CHAPTER 3

MELAMINE COMPOUND AND MANUFACTURING PROCESS

3.1 Melamine Compound

3.1.1 Chemical Data

Reaction of melamine crystal and formalin by heating at about 80 - 100 °C and by stirring leads to melamine-formaldehyde resins. And then the resins will be mixed with pulps, consequently dried, and milled with additive mixtures and colour pigments, finally resulting in melamine moulding compound or melamine compound.

The chemical structure of melamine compound is shown in Figure 3.1.

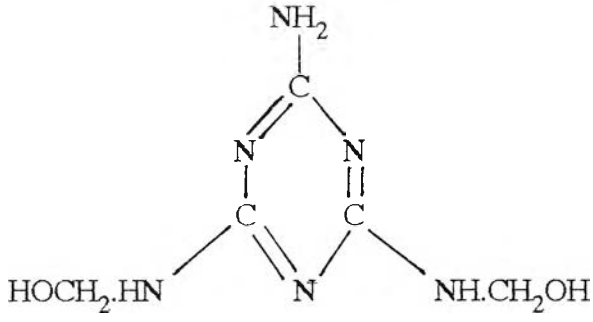

Figure 3.1 : The Fundamental Structure of Melamine Compound.

In Figure 3.1, melamine crystal ($C_3H_6N_6$), which is the center of the structure, builds the bond with formalin (CH_2O), leading to the fundamental structure of

melamine compound. This structure mixed with pulp and additive mixtures and colour pigments becomes melamine compound.

The characteristic of melamine compound is the form of bulk, it is easy for customers to produce melamineware such as bowls, cups, dishes in their moulds.

3.1.2 Curing Time

The curing time, which is an important quality characteristic of melamine compound, is the period of time that is used to form melamine compound becoming melamineware.

In general, the average curing time is about 150-250 seconds required by customers. Also they require the curing time's deviation from the average about $\pm$ 20 seconds. Moreover, the curing time of about 400-600 seconds can be measured from natural compound.

The curing time can be measured by the Rheometer that is set at 140°C and presses melamine compound becoming solid like a melmineware.

The curing time can be gained from reading the graph as the result of operating Rheometer. In Figure 3.2, a point on the graph at 90 percent of the maximum torque in the y-axis is the curing time in the x-axis.

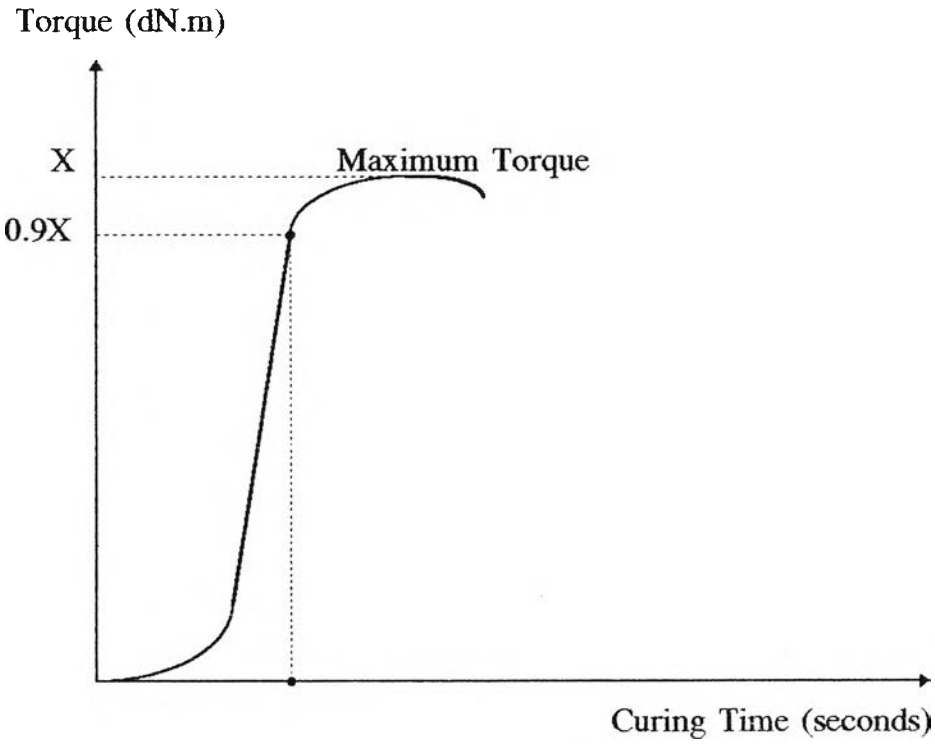

Figure 3.2 : The Graph for the Curing Time Measurement.

3.2 Melamine Compound Process

The manufacturing process of melamine compound of the company, including inputs and outputs in each step of the process are shown in Figure 3.3 and Table 3.1.

In Figure 3.3 and Table 3.1, the raw materials, which are melamine crystal, formalin, water, and sodium hydroxide (NaOH), are loaded into a reactor. When the raw materials are heated together with stirring within the reactor about 2 hours, resulting in melamine-formaldehyde resins after cooling down.

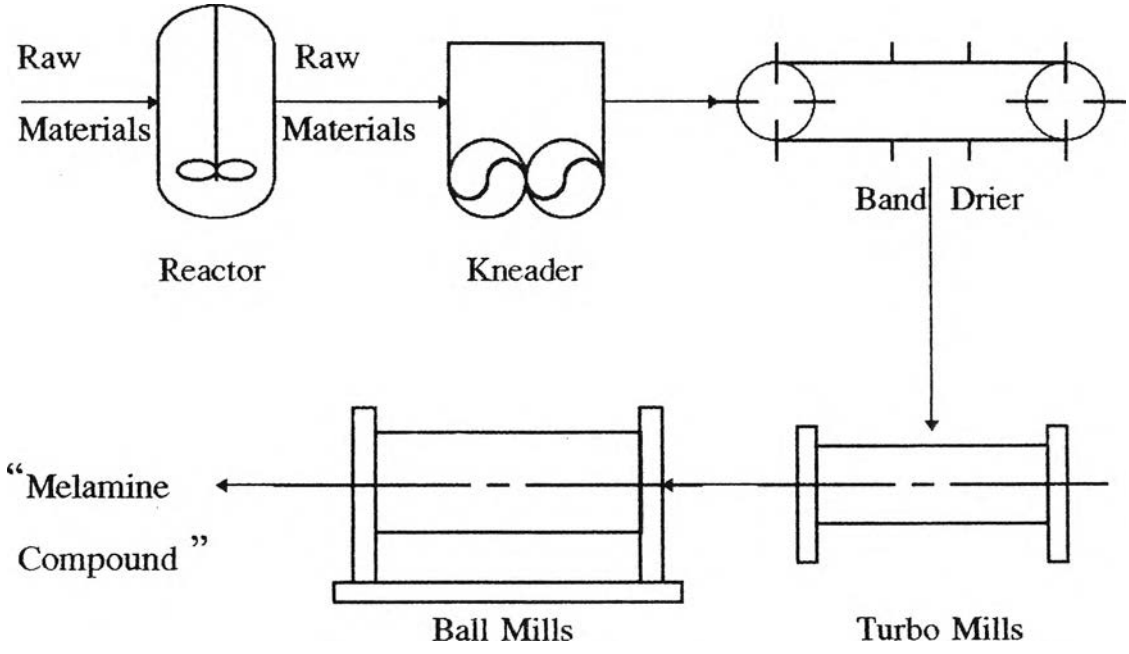

Figure 3.3 : The Melamine Compound Manufacturing Process of the Company.

The resins are mixed with pulps, curing agent type 1, and NaOH by a kneader, becoming mixture called wet popcorn. And then, the wet popcorn is conveyed into a drier to be dried by 80 - 90 $^{\circ}$C heat in several zones of the drier. The dried popcorn is moved to the turbo mills, and then crashed by the turbo mills, after crashing the work-in-process called natural compound as bulk.

The natural compound is milled again and mixed with curing agent type 2, colour pigments, and other additives within the ball mills about 8-15 hours. After completing this process, the final product is melamine compound.

Input	Process	Output
Melamine crystal, Formalin, Water, and NaOH	Reactor	Melamine-formaldehyde resin
Resin, Pulps, Curing agent type1, and NaOH	Kneader	Wet popcorn
Wet popcorn	Band Drier	Dried popcorn
Dried popcorn	Turbo Mills	Natural compound
Natural compound, Curing agent type2, Colour pigments, and other additives	Ball Mills	Melamine compound

Table 3.1 : Inputs and Outputs in Each Step of the Melamine Compound Process.

3.3 Factors Affecting Curing Time

In the melamine compound process, there are the four main factors affecting the curing time of melamine compound as follows.

3.3.1 F/M Ratio

F/M ratio is molar ratio of formalin to melamine crystal. Most F/M ratios used in this industry are in the range of 1.6 to 2.0, especially 1.6 and 1.8.

3.3.2 Sodium Hydroxide

Sodium hydroxide (NaOH) is used to break the reaction at the reactor and to make adjustment to the pH of melamine-formaldehyde resins and wet popcorn to reach pH 8.8-9.0 in order to maintain them as long as possible. And the increase in volume of NaOH in the same F/M ratio causes the increase in the curing time.

3.3.3. Curing Agent Type1

The curing agent type1, which is liquid and can be evaporated, is used at the kneader to make melamine compound be formed melamineware in customers' moulds. Therefore, the volume of this curing agent has directly effect on the curing time. The increase in volume of this curing agent brings about the decrease in the curing time.

3.3.4 Curing Agent Type2

The curing agent type 2, which is in the form of bulk, is used at ball mills to make melamine compound be formed melamineware in customers' moulds. The more its quantity is used, the less the curing time will be obtained.

For the company, this curing agent can reduce the curing time from about 500 seconds of natural compound to about 200 seconds of melamine compound.

3.4 Reactor

The reactor elements of the melamine compound process can be detailed by Figure 3.4.

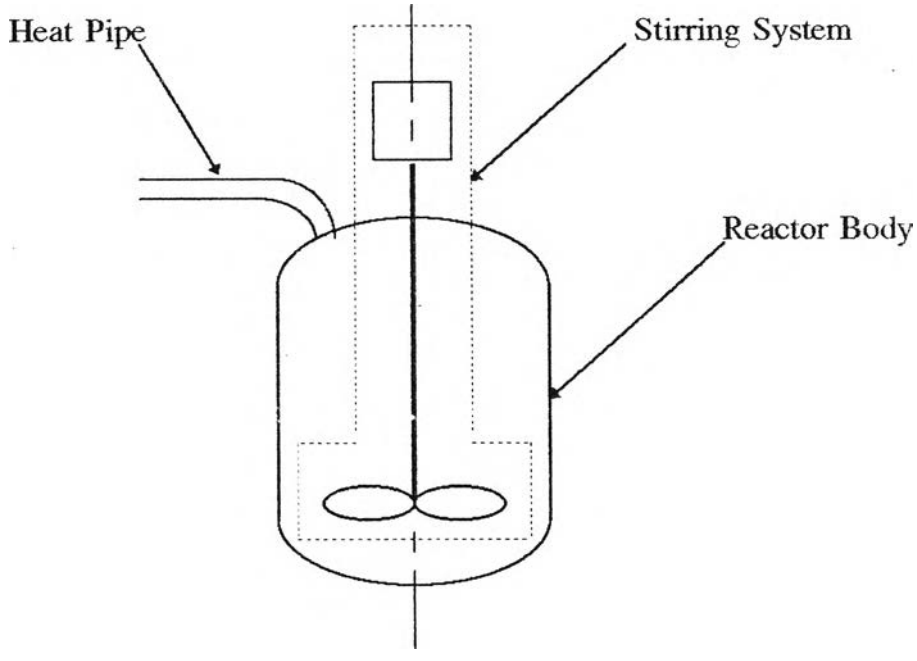

Figure 3.4 : Elements of the Reactor of Melamine Compound Process.

In Figure 3.4, the three major elements of the reactor comprise its body, a heat pipe, and a stirring system. A body contains both raw material and heat. And the heat pipe is used to transfer heat from a boiler to the reactor. Finally, all raw materials are stirred by the stirring system.

The operations for the reactor are the broadly following steps.

1. Loading water, formalin, and melamine crystal into the reactor.
2. Giving 90°C heat to the raw materials and stirring the raw materials at the same time.
3. Checking pH of melamine-formaldehyde resins in the reactor after 30 minutes from step 2. If pH of resins is less than 6.8, NaOH will be added to the resins until the pH reaches 6.8.
4. Breaking the reaction and adjusting pH of the resins by adding NaOH to the resins until the resins' pH is 8.8-9.0.
5. Finally, cooling the resins down to 60°C.