# การจัดทำมาตรฐานในกระบวนการผลิตแชมพู

## Development of Standard Procedure for Shampoo Production

จักรพันธ์ บุญกิตติพร
121 ถ.เชียงใหม่ แขวงคลองสาน เขตคลองสาน กทม. 10600
โทรศัพท์ 0898912824, 024397344
E-mail: oung_22@hotmail.com

**บทคัดย่อ**

งานวิจัยนี้มีวัตถุประสงค์เพื่อศึกษาการจัดทำมาตรฐานสำหรับกระบวนการผลิตแชมพูในโรงงานเครื่องสำอางเพื่อการปรับปรุงประสิทธิภาพในเรื่องของ Right First Time ขอบข่ายของการวิจัยจะเน้นถึงกระบวนการผลิตแชมพูในกลุ่มเพื่อให้ผมนุ่มสวย ซึ่งเป็นกลุ่มที่มีการผลิตมากที่สุดของบริษัทที่เป็นกรณีศึกษา โดยจะเริ่มตั้งแต่กระบวนการเตรียมวัตถุดิบจนกระทั่งถึงการถ่ายผลิตภัณฑ์ไปยังถังเก็บ การวิเคราะห์ลักษณะข้อบกพร่องและผลกระทบ (Failure Mode and Effect Analysis, FMEA) และแผนภูมิการวิเคราะห์เหตุและผล (Cause and Effect diagram) ได้ถูกนำมาใช้ในการวิเคราะห์และระบุถึงปัญหาในกระบวนการผลิตแชมพู จากการศึกษามีการพบว่ามีปัญหาหลักๆที่ส่งผลถึงเรื่อง Right First Time อยู่ 4 ประการ ซึ่งก็คือ 1.คุณภาพของวัตถุดิบในการผลิต 2.ความบกพร่องของวิธีการทำงาน 3.ความไม่เที่ยงตรงของเครื่องวัดน้ำหนักในหม้อผสม 4.ความผิดพลาดจากคน ปัญหาเหล่านี้ได้นำไปสู่ปัญหาในเรื่องของ Right First Time และ ระยะเวลาในการผลิต ซึ่งส่งผลกระทบต่อประสิทธิภาพของการผลิต จากผลการวิเคราะห์นำไปสู่การจัดทำขั้นตอนมาตรฐานซึ่งเปรียบเสมือนเป็นตัวควบคุมคุณภาพในกระบวนการผลิตแชมพู ผลจากการทำขั้นตอนมาตรฐานนี้ได้ช่วยให้เรื่องของ Right First Time ในการผลิตปรับปรุงจากร้อยละ 60.12 ไปเป็นร้อยละ 78.24 และระยะเวลาในการผลิตลดลงจาก 151 นาที เป็น 116 นาทีซึ่งคิดเป็นร้อยละ 23.18

**Abstract**

The purpose of this study is to develop standard procedure for shampoo products in cosmetic manufacturing for the improvement in term of Right First Time. The scope of this study is focused on soft, clean and beauty shampoo production, which is the large volume shampoo production of the case study company that starts from raw material preparation step until discharging to storage tank. Failure Mode and Effect Analysis (FMEA) and Cause and Effect diagram are used as quality tools for problem identification and analysis in shampoo production. Based on this study, it was found that there were 4 major problems that impact to production Right First Time. They include 1.

quality of raw material 2. standard procedure deficiency 3. inaccuracy of load cell in main mixer 4. human error. These problems lead to Right First Time and production batch time problem which affect to production. The result of analysis leads to the development of standard procedures which serve as quality control for shampoo production. This implementation can help improve Right First Time and production batch time in the shampoo production. The Right First Time can improve from 60.12% to 78.24%. Moreover, production batch time also can be reduced from 151 minutes to 116 minutes which is 23.18%.

## 1. Introduction

At present, the competition in many businesses is very intense. Companies have to find the way to gain more market share and profits to stay in the business. Manufacturing efficiency improving including production cost reducing plays vital part on any industries. Cosmetic industry is also one of them that can not survive without efficient production management. Since we live in global village now, process improvement is even more significant important. China and India are fast developing country and they have quite low cost on labor and many resources to develop their businesses. As a result, companies in Thailand need to develop their competition edge to compete with international competitors and also the local one.

Failure Mode and Effect Analysis (FMEA) is studied in this study as a tool to help developing process standard in cosmetic manufacturing to improve production management in terms of quality, cost and time. Production process will be analyzed to identify potential failures that affect to the product quality and process performance. Cause and effect of that failure including process control will also be identified and evaluated. Data collection will be considered and apply to achieve process standard of production.

## 2. Statement of the problem

From cosmetic plant data, it can achieve the Right First Time only 60.12% for Shampoo products which is relatively low. Viscosity, pH, %active, density, color standard are product parameters that must be controlled to get the right product quality and they have to be adjusted several time before getting the proper specification. This also affect to the production batch time since it takes a lot of time per each adjustment. Consequently, it impacts to the productivity and efficiency of cosmetic plant. Production batch time of shampoo products should be improved as well since shampoo is the main product of this plant. Batch time

reduction can be a huge benefit to the factory. Energy cost such as electricity, water and steam will also reduce as batch time reduces as well.

Since Right-First-Time problem can affect to the production batch time problem, it should be the focus improvement of this research. In addition, there are other problems occurred in the cosmetic plant such as machine break down. However, it does not influence too much on the factory.

Standard procedure is needed to be developed for control raw material specification and mixing process of shampoo production to improve this production Right First Time.

Table 1: Percentage of Right First Time of shampoo products

| Month | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Summary |
|---|---|---|---|---|---|---|---|---|---|
| No. of batch | 104 | 91 | 76 | 103 | 130 | 122 | 99 | 115 | 840 |
| RFT (Batch) | 59 | 45 | 46 | 59 | 69 | 82 | 69 | 76 | 505 |
| %RFT | 56.7 | 49.5 | 60.5 | 57.3 | 53.1 | 67.2 | 69.7 | 66.1 | 60.12 |

Table 2: Production batch time of shampoo products

| Month | Jan | Feb | Mar | Apr | May | Jun | Jul | Avg. |
|---|---|---|---|---|---|---|---|---|
| Mixing time | 80 | 77 | 67 | 70 | 71 | 79 | 74 | 74 |
| QC time | 42 | 48 | 56 | 64 | 56 | 52 | 53 | 53 |
| Discharge time | 25 | 24 | 23 | 26 | 27 | 23 | 23 | 24 |
| Total time | 147 | 149 | 146 | 160 | 154 | 154 | 150 | 151 |

## 3. Research Methodology

Process FMEA is applied to eliminate or minimize all possible causes that have impact to Right First Time problem in shampoo production. Process FMEA Table will be used in documentation and facilitating the FMEA process. The FMEA concept is “team approach”, so the FMEA team must be cross-functional and they must be willing to contribute to the project. The team in this study consists of production engineer, process development supervisor, product development supervisor and quality assurance supervisor.

FMEA team members will brainstorm all potential causes of failure for each process step of shampoo production process that affect to Right First Time problem. This process will be facilitated by using process flow chart of shampoo production. Cause and Effect diagram technique will be used to categorize the team’s ideas. The ideas would be classified into 5 categories of cause and effect diagram – material, man, measurement, method and machine. The information from this analysis will be used to fill in the columns of the process FMEA table in relationship to the potential effects of failure and current process control. Recommended actions need to be filled in process FMEA table. Responsibility and Target Completion Date is also important when assigning to appropriate team member.

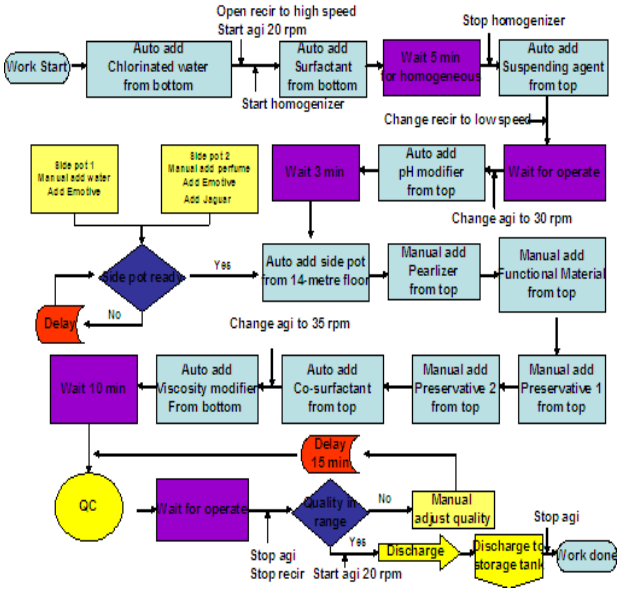


Figure 1: Process flow chart of shampoo production

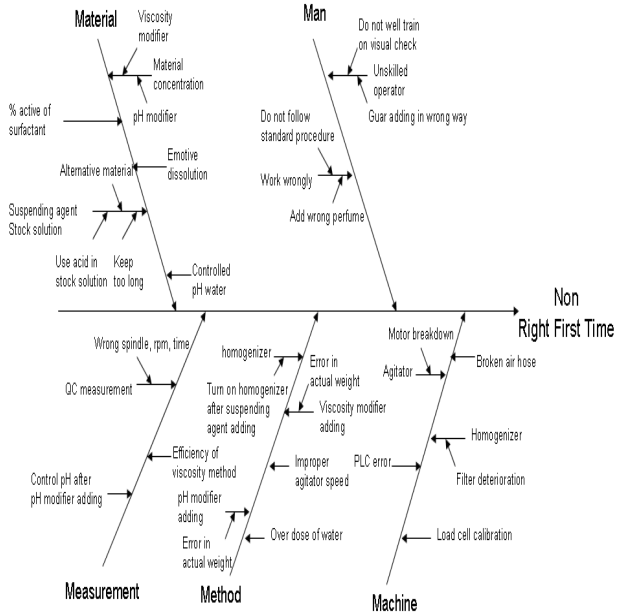


Figure 2: Cause and Effect Diagram

Since the case study company has their own evaluation criteria about the score of severity, occurrence and detection, the author will use those criteria in rating the score in order to prevent the confusion when implement this FMEA process to the case study company.

Table 3: Severity evaluation criteria

| Process FMEA - SEVERITY | | |
|---|---|---|
| Severity Rating | Severity | Comment |
| 1 | very low | no noticeable loss of performance |
| 2 | low | slight customer/ consumer annoyance and |
| | | no noticeable loss of performance |
| 3 | moderate | some customer/ consumer dissatisfaction and |
| | | no noticeable loss of performance |
| 4 | high | customer/ consumer dissatisfaction and some performance failure |
| 5 | very high | serious safety and/or legal implications, death |
| | | and/or damage could result |

Table 4: Occurrence evaluation criteria

| Process FMEA - OCCURRENCE | | | |
|---|---|---|---|
| Occurrence Rating | Possibility of Occurrence | Rate of Occurrence | Comment |
| 1 | zero | ≤ 0.09% | Will never occur |
| 2 | low | 0.1-0.9% | Rarely occur |
| 3 | moderate | 1-4% | Will occur occasionally |
| 4 | high | 5-49% | Will occur frequently |
| 5 | very high | ≥ 50% | Will occur very frequently |

Table 5: Detection evaluation criteria

| Process FMEA - DETECTION | | |
|---|---|---|
| Detection Rating | Likelihood of defect reaching a customer/ consumer | Comment |
| 1 | remote | Visually obvious |
| 2 | low | only a fair chance of the fault being detected |
| 3 | moderate | poor chance of the fault being detected |
| 4 | high | a very poor chance of the fault being detected |
| 5 | very high | defect will not appear during manufacture |

The FMEA team agrees to pursue failures on RPN value > 18 based on maximum score for the RPN is 125 (5*5*5 from severity, occurrence and detection). In addition, RPN score at 18 come from acceptable level of severity at 2, occurrence at 3 and detection at 3. It means that the RPN of failure that has higher score than 18 must be addressed and taken into consideration to find solution and improvement.

Table 6: Example of process FMEA for shampoo production

**Process FMEA (Failure Mode and Effects Analysis)**

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Product Name : | Shampoo product | | | | | | | | | | FMEA Number : | PP-001 | | | | |
| Project : | FMEA | | | | | | | | | | FMEA Date (orig.) : | Apr 30, 08 | | | | |
| Prepared by : | Jakkaphan B. | | | | | | | | | | FMEA Date (Rev.) : | Sep 3, 08 | | | | |
| Key date : | Sep 3, 08 | | | | | | | | | | Page 1 of 5 | | | | | |
| Team : | Team chief, production engineer, process development supervisor, product development supervisor, manufacturing, quality assurance supervisor | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| Process Function and Requirement | Potential Failure Mode | Potential Effect(s) of Failure | S | Potential Cause(s) of Failure | O | Current Process Control | D | RPN | Recommended Action(s) | Responsibility & Target Completion Date | Action Results Action taken | S | O | D | RPN | |
| Chlorinated water | Product pH will out of spec | pH will out of spec. | 4 | pH water is out of controlled at 5.5-8.0 | 1 | Probe controller /alarm | 1 | 4 | | | | | | | | |
| Surfactant | Lump of surfactant | Cleansing performance | 4 | Surfactant is not completely dissolved | 3 | Visual check | 3 | 36 | Set up work instruction to ensure surfactant dissolution | Process Develoment (June 24, 08) | As recommended | 4 | 2 | 2 | 8 | |
| | Low %AI of product | Cleansing performance | 4 | Lower dosage of Surfactant on%active | 4 | Control via PLC and weighing system | 3 | 48 | Set up work instruction for surfactant concentration | Production, QA (June 27, 08) | As recommended | 4 | 2 | 1 | 8 | |
| Surfactant adding | Surfactant is not homogeneous | Cleansing performance | 4 | Too high rate of Surfactant adding | 1 | Control recir rate at high during Surfactant adding | 1 | 4 | | | | | | | | |
| Machine system | Error on agitator | Non-homogeneous of Product | 4 | Agitator speed is not proper | 2 | Process specification | 1 | 8 | | | | | | | | |
| | | Can not mix at all | 4 | Agitator motor breakdown | 2 | Visual inspection | 2 | 16 | | | | | | | | |
| | Error on weighing system/ balance | Loss/gain of material | 4 | Wrong weighing system/ balance calibration | 3 | Visual inspection | 2 | 24 | Set up preventive maintenance | Production, QA (June 24, 08) | As recommended | 4 | 2 | 2 | 16 | |
| | Error on PLC | Can not mix properly | 4 | PLC error | 2 | Visual inspection | 3 | 24 | Set up preventive maintenance | Production, QA (June 24, 08) | As recommended | 4 | 2 | 2 | 8 | |

Table 7: Summary of process FMEA that the RPN value is higher than 18

| Item | Potential Failure Mode | Potential cause (s) of Failure | RPN |
|---|---|---|---|
| 1 | Lump of surfactant | Surfactant is not completely dissolved | 36 |
| 2 | Low %AI of product | Lower dosage of Surfactant on %active | 48 |
| 3 | Error on weighing system/balance | Wrong weighing system/balance calibration | 24 |
| 4 | Error on PLC | PLC error | 24 |
| 5 | Suspending agent solution get lumping | Use alternative material for Suspending agent | 20 |
| 6 | Uncontrolled pH modifier concentration | Improper pH modifier concentration | 48 |
| 7 | Product pH inconsistent | The actual weight of pH modifier is error | 24 |
| 8 | pH measurement on neutralization step | Uncontrol of product pH after pH modifier adding | 24 |
| 9 | Different odour from the standard | Weight wrong amount of the perfume | 24 |
| 10 | Incorrect dosage of Functional material | The Functional material is not charged at the right dosage | 32 |
| 11 | Viscosity modifier preparation | Improper Viscosity modifier concentration | 64 |
| 12 | Product viscosity inconsistent | The actual weight of Viscosity modifier is error | 24 |
| 13 | %AI is out of spec | Amount of water is not match with batch size | 20 |
| 14 | Operation skill of operator | Operators do not well trained on visual check | 48 |
| 15 | Operator discipline | Operators do not follow work instruction | 36 |

From Summary of process FMEA that the RPN value is higher than 18, 15 items of high-risk area are addressed. Therefore, the FMEA team can have meeting to take proper actions to find the solutions for those failures. At last, the action plan is created for each related departments. In addition, items and standard procedure column of action plan in table 8 are represented as the action to improve the failures in table 7 and standard procedure generated to solve the problems respectively.

Table 8: Summary action for FMEA project

Production

| Topic | Due Date | Remark | Item | Standard Procedure |
|---|---|---|---|---|
| **Set up work instruction** | | | | |
| - Set up work instruction for water for flush | June 24, 08 | To control amount of water in the batch | 13 | Document No.7 |
| - Set up working procedure for preparing | June 27, 08 | To control quality of viscosity modifier | 11 | Document No.6 |
| viscosity modifier | | | | |
| - Set up work instruction for functional | June 16, 08 | To control conditioning effect of | 10 | Document No.8 |
| material adding | | Finished Goods | | |
| **Set up preventive maintenance plan** | | | | |
| - Set up preventive maintenance plan for | June 24, 08 | To ensure the accuracy of perfume | 3,9 | |
| balance calibration | | during weighing | | |
| - Set up preventive maintenance plan for weighing | June 24,08 | To prevent the error from weighing | 3,7,12 | |
| system | | system | | |
| - Set up preventive maintenance plan for PLC | June 24, 08 | To prevent the error from PLC | 4 | |
| **Miscellaneous** | | | | |
| - Develop own equipment/ install new | TBC | To ensure the weight of Surfactant | 3,7,12 | |
| equipment with high accuracy | | and viscosity modifier | | |
| - Check dosing system of pH modifier in buffer | May 23, 08 | To ensure that orifice is installed | 7 | |
| tank | | properly | | |
| - Reduce size of pH modifier tube | June 16, 08 | To reduce risk of error dosing of | 7 | |
| | | pH modifier | | |
| **Training** | | | | |
| - Train operators about visual check | June 27, 08 | | 14 | |
| - Train operators about mixing instruction | June 27, 08 | | 15 | |

Quality Assurance

| Topic | Due Date | Remark | Item | Standard Procedure |
|---|---|---|---|---|
| **Set up work instruction** | | | | |
| - Set up work instruction for surfactant | June 27, 08 | To control surfactant specification | 2 | Document No.3 |
| concentration | | before using in production | | |
| - Set up work instruction for viscosity modifier | June 27, 08 | To control viscosity modifier | 11 | Document No.5 |
| concentration | | specification before using in production | | |
| - Set up work instruction for pH modifier | June 27, 08 | To control pH modifier specification | 6 | Document No.4 |
| concentration | | before using in production | | |

Process Development

| Topic | Due Date | Remark | Item | Standard Procedure |
|---|---|---|---|---|
| **Set up work instruction** | | | | |
| - Set up work instruction in form of agitator, | June 24, 08 | To ensure that surfactant is | 1 | Document No.2 |
| recir speed of surfactant dissolution | | completely dissolved | | |
| - Rewse work instruction for preparing stock | June 24, 08 | To ensure that alternative material of | 5 | Document No.1 |
| solution of suspending agent | | suspending agent will not cause lump | | |
| **Miscellaneous** | | | | |
| - Extend measurement step of neutralization | June 16, 08 | Reduce problem about out of pH | 8 | |
| phase in batch sheet | | specification in Finished Goods | | |

After the recommended actions are finished, the FMEA team implements them in shampoo production. The team collects the data of Right First Time problem in shampoo production and compares with before implement the improvement.

## 4. Results

Prior to FMEA implementation, shampoo production in this case study achieves the Right First Time only 60.12% of total batches. After the FMEA implementation, this shampoo production can achieve the Right First Time target at 78.24% of total batches. Moreover, production batch time also reduce from 151 to 116 min after the implementation. Production can save time from quality control time because of higher Right First Time achievement. This will lead to batch time reduction for shampoo production. As a result, this company can save production batch time for 23.18% when compare with prior to the implement starting. Therefore, this implementation can help improve Right First Time and production batch time in the shampoo production. This will lead to reduction of production cost and help the company has more competitive power to compete in the market and gain more profit.

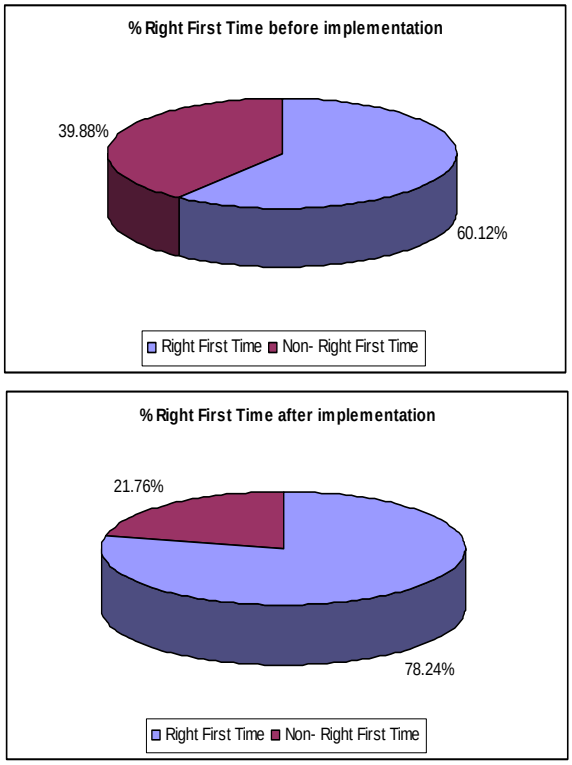


Figure 3: Comparison of Right First Time between before and after the implementation

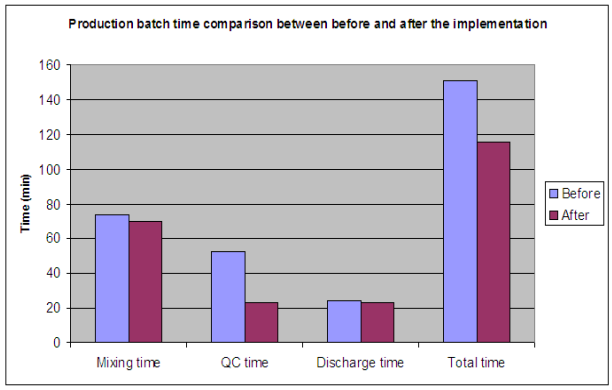


Figure 4: Comparison of production batch time between before and after the implementation

## 5. Conclusion

Main problems of shampoo production are quality of raw material and standard procedure deficiency which can be controlled

and improved by these new standard procedures.

The standard procedure for shampoo production would be summarized as following.

- Surfactant

1. This raw material needs to be completely dissolved in order to let shampoo has its fully cleansing property, so the procedure to ensure surfactant dissolution is generated.
2. In order to improve Right First Time of shampoo production, surfactant must be added at 12.2%. Standard procedure for percentage of active measurement for surfactant would help team to know amount of surfactant that would be added in the production.

- Preparation of suspending agent

  The preparation process of suspending agent must cover an alternative material problem. Since the alternative material is quite hard to dissolve in the mixer, new standard procedure for preparing this material has to be generated.

- pH modifier

  Standard procedure for % pH modifier measurement would help control pH modifier specification and improve Right First Time.

- Functional material

  This material will help shampoo provide conditioning effect to consumer. The right amount of functional material can be added into main mixer by new standard procedure.

- Viscosity modifier

1. To improve Right First Time for shampoo production, viscosity modifier needs to be controlled at 25%. The new mixing procedure can help team to control this material.
2. The procedure for percentage of viscosity modifier measurement is generated.

- Amount of water

  Amount of water for flushing in the shampoo production can lead to inconsistent of %AI in shampoo batch. Therefore, team will pre-weigh water for flushing in shampoo batch follow by new standard procedure instead of flushing in different amount as operators usually do.

From implementing these standard procedures, there is improvement in term of production Right First Time and production batch time. Base on the result, Right First Time of this shampoo production has increased from 60.12% to 78.24%. Moreover, Production batch time is also reduced from 151 minutes to 116 minutes which is 23.18% batch time reduction. From these

results, Right First Time and production batch time have improved significantly when compare with prior to the implementation.

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