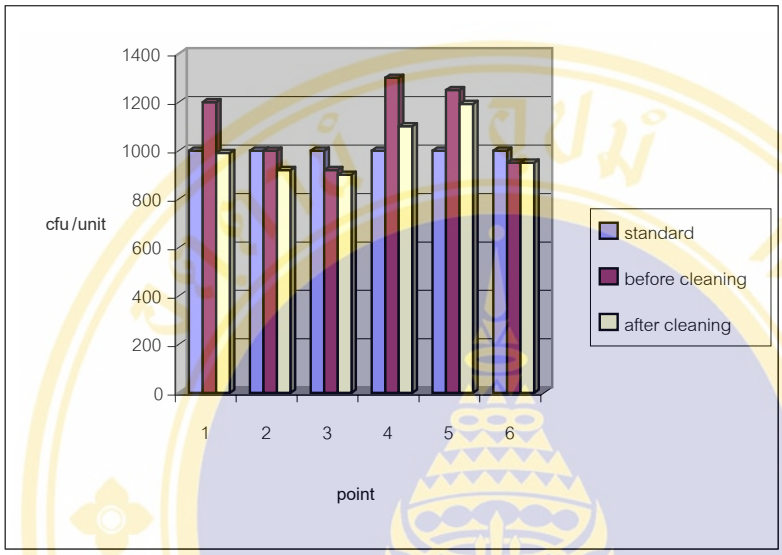
(3) Cleaning process

Result of microbial quality of bael drink after cleaning process were collected for estimate efficiency for pasteurized machine and quantity of spoilage finish product .



1. Inner balance tank
2. Curve of balance tank
3. Bottom of inner balance tank
4. Out let point
5. The end of valve
6. Plastic tube

Figure 4.5 Aerobic plate count by swab test before and after cleaning (after CT option implementation)

Cleaning can be decrease pathogenic bacteria collected in machine .Some point have analysis result over standard this evidences that cleaning may be not effective enough to reduce amount of aerobic bacteria that collected on out let point of balance tank, the end of valve and inner balance tank

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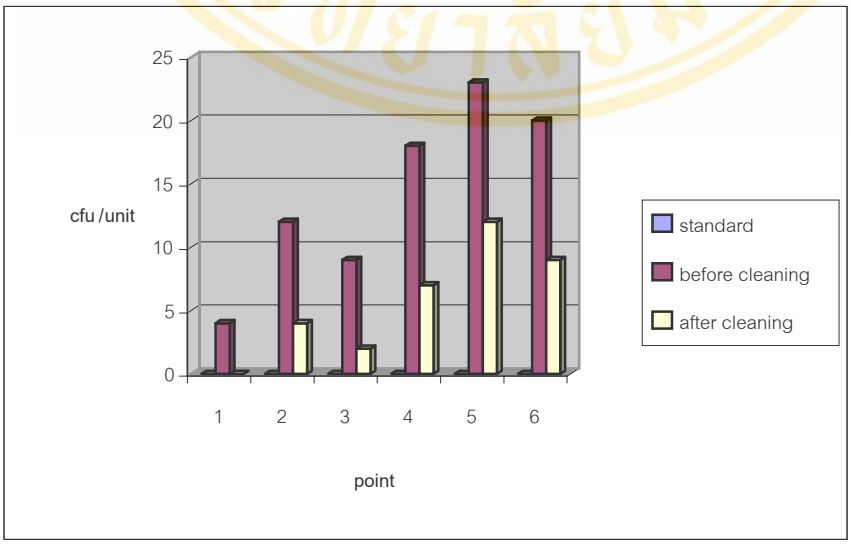
Table 4.18 Aerobic plate count by swab test before and after cleaning (after CT option implementation)

Swab point	Standard Value (CFU/unit)*	Before cleaning (CFU/unit)	After cleaning (CFU/unit)
1. Inner balance tank	<1000	1,200	990
2. Curve of balance tank	<1000	1,000	920
3. Bottom of inner balance tank	<1000	920	900
4. Out let point in balance tank	<1000	1,300	1,100
5. The end of valve	<1000	1,250	1,192
6. Plastic tube	<1000	950	950

* comparison with Thai FDA standard

Aerobic plate count by swab test after cleaning (after CT option implementation) of the end of valve and out let point in balance tank of the machine has bacteria collected over standard ,Therefore after cleaning the result of microbial quality of swab test shown that cleaning methods not efficiencies, Even though cleaning can be reduce collected bacteria but still has bacteria collected over standard.



1. Inner balance tank
2. Curve of balance tank
3. Bottom of inner balance tank
4. Out let point
5. The end of valve
6. Plastic tube

Figure 4.6 Yeast and Mold by swab test before and after cleaning (after CT option implementation)

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Yeast and mold value was acceptable only 1 point after cleaning condition . The result of the other was unacceptable we found out that inner balance tank where was acceptable value have smooth surface than another point where usually collected of bacteria and should be strictly to cleaning were curve of tank , bottom of balance tank, out let point, the end of valve which close to floor and plastic tube

Table 4.19 Yeast and Mold by swab test before and after cleaning (after CT option implementation)

Swab point	Standard Value CFU/unit*	Before cleaning CFU/unit	After cleaning CFU/unit
1. Inner balance tank	None	4	0
2. Curve of tank	None	12	4
3. Bottom of inner balance tank	None	9	2
4. Out let point in balance tank	None	18	7
5. The end of valve	None	23	12
6. Plastic tube	None	20	9

* comparison with Thai FDA standard

Yeast and Mold by swab test after cleaning (after CT option implementation) of the end of valve can not met standard which shown that cleaning methods not efficiencies.

4.4.2 Physical collected data

This study design to collected physical property data for evaluated efficiency of pasteurize machine , physical property with concern as below

(1) Holding time and temperature of product

Data collected from experimental in temperature and holding time is importance to evaluated efficiency of pasteurize machine

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Table 4.20 Comparison temperature and holding time before and after implement CT option

Batch no.	Temperature(^{0}C)				Holding time for pasteurize (second)	
	Machine		Product			
	BF-IM	AF-IM	BF-IM	AF-IM	BF-IM *	AF-IM
1	89	95	81	85	11	15
2	88	92	80	81	10	15
3	85	90	75	79	11	15
4	90	90	81	81	11	15
5	90	90	80	80	11	15
6	85	95	75	85	12	15
7	95	95	85	85	12	15
8	95	95	85	85	11	15
9	90	90	82	81	10	15
10	85	93	77	82	11	15
11	80	95	72	85	11	15
12	87	90	79	80	12	15
Average	88.25	92.5	79.33	83.25	11.08	15.00
Standard	90^{0}C/ 4 bar.	90^{0}C/ 4 bar.	85^{0}C	85^{0}C	15 second	15 second
No. of substandard sample	7 (58.33%)	0 (0%)	10 (83.3%)	7 (58.33%)	12 (100%)	0 (0%)

BF-IM = Before implementation
AF-IM = After implementation, * Under condition : full scale of all three valves *

According to table 4.20 found that change media for heat transfer by using hot oil can be increases the temperature higher than used water and reduce the number of substandard sample which focus on temperature in pasteurize process from 83.3% to 58.33% .Operation follow by operate manual practice was the one of CT option which implement for corrected the problem about holding time not enough for kill pathogenic bacteria made all of sample reach holding time for pasteurized standard

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(2) Energy consumption

This pasteurization energy consumption in process was shown in table 4.21 .The data collecting of gas energy consumption in each batch was 1 kg. by average

Table 4.21 Efficiency energy consumption of pasteurization machine and cost after implement CT option

No.	Gas using /batch		Temperature and holding time for pasteurize					
			Temperature			Holding time		
	Weight (kg)	Cost (bath)	Temp. (^{0}C)	STD (^{0}C)	Result	Time (s)	STD (s)	Result
1	1.0	14	85	85^{0}C	Pass	15	15	Pass
2	1.0	14	81	85^{0}C	Not pass	15	15	Pass
3	1.0	14	79	85^{0}C	Not pass	15	15	Pass
4	0.9	12.6	81	85^{0}C	Not pass	15	15	Pass
5	1.1	15.4	80	85^{0}C	Not pass	15	15	Pass
6	1.0	14	85	85^{0}C	Pass	15	15	Pass
7	1.1	15.4	85	85^{0}C	Pass	15	15	Pass
8	0.9	12.6	85	85^{0}C	Pass	15	15	Pass
9	1.2	16.8	81	85^{0}C	Not pass	15	15	Pass
10	1.0	14	82	85^{0}C	Not pass	15	15	Pass
11	0.9	12.6	85	85^{0}C	Pass	15	15	Pass
12	0.9	12.6	80	85^{0}C	Not pass	15	15	Pass
Average	1	14	79.33	85^{0}C	Not pass 58.3 %	15	15	Pass

Temp = Temperature
s = second
STD = Standard

From table 4.21 Temperature for pasteurization machine in process can not reach standard 58.3 % , Even though holding time long enough for killing pathogenic bacteria all batch but some batch of experimental has high temperature not enough for pasteurization . By average each batch gas consumption about 1 kg. and cost for energy is 14 baht per batch.

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(3) Waste water and solid waste

Volume of waste water ,solid waste in production data can be estimate them per mass volume of finish product and used this data to evaluated environmental index in term of waste water and solid waste.

Table 4.22 Volume of waste and costing for production before and after implement CT options

No.	Waste water (liters/batch)		Solid waste (kg./batch)		Volume of finish product (liters/batch)		Chemical for cleaning (baht)	
	BF-IM	AF-IM	BF-IM	AF-IM	BF-IM	AF-IM	BF-IM	AF-IM
1	12	14	0.5	1.0	5	5	30	30
2	13	13	1.2	1.2	5	5	30	30
3	15	10	0.9	1.1	5	5	30	30
4	14	12	1.1	1.0	5	5	30	30
5	12	10	1.3	0.9	5	5	30	30
6	14	11	0.9	1.2	5	5	30	30
7	13	12	1.0	0.5	5	5	30	30
8	10	12	1.5	1.2	5	5	30	30
9	12	13	1.2	0.9	5	5	30	30
10	11	13	1.0	1.1	5	5	30	30
11	11	14	0.9	1.3	5	5	30	30
12	13	12	1.2	0.9	5	5	30	30
Average	12.50	12.16	1.05	1.02	5	5	30	30

BF-IM = Before implementation
AF-IM = After implementation

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(4) Environmental index

According to table 4.22 average volume of waste water per batch about 12.16-12.50 liters, volume of solid waste about 1.02-1.05 kg. raw information of this study can be evaluated about environmental index as follow

Bael drink process has average volume of waste water about 12.16-12.50 liters per finish product 5 liters that can be assume average volume of waste water 2,432 – 2,500 liters /tone processed

volume of solid waste about 1.02-1.05 kg. per finish product 5 liters that can be assume average volume of solid waste 204-210 kg. /tone processed

(5) Economical evaluate

Analysis of profit CT options which implement :

$$\text{Payback period (years)} = \frac{\text{Total capital investment}}{\text{Total average profit per year}}$$

This method is recommended for quick assessments of profitability.

Improving quality of product $= (P_1-P_0)Q_0+P_1Q_1$

Improving quality of product $= (12-12)0 + 6$

$= 6$ About 50 % improving

Q_1 = the number product after used clean technology option .

Q_0 = the number product before used clean technology option .

P_1 = the cost of product after used clean technology option .

P_0 = the cost of product before used clean technology option .

Longer shelf-life $= (P_1-P_0)\,Q_0 + P_1Q_1$

Longer shelf-life $= (12-12)\,0 + 12\,(12)$

Longer shelf-life $= 144$

Q_1 = the number product after used clean technology option .

Q_0 = the number product before used clean technology option .

P_1 = products cost after used clean technology option .

P_0 = products cost before used clean technology option .

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CHAPTER 5
DISCUSSION

5.1 Efficiency of pasteurize machine

For this study can be assume that the pasteurize machine have not enough efficiency for pasteurized drink in plant .

5.1.1 Physical quality

The efficiency of pasteurize machine can be comparison with standard of temperature in pasteurize process and holding time of product ,for this study temperature in pasteurize process is 85^{o}C at holding time 15 second.

(1) Temperature

Before implement CT option ,the result of data collection show that temperature for pasteurize product lower than standard 83.3%of sample batch . The pasteurized machine design for control temperature on pasteurize range but result of experimental found that the machine can not control follow by standard.

After implement CT option, temperature for pasteurize product meet standard 41.6% of sample batch . Apply pasteurized concept to design the machine should be study of theory and awareness about safety for working not only for producer but also buyer who concern about the machine.

For this issue, the information from study shown that the efficiency of machine can not met standard both of temperature and holding time. This problem can be solve by increasing temperature to product or keep product's holding time longer. Have many CT options solved this issue such as change diameters or length of tube in the machine .that should be calculating for the proper diameter and length. In this study was selected to increase temperature in process by changed media of heat transfer from water to propylene which cheap and proper to the owner.

(2) Holding time

Before implement CT option ,the result of data collection show that temperature for pasteurize product lower than standard 100%of sample batch . The pasteurized

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machine design for control holding time on pasteurize range but result of experimental found that the machine can not control follow by standard.

After implement CT option, temperature for pasteurize product meet standard 100% of sample batch according to the practical operating manual. In this study the simple CT options by holding the bael juice in tube at least 15 second at every time interval of filling of the 25 bottles of bael juice was implemented instead of self automatic holding time of the machine which are not function properly . The best solution should increase the length of tube for extending of the holding time. The lengh of tube must cover both holding the pasteurized time and maximize operation by two filling valves.

5.1.2Microbial quality

Microbial result of experimental both of before and after implemented CT option not found the other pathogenic bacteria beside that Aerobic plate count and Yeast and Mold . This observance may be cause strictly control hygienic of produce the sample bael drink by researcher, Usually in market ,the producer who user this pasteurized machine not only have not know how about good hygienic but also have not good procedure for using machine .The cross contamination always found in finish product of small manufacture ,This reason the pasteurize machine should be control hygiene in process at least should be have effectively pasteurize process .The finish product have standard quality can be acceptation ,The most importance include personal hygiene , efficiency of methods and machine all of process. For pasteurization process pasteurized and cooling were the most importance to indicator for finish produce.

Before implement CT option, the result of microbial quality can not meet standard all 1 00 % of sample, After implement CT option ,the result of Microbial quality can meet standard 58.3 % of sample,

5.2 Experimental design

For this study researcher design to collecting data and control factor which concern to result of experiment as follow.

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5.2.1 Balance tank

The study design to collected temperature and time when product storage in balance tank before pasteurize cause pasteurize machine don not used insulator ,temperature from pasteurize tank can be transfer to product in balance tank ,that means this process can be increase pathogenic bacteria if under proper condition for bacteria growth ,the result of measurement temperature and timing of product in balance tank not in proper condition for bacteria growth .For practical temperature and timing of product in balance tank can be on proper condition for bacteria growth , should be awareness.

5.2.2 Cooling process

The study design to using cool process by apply concept protected cooling water leak in the finish product .The problem always found in this process is cross contaminated from cooling water leaked .Cooling process have many design but reference to the same concept which is reduce the product temperature to 4 ^{o} C within 2 hr. For this

study researcher design to used rack for control bottle of product stand ,In this study do not fill chlorine in cooling water in proper ratio for protect to cross contaminated.

5.2.3 Cleaning method

For result of this study show that cleaning can be reduce quanity of pathogenic bacteria ,that means cleaning method is can be reduce waste at source ,but cleaning method are related to combination of product such as product which has sugar .Cleaning method should using hot water at first step for melt the sugar which melt and cover surface of machine ,but in the another hand if product have composition of protein should be using cooling water rinse at the first time . All plant equipment including pasteurized machine shall be designed and such material as to be adequately cleanable, and shall be properly maintained.

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CHAPTER 6
CONCLUSION

6.1 Conclusion

In this study, the Cleaning Technology concept has been applied in order to increase the efficiency of the pasteurization for the beverage industry by using the pasteurized machine of 55 liters. The sample experiment used in this process is bael juice. This analysis focuses on fundamental data gathering in terms of its efficiency in pasteurized machine compared to temperature standard in pasteurized of sample at 85 celsius by controlling sample close to this level of temperature for 15 seconds. At this level, holding time is sufficient to pasteurized in order to avoid any pathogenic bacteria of sample. Result from data gathering, problem analysis and loss from previous experiment found that 83.3 % of samples were not qualified the temperature pasteurised standard and all the samples were met qualified for the holding time standard. The result of microbial quality analysis from pasteurization of sample indicates that there is contaminated of Aerobic bacteria ,Yeast and Mold 100 % of standard. Finally, this causes the damage of all sample.

From the analysis, cleaning technology system is able to reduce the percentage of temperature was not qualified to standard in pasteurized from 83.3% to 58.33% and to increase holding time of pasteurized to be 100%. microbiology analysis of pasteurized sample found that there is contaminated of aerobic bacteria more than standard level 16% and there is contaminated of yeast and mold more than standard level 41.6%. Finally the overall total loss from product damage has been improved from 58.3% to 41.6%.The machine have not enough efficiency for production in plant either in term of temperature and holding time can be meet standard even though CT option can be improving both of factor better but still can not be acceptable . For cleaning methods can be decrease pathogenic bacteria collected in surface of the machine but still found in the curve or junction which hard to cleaning, hygienic design of machine is importance and should be awareness.

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This study gathering data in terms of waste water quantity of manufacturing process 2,432 - 2,500 liter per finish product 1,000 kgs. and there will be solid waste from manufacturing process for 204 – 210 kgs. per finish product 1,000 kgs. Application of CT- options to reduce losses in beverage process can be done in many technical .To increase efficiency of machine is the alternative which was selected. This study can summarize the result as follow:

6.1.1 CT –option that was Change media for heat transfer from water to propylene

6.1.2 Close prepare pot

6.1.3 Put the machine on the table which have total height 50 cm.

6.1.4 Prepare operation manual

6.1.5 Train the controller for control flow rate of production

6.1.6 Train producer about cleaning methods the machine for decrease pathogenic bacteria collected inner machine

All of CT options solve the problem in term of quality of pasteurize process ,which approved after implementation .In the future study should be concern about energy losses and reused or recycle the recourses in process.

6.2 Recommendation

For this study and next step

6.2.1 The CT –options that is Change size ,diameter or distance of pasteurize tube is the importance technical design of machined for the future research**.**

6.2.2 Reused/recycle waste and energy from pasteurization process is the next step

6.2.3 Cooling process should be checking- chorine residues in cooling water .

6.2.4 In the future study , the researcher should be considered to reduce the product the losses more than this which still height of losses.

6.2.5 Hygienic design of equipment was should be study and apply for solved.

6.2.6 The future study should be study deeply in the detail of reducing the losses in other sources such as energy used because energy is the one of importance factors that effects directly with cost of production.

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APPENDIX

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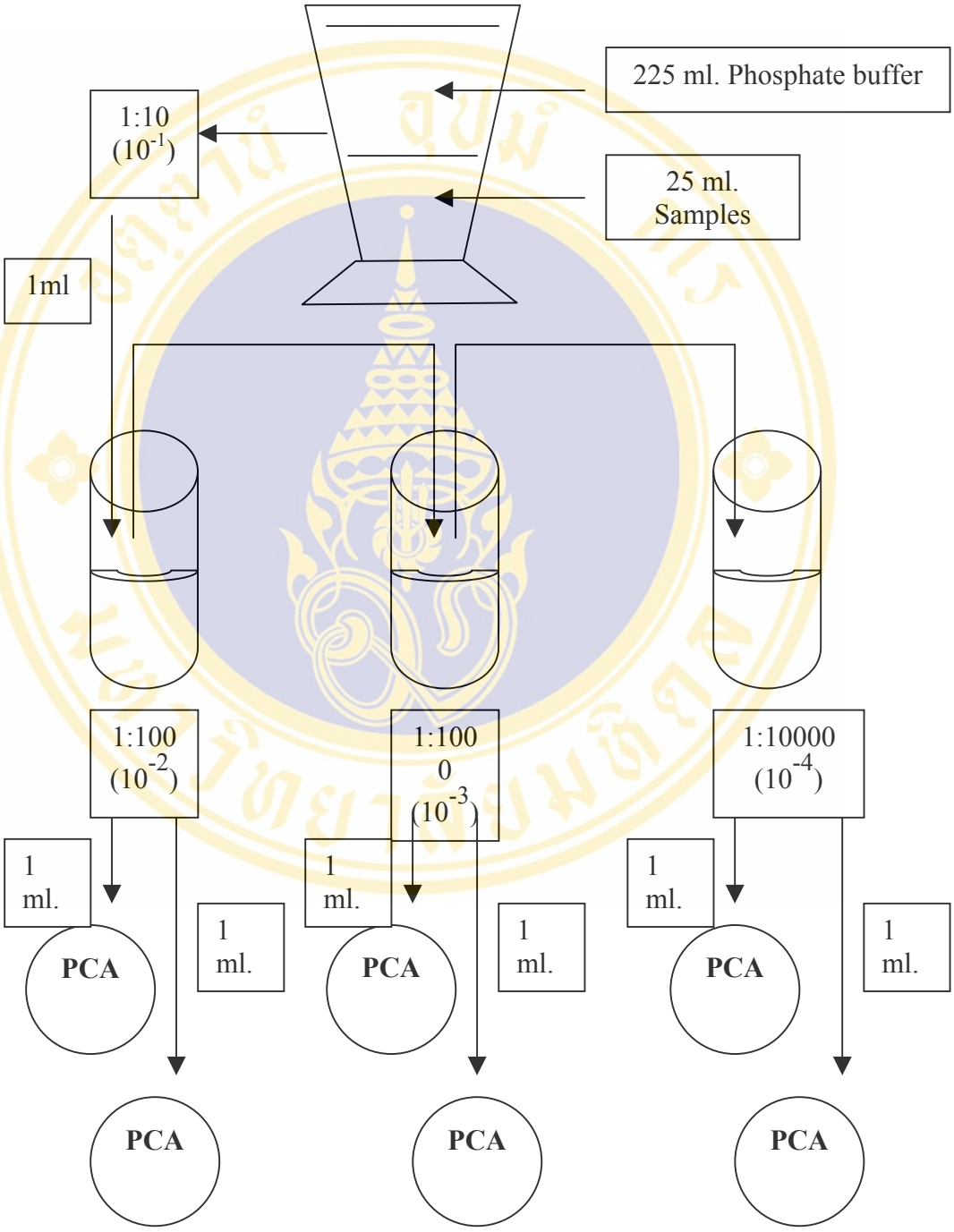
The microbial quality standard methods

The microbial quality standard for swab test were carried on the precedence of the department of medical science (12) and for finish product analysis was followed the standard of Thai FDA (12) . The microbiological including



Incubate at 35 ^{0} C for 48 hr., count plates containing 25-250 colonies

Figure A-1 Aerobic plate count Analysis Method

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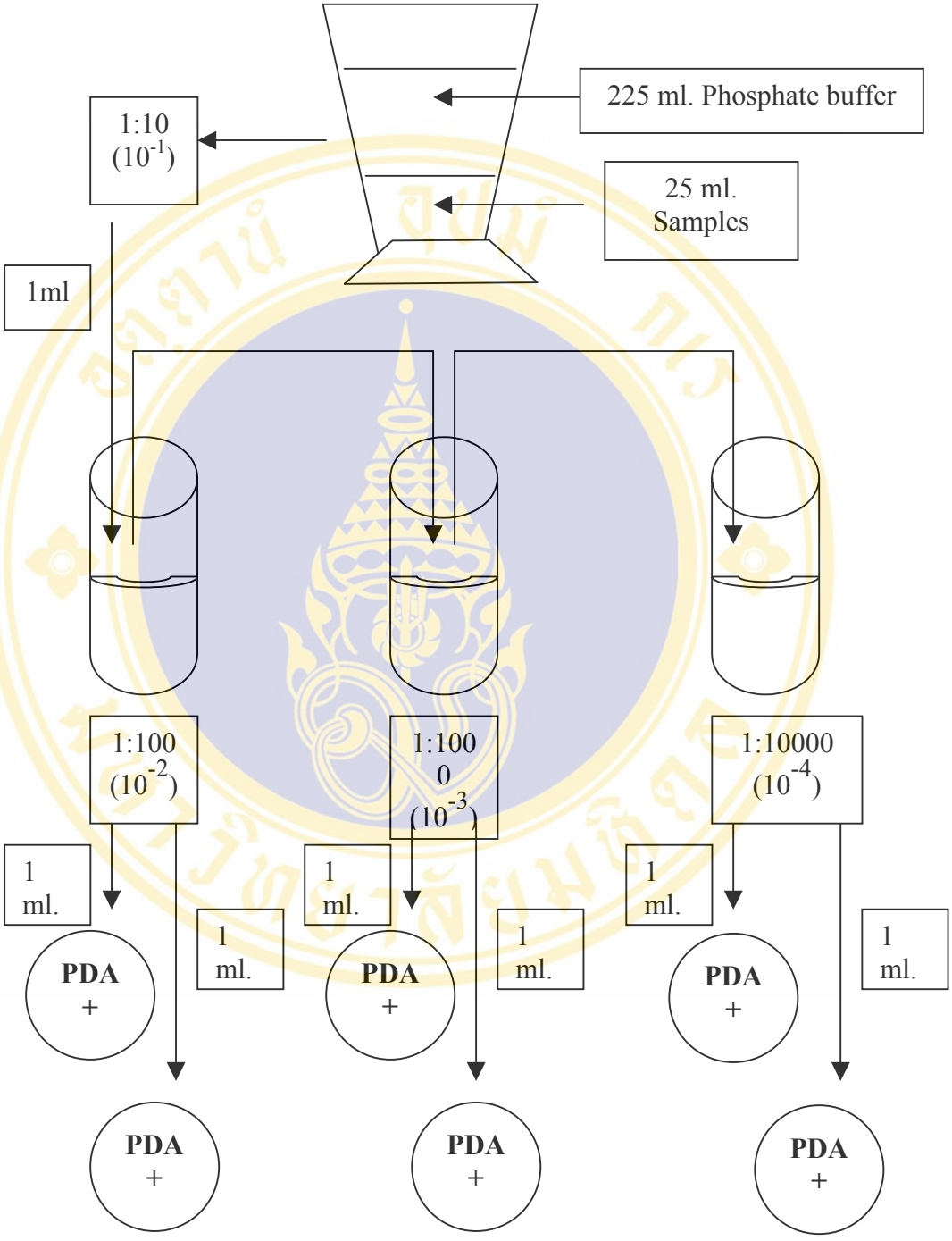

PDA + means PDA + tartaric acid , Incubate at 25 ^{0} C for 5days., count plates containing 25-250 colonies

Figure A-2 Yeast and Mold Analysis Method

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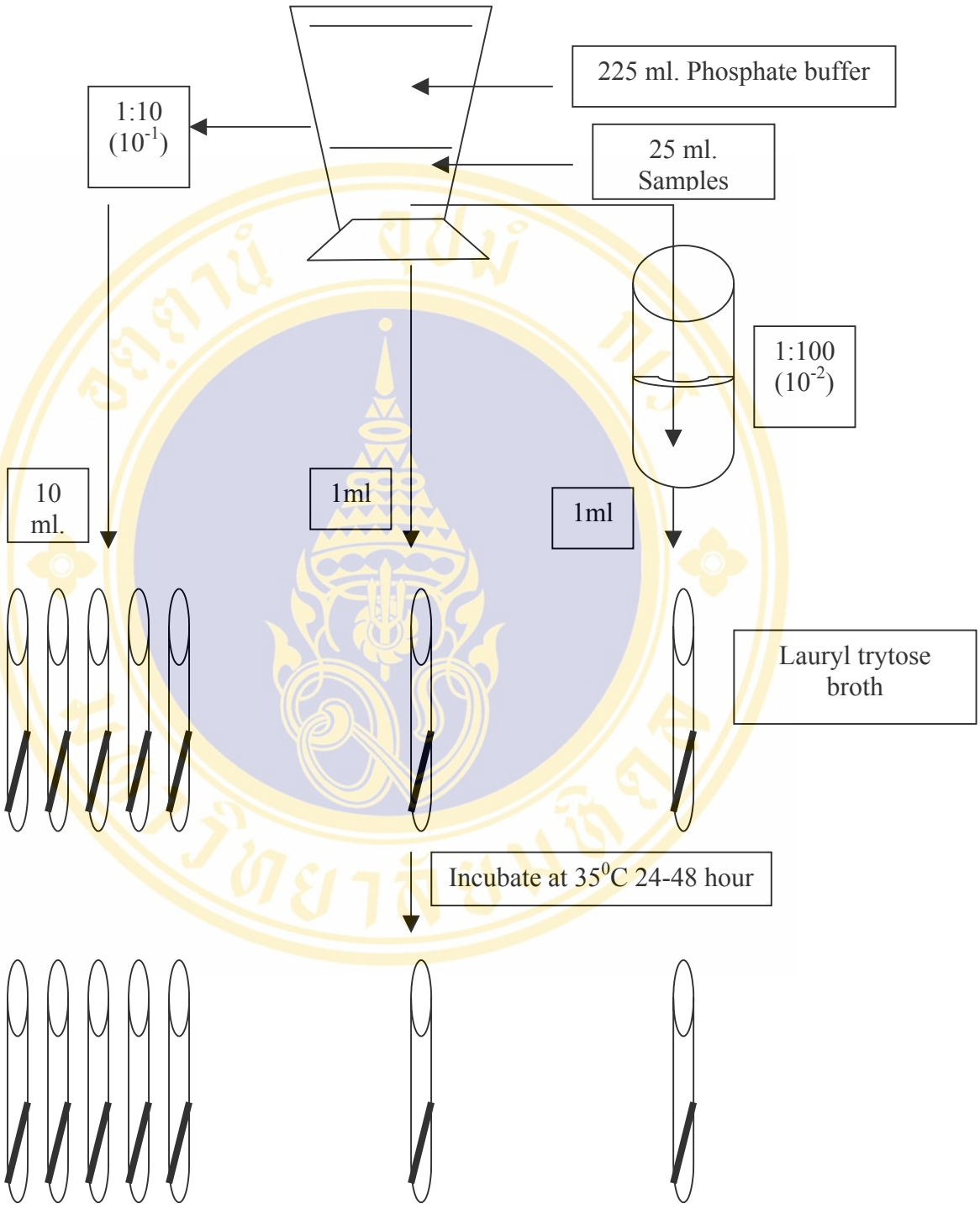

Incubate at 35 ^{0} C for 48 hr., Gassing in BGB tubes are positive

Figure A-3 Enumeration of Total Coliforms

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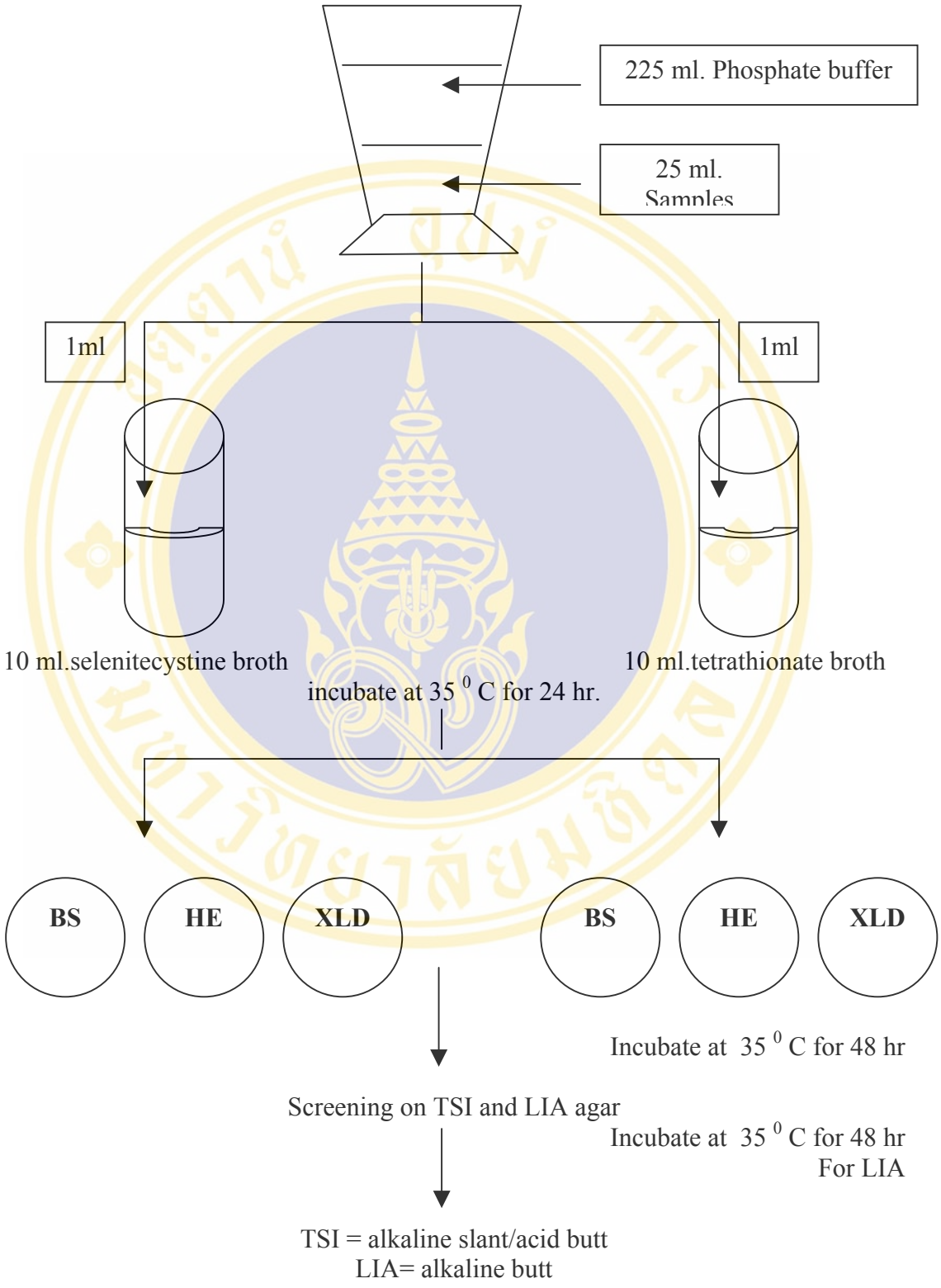

Figure A- 4 Detection of *Salmonella*

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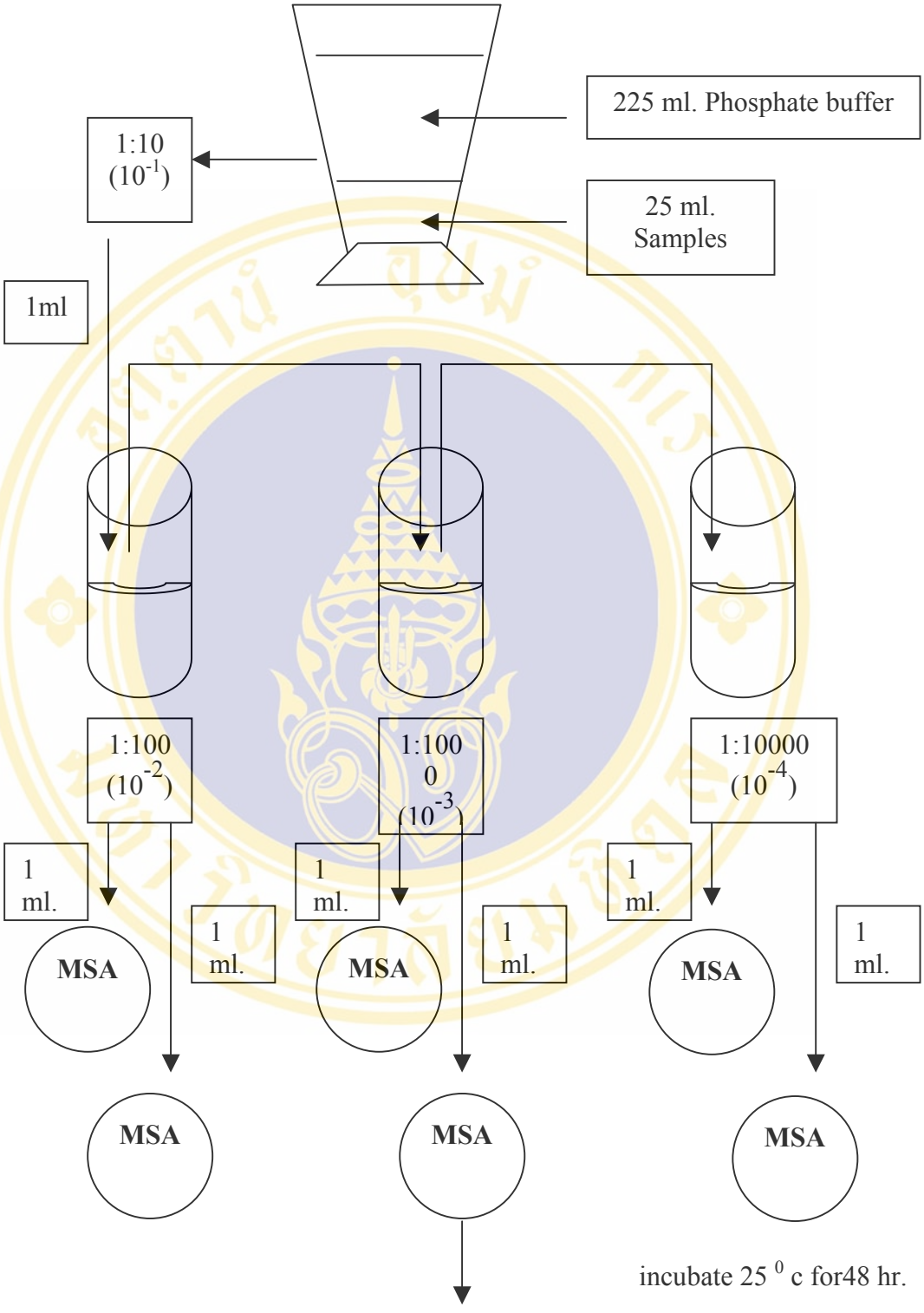

Figure A-5 Enumeration of *S.aureus*

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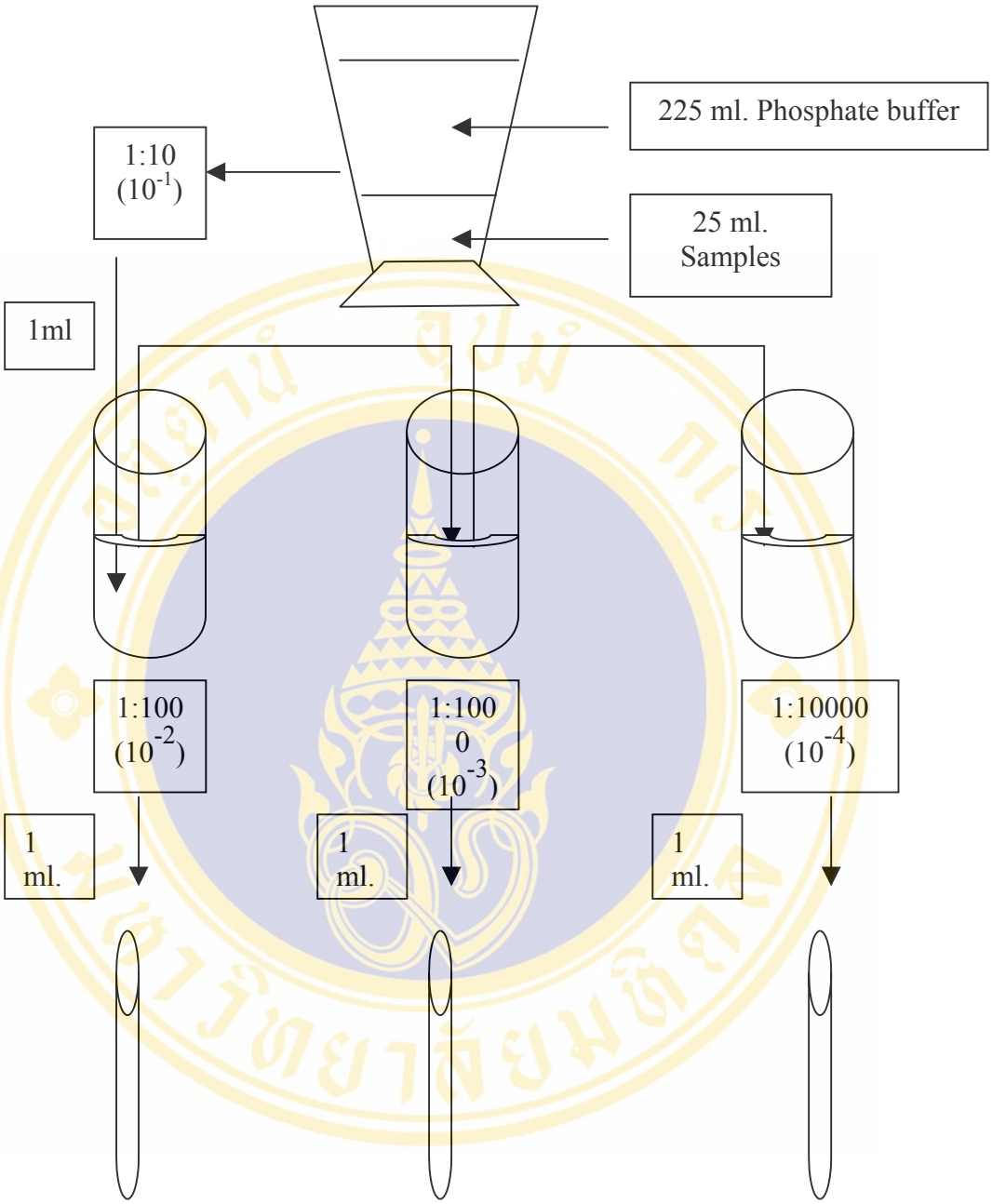

Tryticase soy-polymyxin broth

↓

Streak on Manital- Egg York-Polymyxin Agar
Incubate 30 ^{0} C for 24-28 hr.

↓

Biochemical confirmation

Figure A-6 Detection of *B. cereus*

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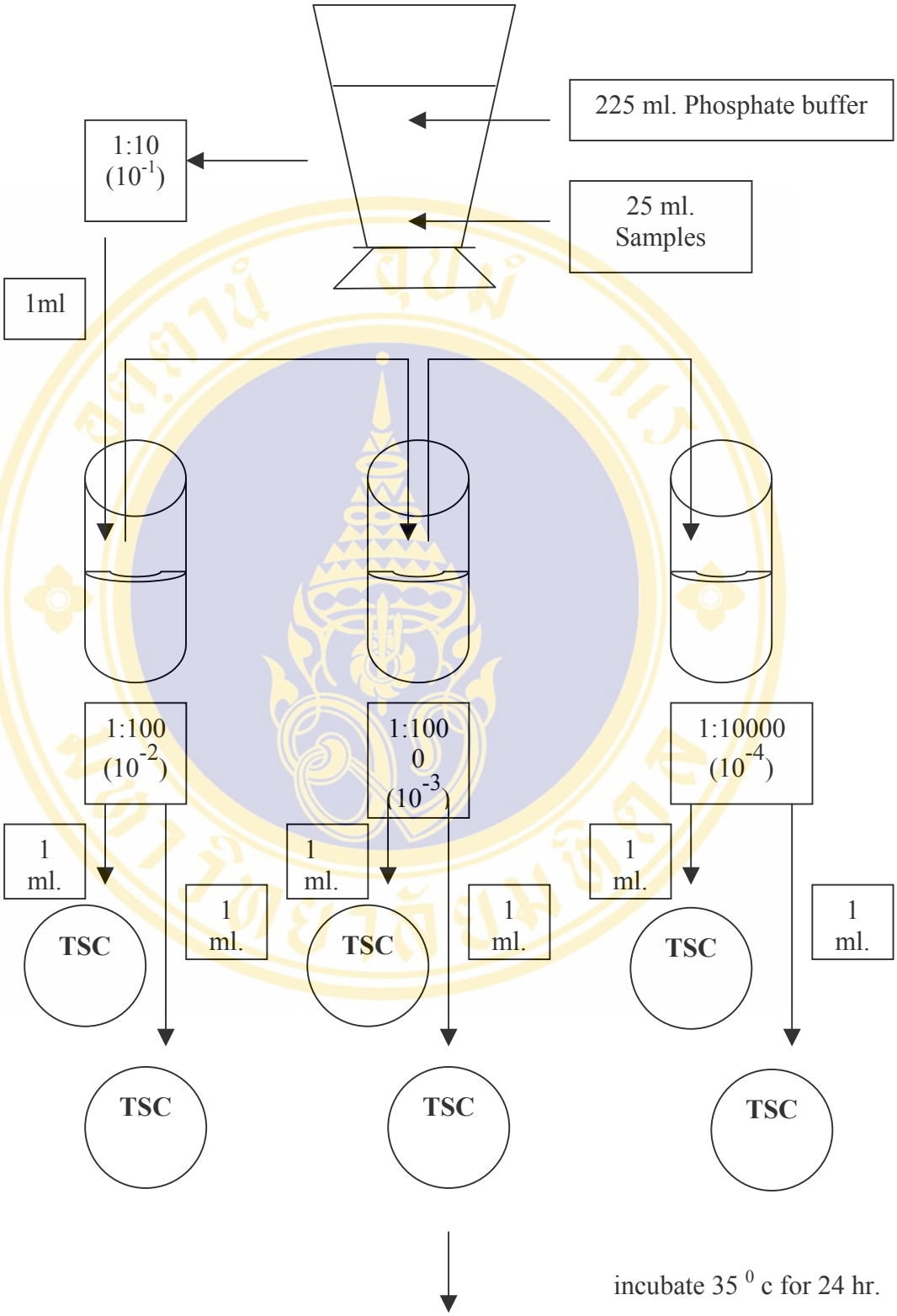

Figure A-7 Enumeration of *C.perfringens*

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Swab test method

Screw capped test tube , prepare to contain 20 ml. of buffered solution and cotton stick and then autoclaving. To sample equipment surfaces open the swab container and remove the cotton stick , being careful not to touch any portion of tube . Hold the swab handle to make 30 degree angle contact with the surface . Rub the swab hand slowly and thoroughly 4 square cm. of surface three times reversing direction between successive strokes. Return the swab test in the buffer solution tube. Replace the finish swab in the waterproof container pack in ice box. Deliver to the laboratory and analyze within 24 hours. The significant area of equipment consist of the surface that usually contact food all time or very often , curve , junction , end of pipe , surface where hardy for clean. (12)

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Cleaning procedure (Pasteurizing machine)

(1) Flush with pipe water when the machine close but still have heat for 1-2 minutes, clean up bael juice which stick inner surface ,joint, tube ,tank

(2) Separate every part of machine which can be done

(3) Cleaning with base composition substance for this experiment set to use tipol for cleaning ,using spongy scrub in inner surface of machine

(4) Rinse with pipe water for 1-2 minutes

(5) Using disinfectance and rinse with pipe water

(6) For other product with have protein composition every 2 batch after cleaning with tipol and rinse should be cleaning with acid composition substance .

Alternative of Cooling methods

(1) **Cooling method**

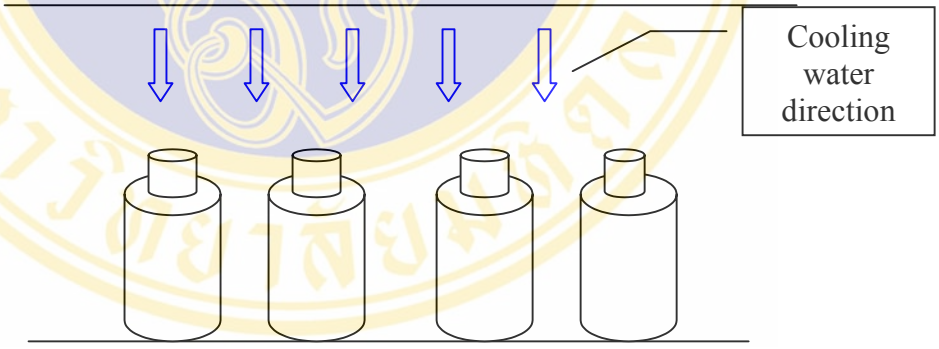

Figure B-1 Picture of alternative cooling method , spray cool water from the top

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(2) **Cooling for this study**

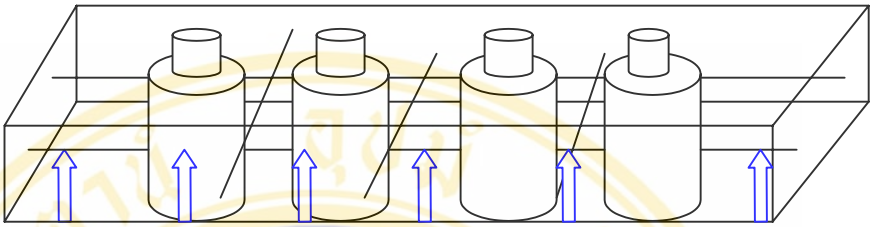

Figure B-2 Picture of alternatives cooling method using the rack controlled the bottle

Operating procedure

(1) Fill product which want to pasteurized after temperature and pressure of machine reach to 95 ^{o}C ,4 bar (avoid to storage product in balance tank longer 20-30 minutes) and always close lidded of balance tank .
(2) Close filling valve .
(3) Open out let valve from balance tank and open filling valve drain little product about 1-2 ml. And close valve immediately.
(4) Holding time at least 15-20 second.
(5) Filling finish product to bottle size 250 ml. Can be filling continue 20-25 bottle and do follow step (4)
(6) Person who filling product should not sitting when working in line production.
(7) Cleaning before and after used the machine.
(8) Manual checking temperature of finish product and holding time (85 ^{o} C, hold on 15 second)

Good design for balance tank

Balance tank was designed for well draining of the water , the slop of the bottom of balance tank should be proper and complicated for cleaning the sample of good design for balance tank was shown as follow

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(1) (2)

Figure B-3 Picture of alternatives design for balance tank.

The equipment in food plant is very specific for the type of foods processed. However , there are basic factors that must be considered essential in the design and in the installation of equipment to maintain a clean and safe. The surface in contact with food should be inert to the food under conditions of not migrate into the food or be absorbed by or in the food. And surface in contact with the food must be smooth and non porous to the food or to bacteria, yeast or molds. All product contact surface must be free recesses, dead ends, open seems and gaps, crevices, protruding ledges, inside threads, Permanent joints must be butt weld and the welding must be continuous, smooth, and flush with adjacent surfaces. Balance tank should be provided with cover so design to prevent any dripping back into the interior of the vessel and they must be self draining.

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