



## CHAPTER 3

### PLASTIC INJECTION PRODUCTS AND PROCESSES

This chapter introduces an overall detail of plastic injection products and process. It shows the sample of plastic products, which including company's product. Moreover, the production process will be explained in the first three steps that is a scope of research: raw material receiving includes raw material heating, injection process, and self inspection and process quality control.

#### 3.1 Plastic injection products

Nowadays, plastic products have a major role in everyday life. There are a lot of advantage such as a lighten weight, long life, cheap price, colourfull, and easy to produce. Therefore, our surrounding are made from plastic instead of other materials. The following pictures show the sample of plastic products.

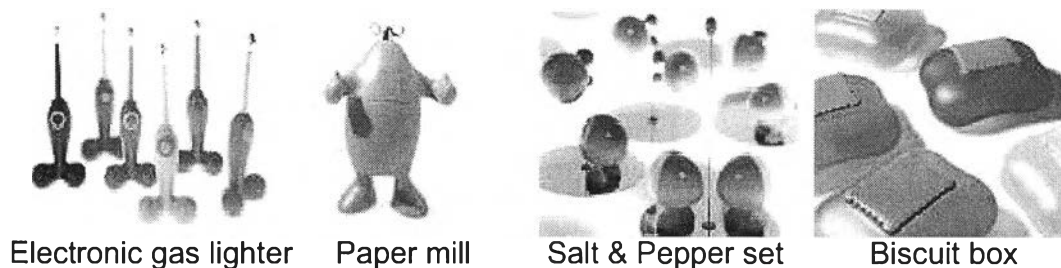


Figure 3.1: Plastic products

At a previous stage, an electrical appliance is one thing that consists of the plastic part. For example, front cabinet and rear cover of television, handle of refrigerator, and case of projector. All of these can made by an injection process. According to chapter 1, the ABC Company produces these products by injection process and the research's product is the front cabinet of television 14 inches. The research's product and the rest of the company's products are demonstrated in the figures below respectively.

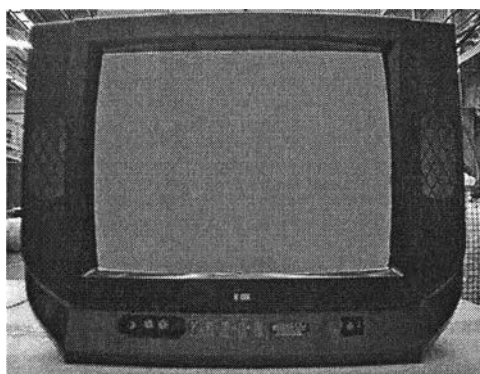


Figure 3.2: Research's product

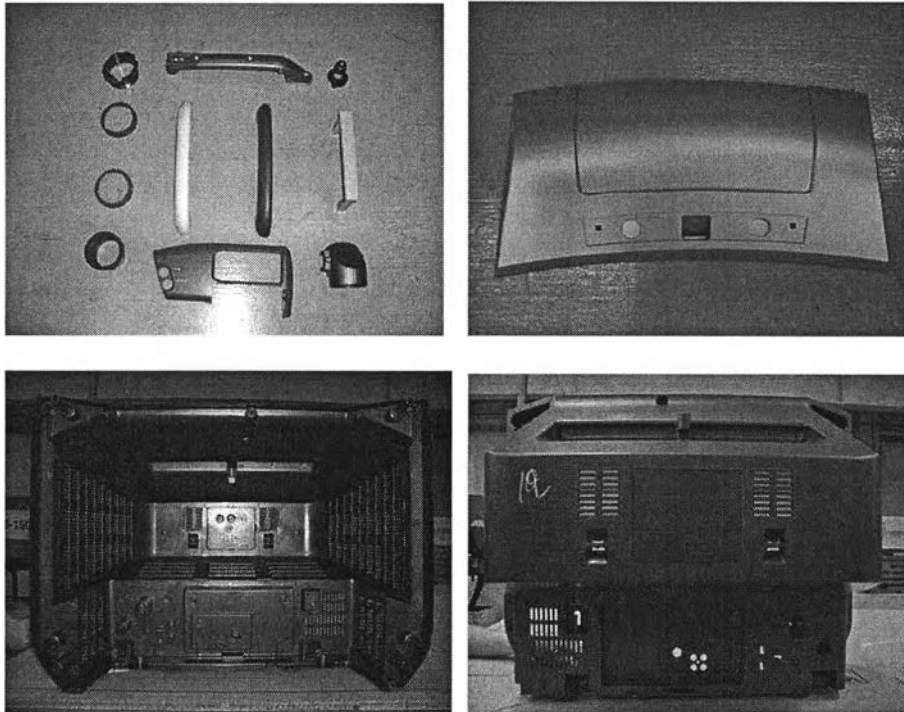


Figure 3.3: Company's product

### 3.2 Overall production process

An overall plastic injection process of the company is illustrated in the figure 3.4. It can be divided in to three categories, injection process, painting process, and screening process. The first step concerns to raw material. To get started, the polystyrene is used as a raw material for research's product. Then, it is taken to heat raw material stage to get rid of humidity. After that it goes through to the injection process to produce a product/make a shape. The workers visually inspect the products.

To assure the quality, the company has Process Quality Control (PQC) to cross check the products. PQC is a person from QC department. They check the product by using a sampling method. The products that meet the requirement will be sent to the next stage, painting process, while the rest that fails will be sent to the recycle process. The product from injection process is painted the colour according to the customer's demand. The company uses an oven to dry the painting product. Every piece of products is checked by the worker but not including the PQC. If it passes, it will send to screening process. The failed painting products will be sent to rework process in case it can edit a mistake. In contrast, the products that cannot rework are considered a waste. Finally, screening process is a last step. The passed painting products are screened the brand logo, sign, and words on the surface. The workers will visual check followed by the PQC.

If it passes, it is a finished product and will be sent to the warehouse waiting for the Final Quality Control (FQC) before going through to the

customers' hand. All failure products will be sent to rework and paint again if it can edit. It is going to be a waste if it cannot edit.

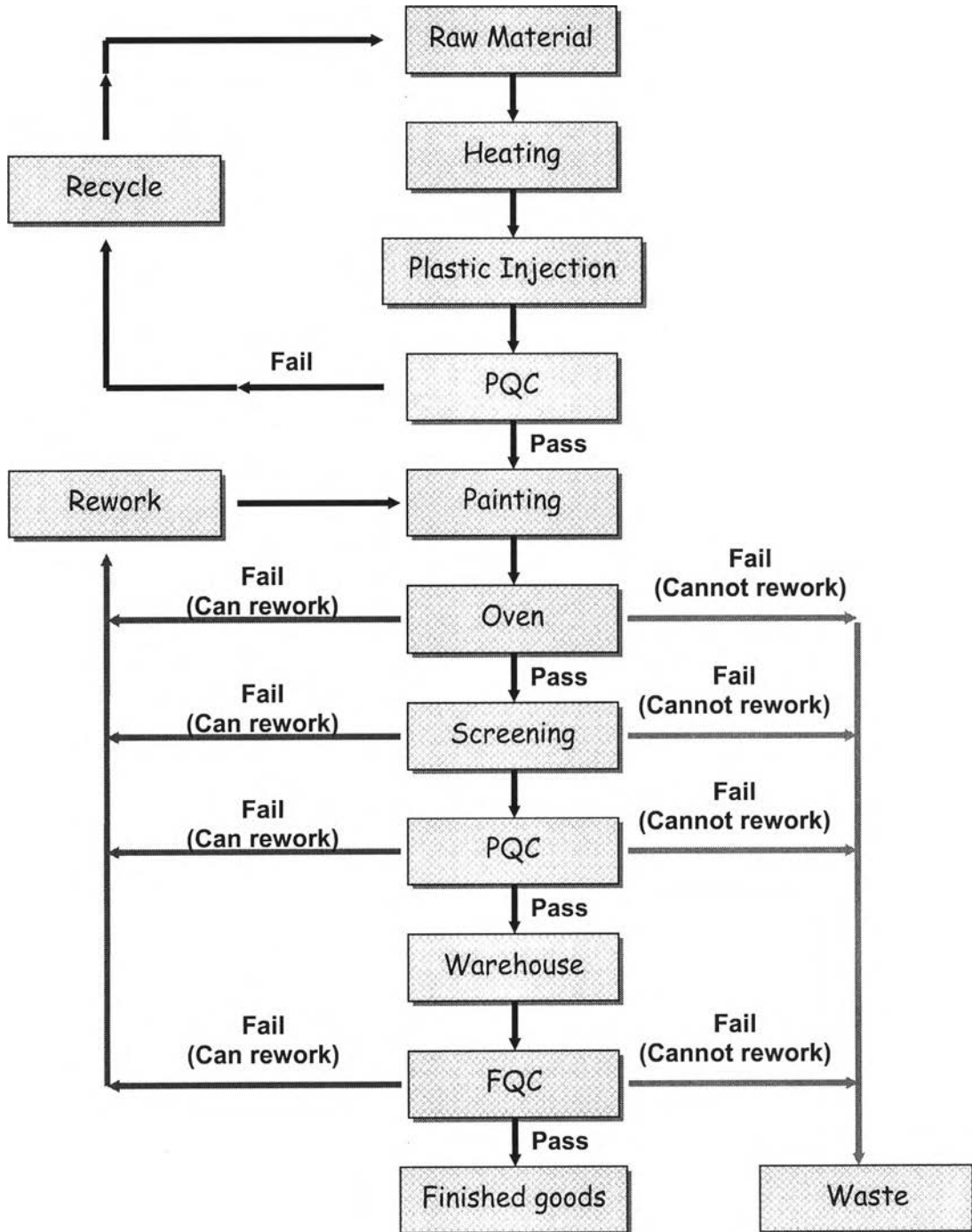


Figure 3.4: Plastic injection process

### 3.3 Raw material

Polystyrene (PS) is a raw material for front cabinet of television 14 inches. The company orders from supplier name A, where they are famous for polystyrene. There are three types of raw material, grade A, grade B and master batch. The figures show all ranges of raw materials.

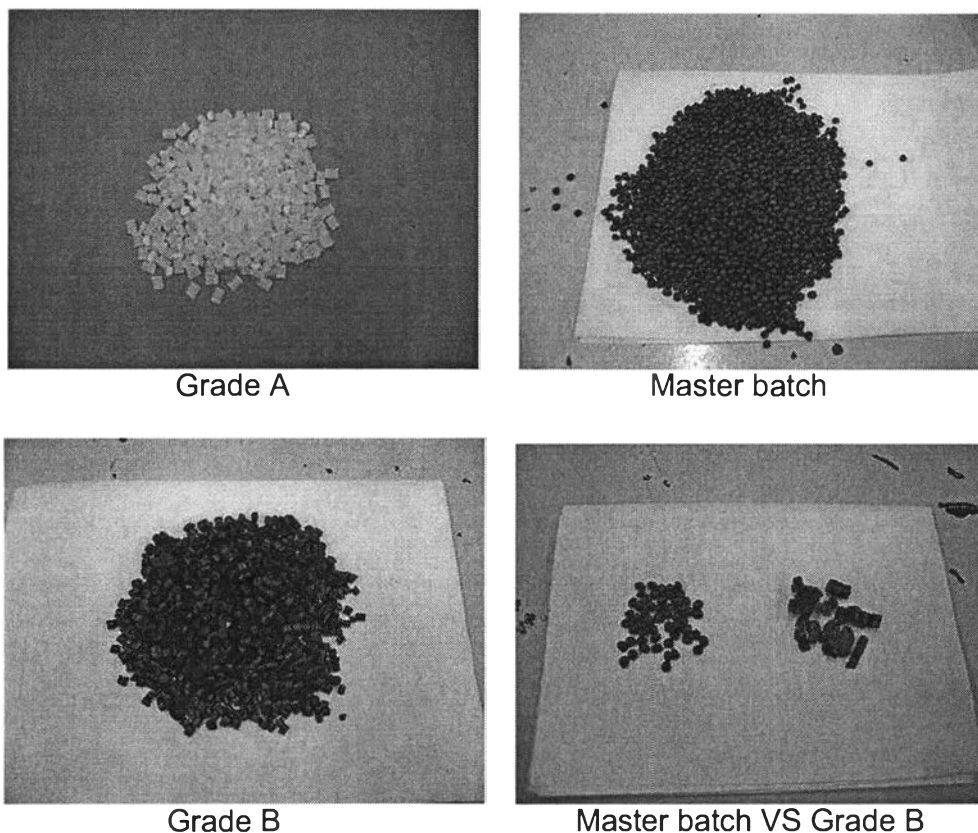


Figure 3.5: Raw material

Grade A is white, inflammable, and dimension as likes a small cylinder. For ordering PS grade A, the company receives a certificate every lots. This certificate shows the material has been inspected and tested with the conditions and requirements of the contract or purchase order. The supplier uses American Standard Test Method (ASTM) for testing raw material qualification. That is Melt Flow Rate (MRF) test by ASTM 1238, Yield Tensile Strength test by ASTM D638M, Izod Impact Strength test by ASTM D 256A and Vicat softening point test by ASTM D 1525. Similar to grade A, master batch is one raw material that orders from supplier. Their qualifications are similar to grade A only colour and dimension are different. It is black and its dimension can be compared a seed. Master batch is a primary colour of research's product. Therefore, the supplier sends master plate colour with certificate for colour checking.

Quality Control department is responsible for raw material receiving process. The appearance and qualification are checked visually. For example,

checking lot number at raw material bag, a certificate or colour plate, neatness of raw material bag, order quantity (one bag is twenty-five kilograms), and inflammability by lighter. In addition, QC has a sampling plan that includes a switching sampling plan.

If ten lots carry on accepted in normal standard, it will be switched to reduce standard. On the other hand, it will switch down to normal standard if only one lot is rejected in reduce standard. However, it will be switched to tighten standard if two lots in five lots are rejected in normal standard. By tightening standard, it can switch up to normal standard again if five lots carry on accepted. However, and order of both raw material depends on monthly capacity.

For raw material grade B, the company receives it from recycle process. Their quality is lower than raw material grade A such as the dimension is not consistence (see figure 3.5 master batch VS grade B). Therefore, QC does not check it like raw material grade A and master batch.

Then, raw material grade A and master batch are mixed together in ratio 97:3. It will send to heating process, which uses to get rid of humidity. The duration for heating is two hours at sixty-five centigrade. The company uses a hopper for heating. If raw materials are heated too short, the product maybe a short shot. In contrast, it maybe black spots or/and brown streaks if it is heated too long. After that, grade B are mixed into the mixing raw materials for save cost in ratio 15:85. Moreover, the company mixes raw material followed the UL standard.

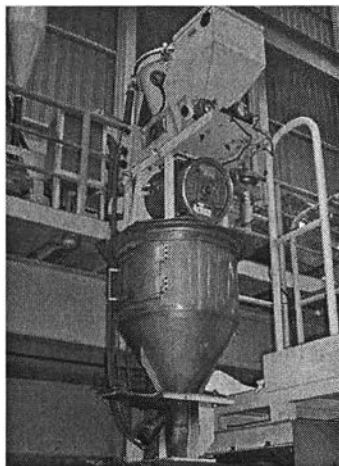


Figure 3.6: Hopper machine

### 3.4 Injection process

Injection process produces the front cabinet of television 14 inches. The company uses machine power 650 tons. The specification is as followed:

- Machine weight 38 tons
- Machine dimension (L x W x H) 11.1 x 2.5 x 2.5 M.

- Injection pressure 1820 kgf/cm<sup>2</sup>
- Injection capacity (theoretical) 3190 cm<sup>3</sup>
- Injection rate (theoretical) 579 cm<sup>3</sup>/sec.

The heated raw material is fed to the cylinder part of machine. There are four positions of heater to melt raw material from solid to liquid. It calls molten resin. In addition, there are two positions of heater, near the shut off valve and at the shut off valve. It uses to keep the resin's temperature stable and easily injected into the mould. The next step is the injection of molten resin into the mould by using a short shot process. In other words, the company can shoot enough resin in to partially fill the mould (80% - 98%) depending on the part design and channel size. Also, the company uses a shut off valve as a tool of short shot process. At this stage the resin is isolated in the mould and nitrogen gas is injected, nitrogen is used because it is inert and low cost.

After the resin is injected, it is isolated and the gas is injected and held (screw recovery may start at this point). The gas pressure is then vented prior to mould opening. The gas hollows the thicker resin channels because gas follows the path of least resistance after the resin is injected. Since the resin is still molten in these thick areas, the gas follows these thickened channels; it forces the molten resin ahead of it, filling in the short areas of the part. The finished product has less stress and warp; the part is also structurally stronger because of the tubular sections now molded in.

For gas injection, the company set the gas option themselves. The problem lie in not using the gas option as instructed. Therefore, the company gas option has a delay time and difficult setting match to mother machine. The next step is to cool products by water for which its temperature is reduced and formed approximately sixty seconds per one cycle time per one product.

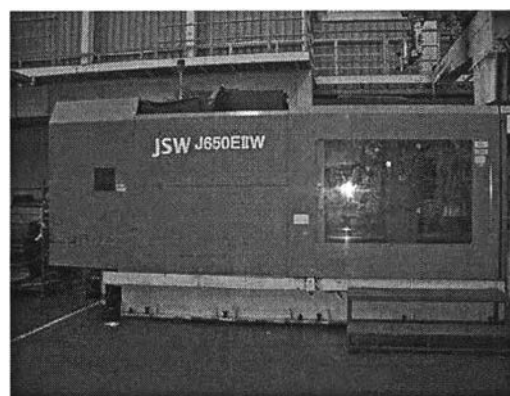


Figure 3.7: Injection process machine

### **3.5 Self inspection and process quality control**

Self inspection and process quality control (PQC) is the checking process of product's quality. The worker checks every piece of product from injection process by themselves. From one hour of injection process, it can produce about sixty pieces of product. That means one cycle time is sixty seconds approximately. PQC checks it after worker's checking. Unlike workers, the PQC does not check every piece. They use sampling method, which is same as the sampling plan in raw material topic. They pick up 4 % of product per 1 hour. Therefore, PQC pick two pieces of sixty pieces for checking every hour. Both of them check the product visually and record the result in the check sheet, one for the worker and another for PQC. The check sheet for worker records all defects numerically within work hour. PQC's check sheet records two results of sampling product pass or fail in every hour.