CHAPTER 1

INTRODUCTION

Bricks are wildly used around the world as construction materials. In Thailand, clay bricks are the most popular. It is locally produced as household products using local clay in a rural area. Thailand has produced bricks for construction use since ancient time. There are still several historic buildings and ruins left in certain ancient cities displaying different states of deterioration. Bricks with good properties: high compressive strength, low water absorption, small size apparent porosity and high density, can endure harsh weather and last long with little maintenance [1].

Properties of bricks are affected as a result of physical, chemical and mineralogical alteration. Besides brick cracks, compressive strength and water absorption are two major physical properties of bricks that are potential predictors of their ability to sustain weathering effects reasonably well [2]. The main factors involved in manufacturing bricks are the type of raw material used and the firing temperatures, both of which affect the final product [3]. Bricks become homogeneous, harder and stronger due to the ceramic bond from the fusion phase of the silica and alumina clay constituents during firing process [1].

For raw material, Hang Dong clay has been locally used for brick production for a long time in the northern part of Thailand. Hang Dong clay is harvested from a rice paddy at Hang Dong District in Chiang Mai province. The main characteristics are clay loam or sandy clay loam with brownish grey clay loam on the surface and yellowish brown sandy clay loam in the deeper layer at 10 cm. Its apparent porosity is

14.22% after firing at the temperatures from 700-900 °C and after 950 °C, its apparent porosity starts decreasing due to flux which is the main content in Hang Dong clay. Consequently, Hang Dong clay has been used as raw material for bricks as construction materials. However, the production process is still traditional, i.e., green bricks are molded by hand or machine, then and air-dried and burnt at 750-950 °C. After firing, bricks become dense with low apparent porosity [4].

In order that bricks possess more appropriate physical and mechanical properties for construction materials, additives are frequently used in brick production and the selection of additives depends on the characteristics required. Lightweight bricks with high compressive strength and low water absorption are desirable. One way to increase such capacity of bricks is to generate porosity in the clay body. The most frequently used pore formers in clay brick manufacturing can be classified into two groups: organic and inorganic pore generators. Organic pore formers are generally cheaper than inorganic ones and also have the advantage of ensuring a heat contribution to the firing furnace. Thus, it is more fuel efficient and environmentally friendlier than firing pure clay bricks. However, inorganic pore formers have less environmental problems but they may change the plasticity of the clay system negatively and increase the amount of water needed to maintain acceptable plasticity [5-7].

Organic product residues are extensively used as a pore former in the brick industry [8]. Several research studies and attempts have reported to incorporate certain additives to increase required properties of clay bricks, for example, rubber, limestone dust, wood sawdust, processed waste tea, fly ash and sludge [9]. Normally, good qualities of bricks exhibit shrinkage below 8%, water absorption below 25%

bulk density between 1.8-2 g/cm^3, and compressive strength as high as 35 kg/cm^2 [10,11].

The porous-brick or hole-brick will decrease the thermal conductivity and heat transfer [12]. Decreasing the thermal conductivity in bricks will produce porous [13]. This process can be done by adding organic substances such as charcoal, sawdust, rice husk or fragments of remaining materials left from industrial or agricultural or even adding with inorganic compound such as calcium carbonate, dolomite, or foam. The porous bricks will have low thermal conductivity and can prevent heat and cold to transfer from one side of the surface to the other.

The transfer of heat is more or less depending on the thermal conductivity of the material. Moreover, the thermal conductivity of the material can help in energy savings and control the temperature. However, the internal structure of the bricks must be dense enough to avoid the intrusion of water. The reason for this is when water absorption infiltrates the bricks, it decreases the durability of bricks. Decreasing water absorption is to decrease the amount and size of porosity because the higher number and the larger size of porosity the bricks have, the more water absorption of the bricks can occur.

Charcoal is an organic additive which is available in abundance in the northern part of Thailand and has never been used and tested. Charcoal is a form of amorphous carbon. It is produced when wood, peat, bones, cellulose, or other carbonaceous substances are heated with little or no air present. As a result, a highly porous residue of microcrystalline graphite remains. If it burns completely it will produce carbon dioxide as shown $C + O_2 = CO_2$ [14].

The interesting subject is to produce bricks that have low thermal conductivity for housing, factories and incinerator. The investments on clay bricks will promise a prosperous future. Thermal conductivity performance is an important criterion of building materials, as the thermal conductivity influences the usage of the material in engineering applications [12]. The thermal conductivity of a brick is the rate at which a brick conducts heat. Heat losses from buildings are dependent on the thermal conductivity of materials in the walls and roof. Building bricks has to minimize the heat flow from one side of the brick to the other side [15]. The thermal conductivity of bricks and other masonry materials depend on the density and therefore porosity of the materials. For example the thermal conductivity of a commercial insulation brick, clay brick-related-word, concrete and lightweight concrete equal to 0.13, 1.15, 1 and 0.3 W/m K, respectively [16].

Accordingly, Hang Dong bricks have desirable compressive strength pertaining to Thai Industrial Standards Institute; TISI77-2531. However, an important property that can be studied and improved is low thermal conductivity. A charcoal additive is introduced and incorporated in Hang Dong clay to be studied for this purpose. Moreover, this study yields findings for brick manufacturing and also to set a stage of using other local wastes as additives for brick manufacturing.

1.1 Objectives

1.1.1 To investigate the feasibility of using charcoal addition on the clay body.

1.1.2 To study the effects of physical on thermal insulation properties and produce low thermal conductivity of fired test briquettes while maintaining their strength.

1.2. The scope of work

The study is limited to only one raw material: Hang Dong clay and one organic additive: charcoal with different percentages and sizes to examine the effects of charcoal additive on Hang Dong clay when they are mixed and processed into test briquettes and fired at different firing temperatures.

1.2.1 The raw materials selected are

- Hang Dong clay and charcoal used as raw materials are obtained from Hang Dong district in Chiang Mai province.

- Hang Dong clay, the particle size distribution is obtained by dry sieving through No. 60 mesh.

- Charcoal additive is sieved step by step through meshes No. 35, 40 and 45 to obtain various sizes in the range of size 1 (2-3 mm.), size 2 (1-2 mm.) and size 3 (less than 0.5 mm.).

- Production of test briquettes fired at 900 °C, 950 °C, 1000 °C and 1100 °C.