CHAPTER V
QUALITY IMPROVEMENT BY FMEA TECHNIQUES

After conducting the FMEA, several improvements are required for rice coating and drying processes. The recommendation actions of the process that have RPN over 100 are generated. Hereunder are the improvement points in rice coating and drying processes.

5.1 Improvements In Rice Coating Process

5.1.1 Contaminates In Rice

The problems that have the highest RPN score in rice coating process is the contamination of impurities such as sand, stones, or other materials in the rice fed into the cylinder coating drums. This is caused by the poor manual inspection by the operators. After conducting the FMEA, the team has decided QC department to set up work instruction as shown in Document no.1 in Appendix III.

5.1.2 Variation of Paste Viscosity

In paste coating process, it was found that paste viscosity varies batch by batch. This is because of the deviation of coating quality. There are also many different kinds of pastes which have different properties. The FMEA team has assigned QC department to set up work instruction to control the quality of paste more precisely during paste preparation process. Since there are many different pastes used in coating, therefore there are different work instructions for each type of coating. An example of the work instruction for control the quality of coconut milk and gum Arabic paste and other examples are shown in Document no. 2(a)–(d) in Appendix III.

5.1.3 Improper Conveyor Speed

Improper conveyor speed can cause products off-spec or the adjustment of the product quality. Too high speed makes some rice uncoated while too slow speed causes lower productivity. Proper speed mainly depends on the viscosity of the paste. If the viscosity of the paste can be controlled precisely and consistently, this failure mode cannot be happen. Therefore the solution for this relies on the quality control of the paste viscosity. As the QC is assigned to control the paste viscosity as mentioned in section 5.1.2, this failure will be automatically reduced. However this failure can be caused by that operators don't follow the work instruction strictly. Therefore, production engineering team is assigned to set up training to the operators to make them seriously realize the consequence of this failure.

5.1.4 Inconsistent Quality of Rice

The quality of rice is also important for the rice coating process. The rice quality is varied by the difference in its moisture content during transportation or contaminates occurred from rice miller to the factory. Different sources of rice and poor transportation are the main causes of this failure. To reduce this failure mode, the QC is assigned to set up work instruction for quality control of rice during transportation and before processing. The work instruction for control the moisture during transportation is shown in Document No.3 in Appendix III while the work instruction for control contaminates is already mentioned in Document No.1 in Appendix III.

5.1.5 Improper Brush Speed

Similar to improper conveyor speed, improper brush speed directly affects the quality of coated rice. An appropriate brush speed depends on the quality of the paste, particularly the viscosity of the paste. If the QC can control the quality of the paste consistently, therefore the effect of this failure can be reduced or eliminated. In addition, this failure can be caused by that operators don't follow the work instruction strictly. Therefore, production engineering team is assigned to set up training

programs to the operators to make them seriously realize the consequence of this failure.

5.1.6 Uncleanness of Paste Mixing Tanks

Uncleanness of paste mixing tanks can cause deviation of coating quality. This in turn affects the quality of final product. Uncleanness of paste mixing tanks is mainly caused by old cleaning brush and unawareness of operators. At the moment, the control is based on visual inspection. However to improve the cleanness of paste mixing tanks, process engineering team is assigned to replace the old brush with the new one for more proper cleaning of the tanks. More frequent work instruction for cleaning paste mixing tank is required as shown in Document No. 4 in Appendix III.

5.1.7 Solidification of Paste

Paste for coating is transported through pipes to the cylinder coating drum and during transportation sometimes some paste are solidified and deposited inside the pipes. This particularly happens when the room temperature is low. Serious effect of this failure is the shut down of the coating process. The FMEA has realized that the main causes of this problem are poor temperature control and the heat loss during transportation. The production team then is assigned to build insulation around paste lines and set up work instruction for the routine inspection of the insulation. Type of insulation is based on the insulative properties of insulation materials (R-value). The production team contacted the insulation selling company and decided to use glass wool insulation as suggested by the firm because it had the R-value of more than 1 m^2 K/W and not expensive. After set up insulation around the pipes, data is collected and compared. It was found that numbers of occurrence of solidification of paste were reduced significantly (from 10 times in June 2007 to 1 time in July 2007). The work instruction for checking insulation around pipes is mentioned in Document No. 5 in Appendix III. It includes the procedure to regular check insulation, how to evaluate the efficiency of insulation, and the time period to replace old insulation.

5.1.8 Uncleanness of Coating Brushes

Uncleanness of coating brushes can cause the impossibility to carry on the next coating process, particularly if the old paste strongly strict to the brushes. The cause of this failure is from non-optimized cleaning procedure. The current control of this failure is by visual inspection. To improve the cleanness of coating brushes, process engineering team is called to create work instruction for the cleaning process of the coating brushes as shown in Document No.6 in Appendix III.

5.1.9 Uncontrolled Moisture In The Air

Uncontrolled moisture in the air, or humidity in air, can somewhat affect the coating process. Too much moisture can cause deviation on coating quality, i.e. wet paste coated rice passing to the drying unit which requires higher energy for drying. The FMEA has realized that raining is the main cause of the high humidity in air. At the moment, there is no control of the air at the coating process. To minimize this affect, process engineering team is assigned to design and develop system that can control the moisture of the air in the coating unit. The team has bought a humidity control system and placed it at the coating unit. The detail of the humidity control system is shown in Document No. 7 in Appendix III.

5.1.10 Inhomogeneous Paste In Mixing Tanks

Inhomogeneous paste in mixing tanks cause deviation of coating quality which in turn affects the quality of final product. Inhomogeneous paste in mixing tank is caused by several factors as follows:

- Operators don't follow the formulation although the formulation is already mentioned in the work instruction. Some ingredients cannot completely soluble when they are added too much into the mixing tanks. To cope with this problem, production engineering team is assigned to set up trainings to make operators realize the consequence of this failure.
- Nonsuitable stirring time for mixing. There is currently only one stirring time mentioned in the work instruction but there are several types of pates used in the rice coating process. Production engineering team is assigned

to specify more stirring times for every formulation of mixing and revise the current work instruction as shown in Document No.8 in Appendix III.

- Level of impeller does not match with level of paste. Since the level of impeller is non-movable, therefore it can do nothing with the level of impeller. The only possible action is to control the level of paste constantly but this is impossible since sometimes the factory receives extra order in a limited time period.
- Stirring speed does not suit with paste volume. Again the stirring speed of the impeller is non-adjustable, therefore only the control of paste volume that can be performed.

5.1.11 Wrong Weighing of Raw Materials

Wrong weighing of raw materials can lead to off-spec products or the adjustment of the product quality. This failure is mainly caused by that operators do not understand scaling procedure. To cope with this problem, production engineers are assigned to set up training programs for the operators.

5.1.12 Inaccurate Temperature During Coating

Inaccurate temperature during coating can cause deviation in coating quality. This failure is caused by the poor maintenance on the temperature indicators at the coating unit and the temperature indicator false. The current process control for this failure is periodical check of temperature indicator but the temperature indicators are not calibrated for a long time and no work instruction mentioning how to calibrate the temperature indicators. Therefore the maintenance team is assigned to set up work instruction for calibration of temperature indicators at the coating unit and routine check of the workability of the temperature indicators. The work instruction is shown in Document No. 9 in Appendix III.

5.2 Improvements In Drying Process

5.2.1 Long Drying Time

In drying process, long drying time has the highest RPN score. This failure is caused by improper ventilation system in drying rooms. The effect of this failure is that the products are too dry and higher energy is consumed. To cope with this problem, maintenance team is assigned to check flow rate of vent air leaving the drying rooms and set up preventive maintenance (PM) for ventilation system in drying rooms as shown in Appendix IV.

5.2.2 Poor Distribution of Coated Rice On Belt

Coated rice from coating unit will be distributed on screw conveyor through a hopper. Poor distribution of coated rice on belt of screw conveyor can cause high humidity products which, in turn, lead to the off-spec products. Improper design of hopper is believed to be the main cause of this failure; humidity in lump coated rice which cannot be distributed uniformly (coated rice that sticks into lump) is certainly difficult to be removed by drying process than uniformly distributed coated rice. Since batch-by-batch adjustment of space inside the hopper is impossible, therefore, preventive maintenance to keep the hopper and screw conveyor clean and non-stuck is the solution for this failure. Maintenance team is responsible for such preventive maintenance as shown in Appendix IV

5.2.3 Nonsuitable Temperature In Drying Rooms

Nonsuitable temperature in drying rooms for various types of coated rice is another serious problem occurring at drying room of the studied factory. Not enough drying causes products have humidity higher than required (off-spec products). In opposite, too much drying wastes the energy. The nonsuitable temperature failure is caused by several factors as follows:

- Heat loss of hot air during transportation from hot air tank to drying rooms: This failure can be solved by installation of proper insulation. Process engineering team is assigned to design a new and proper insulation

to prevent heat loss of hot air during transportation. The team contacted the insulation selling company and decided to use glass wool insulation as suggested by the firm because it had the R-value of more than 1 m^2 K/W and not expensive. It has the higher R-value than the old insulation (foam) which has R-value of 0.5 m^2 K/W and quite old. After set up insulation from hot air tank to drying rooms, data is collected and compared. It was found that the temperature in drying rooms was increased 1-2 °C after installation of such insulation. The work instruction for checking this insulation is also presented in Document No. 10 in Appendix III. It includes the procedure to regular check insulation, how to evaluate the efficiency of insulation, and the time period to replace old insulation.

- Different properties, particularly humidity, of coated rice feeding to drying rooms: It is certain that feeding with different moisture contents requires different drying temperatures and/or different drying times to obtain final products having same humidity that pass the specification. To cope with this failure, process engineering team is assigned to update the work instruction for varying drying temperature and/or drying time according to the inlet humidity of coated rice feeding. The work instruction is shown in Document No. 11 in Appendix III.
- Low efficiency of blowers: at present there is no control on the efficiency of blowers used in drying rooms. Therefore maintenance team is called to set up PM for the blowers in drying rooms as shown in Appendix IV.
- Operators do not follow work instruction strictly: although there is a procedure of drying coated rice mentioned in the current work instruction already, sometimes operators do not follow such instruction, which in turn affect drying temperature in the drying rooms. To cope with this failure, therefore, production engineering team is assigned to set up training programs for the operators to realize the consequence of this failure.

5.2.4 Deposits On Drying Belt

Deposits on drying belt leads to energy loss. This failure is caused by the cleanness of the drying belt. The current control of this failure is to sometimes stop drying belt for cleaning but this activity is not performed regularly. To cope with this failure, therefore, the production team is assigned to set up schedule for regular cleaning of the drying belt as shown in Document No. 12 in Appendix III.