CHAPTER V
ESTABLISHMENT OF THE PROPOSED FMEA TECHNIQUE

After conducting the FMEA, it leads to a significant improve in existing process. The recommendation actions for process that have RPN over 100 are created. The following are the improvement points in each workstation unit.

5.1 Maize drying room workstation unit

The failure modes that have the highest RPN score at maize drying rooms are (i) non-uniform temperature in drying room caused by improper positions of blowers and efficiency of blowers; (ii) poor hot air distribution; (iii) uncontrolled hot air direction and heat loss at drying rooms (Table 4.12). These negatively impact the quality of maize sheaths (maize sheaths have high humidity than specification), longer drying time and the inefficiency use of energy. At the moment there is no control procedure to solve theses problems or reduce these impacts. After conducting FMEA, process engineering and production teams were assigned to solve these problems.

To solve the interrelated problems of non-uniform temperature in drying rooms, poor hot air distribution, and uncontrolled hot air direction, several things are performed. First the team has installed more numbers of temperature indicators inside the drying rooms in order to measure the temperature in several positions in the rooms. This will suggest how well the heat distributed inside the rooms, leading to a new design of more proper positions of blowers inside the rooms. These temperature indicators are daily checked and calibrated in order to report temperature distribution in the drying rooms precisely and regularly. In addition, the process engineers have calculated the current efficiency of the blowers and modify by replacing some components of the blowers to make them more efficient. Some blowers are also replaced with adjustable-speed blowers in order to make the air distribution in the rooms better. Positions of blowers are somewhat changed. Finally the drying rooms are modified by adding baffles to improve circulation of the hot air in drying room and prevent hot air blowing to the corners of the rooms to improve energy loss.

For heat loss at drying rooms, the main cause of this failure is due to the old, inefficient, and probably improper insulation at drying rooms. This results in high energy consumption and high fuel cost. There is no current control for this failure. To cope with this problem, the FMEA team assigns production team to set up work instruction. The work instruction suggests the procedure to regular check insulation, how to evaluate the efficiency of insulation, the time period to replace old insulation.

The next problem that has RPN score of 315 is contamination and impurities in maize sheaths caused by inappropriate work instruction for inspection and human error. The contaminates and impurities cause heat loss to unnecessary materials and, in turn, humidity of final products can be affected. To cope with this problem the FMEA team studies and proposes the work instruction for systematically visual check by operators. Contaminates can result in the rejection of products from customers. To solve this problem, FMEA assigned QC team to organize internal training for operators at loading and inspection workstation unit. In addition formal work inspection is set up and taught to operators.

The next problem that have RPN score of 288 is that some areas in drying room are too hot which is caused by non-worked blowers. The current process control for this problem is the visual check by drying room operators which is based on their skills and experiences. Often they are lacking of the observation skill and this failure is mostly detected by process and production engineers. To solve this problem systematically, FMEA team assigned the maintenance team to set up preventive maintenance plan to prevent too hot positions in the drying rooms. The preventive maintenance plan is shown in Appendix IV. Moreover the training to drying operators is created.

The next problem that has RPN score of 280 is the non-constant blowing rate of hot air caused by old and low quality blowers. This causes the variation in drying time, and in the worst case, products are off-spec. To solve this problem systematically, FMEA team assigned the maintenance team to set up preventive maintenance plan for blowers as shown in Appendix IV.

The next problem that has RPN score of 240 is the variation of humidity of maize sheaths batch by batch which directly affects the variation in drying time. Products that have humidity higher the specification need to be re-dried, leading to more energy consumption. To solve this problem systematically, FMEA team assigned the process engineering team to set up work instruction for quality control of drying time according to inlet humidity. The team collected the historical data of drying time and classified by the humidity of maize sheaths (sweet corns and field corns). Then software program is used to determine the relationship between drying time and humidity reduction. The result is used for set up work instruction for appropriate drying time according to the humidity of maize sheaths and dried products. Moreover calibration procedure and calibration schedule of all equipments used for checking drying time such as drying time recorder are created in order to ensure the precision of the equipments.

The next problem that has RPN score of 240 is the high humidity of maize sheaths which makes drying time longer. In addition products that have humidity higher the specification need to be re-dried, leading to more energy consumption. To solve this problem systematically, FMEA assigned production team to set up work instruction for more systematically control the humidity of raw material. The work instruction includes the handling system of maize sheaths from loading workstation unit up to drying room workstation unit. In addition, work instruction for sun drying of maize sheaths are set up in order to partly reduce the humidity of raw materials.

The next problem that has RPN score of 200 is the weak hot air blowing which make drying time longer. In addition products that have humidity higher the specification need to be re-dried, leading to more energy consumption. To solve this problem systematically, preventive maintenance plan for blowers created by maintenance team is suggested as shown in Appendix IV.

The next problem that has RPN score of 175 is inaccurate temperature in drying rooms caused by temperature indicator false and poor maintenance for the temperature indicator. The current control for this failure is to regular check of temperature indicator. To solve this problem in long term, work instruction to check the temperature indicators and calibrate them regularly is suggested. In addition, old

temperature indicators are replaced and the team has looked for new type of temperature indicators that can have a longer life time.

The next problem that has RPN score of 175 is that packing of maize sheaths in drying room varies batch by batch. This happened mainly because production operators do not follow the manuals. The current control for this failure is the visual inspection by shift engineers. To cope with this failure, the FMEA team assigns production team to set up work instruction. The work instruction described how to pack maize sheaths, how to place maize sheaths on the drying containers and how to organize the containers in drying rooms.

The final problem of drying process that has RPN score of 125 is improper packing of maize sheaths in drying rooms caused by that operators do not follow the manuals. The current control for this failure is visual inspection by shift engineers which sometimes is not enough. To solve this problem, the FMEA team assigns production team to set up work instruction. The work instruction described how to pack maize sheaths, how to place maize sheaths on the drying containers and how to organize the containers in drying rooms.

5.2 Furnace (Fuel burner) workstation unit

The failure modes that have the highest RPN score at furnace workstation unit is the heating system is not optimized (RPN score of 400). This is a result of initial design of the furnace and heating system based on the lowest fixed cost when the factory first operated. It saves the money at the beginning but in long term operating costs due to high energy and fuel consumption are observed. To cope with the failure, process engineers are assigned to look at the heating system and found two important points that can be improved.

Based on Figure 3.2, air released to atmosphere still has high temperature and it therefore should be used to exchange its heat with water fed to the boiler. Therefore a new heat exchanger is developed to transfer the remaining heat from air to water. This will help reducing energy required to heat up the water to 80 oC for drying rooms.

The second recommendation is the position of the blower (F1) in Figure 3.2. The process engineers suggest that this position is not optimize since the blower is located above the fire. Instead the suitable position of the blower should be underneath. Moreover the blowers F1 and F2 work simultaneously, not independently. They both consume total energy of 22 kW which might be not necessary to make them work together. The process engineers suggest to develop a new independent blower underneath (blower F3). Therefore new heating system at furnace workstation unit is developed as shown in Figure 5.2.

Figure 5.1: Heat Exchanger unit (after modifying)

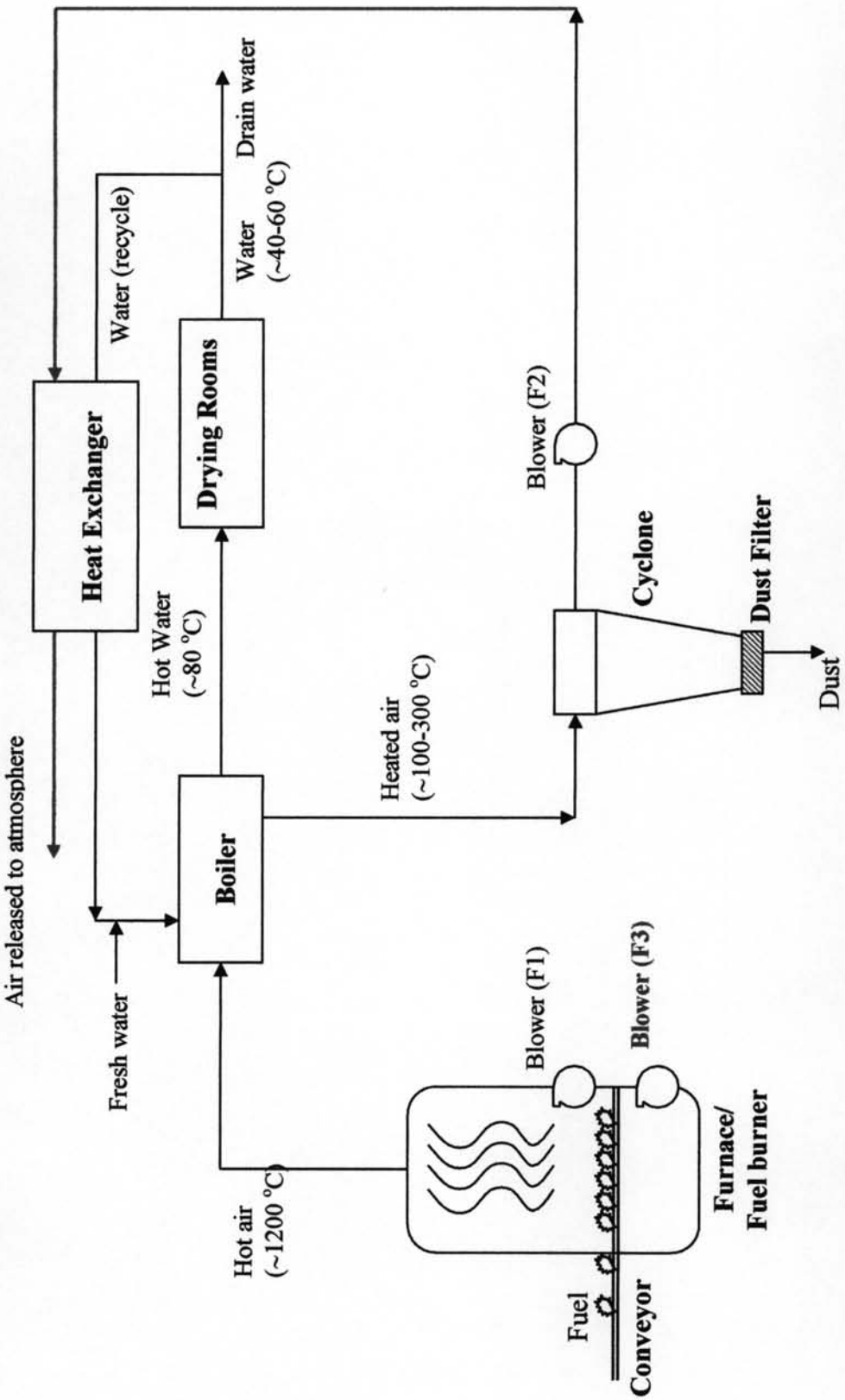

Figure 5.2: Fuel burner workstation unit (after modifying)

The next problem that has RPN score of 320 is heat loss at the furnace. This is a result of old insulation and inefficient insulation. To cope with this failure, FMEA assigned production team to set up work instruction to regular check the insulation system at the furnace. With the help of process engineers and sale services, proper insulation type and thickness is suggested. This forms a basis for creating work instruction.

The next problem that has RPN score of 200 is the insufficient heat generation caused by not good quality of fuel and the variation of fuel type. This causes a longer drying time. In addition products have humidity vary batch by batch according to the type of fuel and its quality used. At the moment there is no control on the quality of fuel. To solve this problem, FMEA assigned process engineering team to develop method to evaluate the quality of fuel and develop formulation for fuel composition in order to create sufficient heat for the drying process. Corncob is the most recommended fuel to be used at the furnace since it is a process by-product that does not to be purchased, unlike other types of fuel.

The next problem occurring at furnace workstation unit which has RPN score of 175 is insufficient supply of fuel caused by poor management and purchasing system and operators who do not follow work instruction. These cause off-spec dried maize sheaths and sometimes they have to be re-dried, leading to a higher energy cost. It is found that the current control at the furnace workstation unit is very weak; normally order for fuel will take place when it is nearly empty. This sometimes is not enough, particularly when extra orders of products are required by customers. Therefore FMEA assigned inventory (Stock and Purchasing Department) to reconsider the work instruction for fuel supply control to make it more efficient.

The next problem occurring at furnace workstation unit which has RPN score of 140 is inaccurate temperature at furnace caused by temperature indicator false and poor maintenance for the temperature indicator. The current control for this failure is to check of temperature indicator in every shift. However to solve this problem in long term, work instruction to calibrate the temperature indicators regularly is suggested. In addition, old temperature indicators should be replaced.

The final problem occurring at furnace workstation unit which has RPN score of 140 is insufficient heat generation due to that fuel feed is not enough and/or the feeding is inconsistent. These cause off-spec dried maize sheaths and sometimes they have to be re-dried, leading to a higher energy cost. It is found that the current feeding control at the furnace workstation unit is done manually and based on the experience of the operators. Therefore FMEA assigned production to set up work instruction for automatic feeding of fuel at the furnaces. Training for operators is also required. In addition, proper stocking can control the insufficient feeding of fuel. This requires cooperation with stock department of the factory.