CHAPTER 3 METHODOLOGY

3.1 Materials

Phosphogypsum	The by-product from fertilizer industry : Used in the form of β-plaster which is a main raw material of the cat-litter
Tissue paper	MAXMO multi-purpose towel : Raw material of paper pulp
Coconut coir pith	Mixed with plaster to improve adsorption capacity
Deionized water	Used as a component in the cat-litter production
	Used to make boric acid solution
	Used in test of water adsorption
Polyvinyl alcohol	AR grade : Used as a binder in the cat-litter production
Boric acid	AR grade : Used to make boric acid solution

3.2 Equipments

3.2.1 The cat-litter production

3.2.1.1 β-plaster preparation

- Sieve shaker (Retsch VE 1000)
- 60 mesh sieve
- Hot air oven
- Desiccator

3.2.1.2 Paper pulp preparation

- Electric chopper

3.2.1.3 Coconut coir preparation

- Hot air oven

3.2.1.3 The cat-litter production

- Electric digital balance
- Extruder
- Scissor

3.2.2 Characterization of the cat-litter

3.2.2.1 Density

- Electric digital balance
- Vernier caliper

3.2.2.2 Abrasion resistance

- Electric digital balance
- Sieve shaker (Retsch VE 1000)
- 60 mesh sieve
- 16 mm balls

3.2.2.3 Water adsorption

- Electric digital balance
- Stop watch

3.3 Methodology

There are two main steps to achieve the objective which are cat-litter production and data analysis.

3.3.1 β-plaster preparation and cat-litter production

β-plaster can be produced by the dry process. Size of phosphogypsum particles might be selected by using mesh no. 60 sieve shaker. After that, phosphogypsum will be heated by hot air oven at 150°C for 3 hours then phosphogypsum or calcium sulphate dihydrate will be changed to β-hemihydrate or β-plaster.

Cat-litter is produced from β-plaster, water and fiber materials which are paper pulp and coconut coir. Poly(vinyl alcohol) is also added as a binder. β-plaster, PVA solution and fiber material will be mixed together. Then, the mixture will be fed to the extruder and then a bar of plaster will be soaked in boric acid solution. Boric acid will generate cross-linking in molecule of PVA. The bar of plaster will be cut into little pellets. After that, the pellet will be dried by hot air oven at 110 °C for 5 hours. Finally, the product cat-litter from phosphogypsum is produced.

3.3.1.1 Preparation of β-plaster

1. Screen the phosphogypsum by a sieve shaker (mesh no. 60)
2. Heat the phosphogypsum by a hot air oven at 150°C for 3 hour in order to turn the phosphogypsum into β-plaster
3. Keep the β-plaster in a desiccator for further use in cat-litter production

3.3.1.2 Preparation of tissue paper

1. Shred tissue paper sheets to small pieces
2. Cut the paper by using an electric chopper
3. Keep the paper pulp in the desiccator for further use in cat-litter production

3.3.1.3 Preparation of coconut coir

1. Heat the coconut coir by the hot air oven at 110°C for 5 hours in order to dry up moisture in the particles of coconut coir
2. Keep the coconut coir in the desiccator for further use in cat-litter production

3.3.1.4 Production of the cat-litter

1. Mix the β-plaster, paper pulp/coconut coir, PVA, and water together
2. Inject strings of cat-litter by using extruder
3. Soak the strings of cat-litter in a concentrated solution of boric acid for 12 hours
4. Neutralize the strings of cat-litter by water washing
5. Cut the strings into little pellets
6. Heat the moist cat-litter pellets by the hot air oven at 110°C for 5 hour in order to dry up moisture in pellets
7. Keep the cat-litter in the desiccators

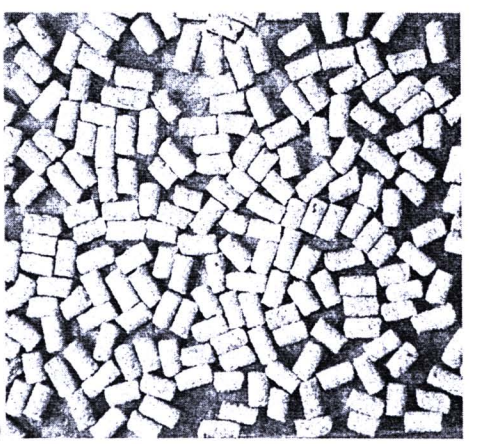
a)  b) 

Figure 3.1 : The produced cat-litter a) with added paper pulp, b) with added coconut coir

3.3.2 Data analysis

After cat-litter is produced, properties of cat-litter such as density, abrasion resistance and water adsorption will be tested. In this research, two different kinds of the fiber materials are mixed into the plaster in order to improve adsorption characteristic.

3.3.2.1 Study on various composition of samples

In this research, their properties namely, density, abrasion resistance and water adsorption are studied on different composition of each component. Weight percentage of paper pulp/coconut coir in cat-litter is fixed at 10 percent (dry basis) for all samples. Moreover, there are five values of weight percentage of water in the mixture which are 40, 42.5, 45, 47.5, and 50. This is because cat-litter cannot be produced when the weight percentage of water in the mixture is not in range of 40 to 50 [7]. Either paper pulp or coconut coir are added in order to improve the properties of cat-litter. Therefore, the paper pulp/coconut coir compositions of all samples are fixed at 10 percent by weight. Furthermore, weight of PVA in the mixture is fixed at 5 percent by weight of mixture for all samples. Weight percentages of all samples are summarized in Table 3.1.

Table 3.1: Mass composition in each of samples

	PVA (%wt)	Water (%wt)	Plaster+ Paper pulp/Coconut coir(%wt)	Plaster (%wt)	Paper pulp (%wt)	Coconut coir (%wt)
A1	5	40.0	55.0	49.50	5.50	-
A2	5	42.5	52.5	47.25	5.25	-
A3	5	45.0	50.0	45.00	5.00	-
A4	5	47.5	47.5	42.75	4.75	-
A5	5	50.0	45.0	40.50	4.50	-
B1	5	40.0	55.0	49.50	-	5.50
B2	5	42.5	52.5	47.25	-	5.25
B3	5	45.0	50.0	45.00	-	5.00
B4	5	47.5	47.5	42.75	-	4.75
B5	5	50.0	45.0	40.50	-	4.50

3.3.2.2 Testing of cat-litter properties

3.3.2.2.1 Density

1. Determine weight of a cat-litter pellet by using an analytical weighing balance
2. Determine height and diameter of the pellet then calculate volume of the pellet by using vernier caliper.
3. Evaluate density of the cat-litter pellet by following equation

$$density\ of\ cat\ litter\ pellet\ (\frac{g}{ml}) = \frac{weight\ of\ cat\ litter\ pellet}{volume\ of\ cat\ litter\ pellet}$$

3.3.2.2.2 Abrasion resistance (ASTM E 728-91)

1. Use sieve shaker to screen the dust from cat-litter
2. Put 50 g of cat-litter in and balls (grinding media for ball mill) in sieve shaker then shake them for 10 minutes
3. Put the balls out from the sieve and continue shaking to screen the excess dust
4. Weigh the remained cat-litter
5. Report the abrasion resistance test by following equation

$$abrasion\ resistance\ (\%) = \frac{weight\ of\ cat\ litter\ pellet\ after\ test}{volume\ of\ cat\ litter\ pellet\ before\ test} \times 100$$

3.3.2.2.3 Water adsorption

1. Put 20 g of cat-litter in 500 ml of water for 300 seconds
2. Record weight of the cat-litter every 10 seconds of the first minute after that, record every 30 seconds until the end (eg.10, 20, 30 ,..., 60, 90, 120,..., 300 seconds)
3. Percentage of water adsorption (g water/100 g dry solid)

$$= \frac{w_b - w_a}{w_a} \times 100$$

where : w_a= weight of dry cat-litter

w_b= weight of cat-litter with adsorbed water