CHAPTER I

INTRODUCTION

This chapter includes background of the research problem relevant to heat transferred through exterior envelopes of building. Significance, objectives and outline of this research are also presented in this chapter.

1.1 Background

Exterior envelopes of buildings are required to perform a variety of roles including maintain comfort condition of the interior. Although building envelopes generally meet these requirements, there are cases in which they do not perform as much as expected. Shortcomings in thermal performance are manifested by excessive heat transferred that can lead to increasing of energy consumption because of poor thermal comfort within the occupied space, while some cases of poor performance occur due to the specification of insufficient levels of thermal insulation (Persily, 1993). These problems result from design phase, which is inadequately accounted for heat transmission and disable durability to perform over time. Thermal envelope defects can also occurred due to poor technique during the construction phase. Since the finite supply of fossil fuels and the high cost of energy, the needs to design energy-efficient buildings that are also economical become very important. Various researchers are updating and refining energy conservation standards and guidelines for use in the design phase of new buildings.

From a functional point of view of wall functions, walls are complex constructive elements of building envelops. For the occupants, they act as a physical barrier against climatic phenomena of the world outside. On the other hand, walls have the special function of communicating by opening door and window to control amounts of light, air, view, noise, moisture, limiting the transfer of heat, supporting structural loads and providing an aesthetically pleasing appearance. The combination of those functions includes esthetic and economical situation has led to specific technique and intelligent design for exterior walls. In construction, installation thermal insulation locates in cavity wall continues to function under a variety of temperature, humidity and total assembly conditions. In the process of assessing design values for thermal resistance of insulating materials, knowledge related to physical and mechanical properties are very important (Yucel et al, 2003).

Concerning thermal insulation, expanded polystyrene (EPS) is known as a very good thermal insulator compare to other thermal insulation materials. It is extremely lightweight material with high thermal resistance; therefore, it has been used as ice-container and other insulating products. EPS packaging foam is commonly used for packaging construction material, electronic instruments, food, etc.

The issues mentioned above lead to the initiation of this research project, which has its goal to develop a low cost of thermal insulation by using disposed packaging EPS foam for exterior wall panels. This kind of insulation material may be cheap and possible for low incomers of Southeast Asia countries to install in wall panels of their homes.

1.2 Problem Statement

Southeast Asia region locates in both southwest and northeast monsoons with high intensities of solar radiation. Temperatures are fairly uniform across the central region with an annual average of about 28-30°C. This area is warm year round with the maximum temperatures in the region of about 35-38°C when the hottest period is in April, which is common before the start of rainy season. During daytime, air temperatures in the central region rarely drop below 30°C and can go up above 40°C. Even indoor, solar-heated walls and roofs can increase heat gain of any buildings. Therefore, energy consumption is required for air conditioner to control the indoor temperature.

Most of residential building envelopes in the region were built from materials such as timber, clay brick and cement brick plaster, clay tile or cement tile roof, concrete roof, steel roof and etc. The use of these materials can result in excessive heat gain into the buildings through roof and wall by absorbing as well as emitting radiation. The amount of absorbed solar radiation varies depending on type of material used as building surface. In refer to Koch-Nielsen (2002), roof such as new aluminum roofing sheet absorbs solar radiation 10-25% and emits 10-25% while oxidized one absorbs solar radiation 30-50% and emits 20-50%. New fibro cement sheet absorbs solar radiation 35-50% and emits 85-95%, while an old one blacken by algae absorb 60-85% and emits 85-95% as well. New bricks or plastered walls with light colors absorb solar radiation 25-30%, and emits 85-90%, and weathered ones absorb solar radiation 30-40% and emits 85-95%, red-brick stone or tile absorbs solar radiation 65-80% emits 85-95%, and concrete tile or slab absorbs solar radiation 45-65% and emits 85-95%. The absorption of these materials is an expression of the short-wave radiation gained in percentage of the total amount of radiation impacting on a surface, between 100 and 400 W/m^2 depending on location, time and climate (Koch-Nielsen, 2002). In contrast, the envelope thermal transfer value of buildings in Southeast Asia region as determined in accordance with the formula set out in the "Guidelines on Envelope Thermal Transfer Value for Buildings" issued by the Commissioner of Building Control, shall not exceed 50 W/m^2 (NCCC, 2007). According to Hui, (1997), the overall thermal transfer value limits for walls in Bangkok is 45 W/m^2, while Chirarattananon et al, (2005) indicated the overall thermal transfer value requirement is less than 45 W/m^2 for new buildings and 55 W/m^2 for existing buildings. This reason causes a consideration of using insulation at the design phase for new construction and needs to improve thermal property for outer wall of existing buildings.

However, insulations are expensive. The cheapest thermal insulation in Thailand costs 60 Baht/m^2 and provides thermal resistance only 0.66 $^{\circ}$C•m^2 /W (SFG, 2007). In case people need higher thermal resistance insulation, they have to buy the thicker insulation and the cost will be more expensive. Concerning the poverty profile of

Thailand based on 2004 data, 10 percent of Thai populations are living below the poverty line (The World Fact Book, 2007), which normally can afford neither thermal insulation nor air conditioner. There should be more people in other countries with this situation since Thailand is recognized as one of the most developed countries in Southeast Asia. As a result, a large number of people have to live in discomfort condition.

In order to obtain low-cost thermal insulation, re-use of disposed materials is taken into consideration in this study. Among disposed materials, packaging foam is abundant because most of fragile products, especially, appliances required packaging foam to protect them from breaking and preventing heat transfer. The majority of packaging foam is expanded polystyrene, which is known as non-perishable material and very good thermal insulator compared with other insulation materials (Hornbostel, 1991). This reason leads to this research project with the ultimate goal to use disposed EPS packaging foam as thermal insulation in exterior wall panel systems.

1.3 Research Question

Packaging foam has variety of shapes and sizes, therefore, the research question was that how can people use those packaging EPS foam to improve thermal resistance of conventional wall materials most effectively?

1.4 Significance of Research

This research will help low-incomers to live in more comfort condition without paying high electricity cost for air conditioning, while they can also save insulation cost.

1.5 Research Objective

The objective of this study is to find the most appropriate approach to use EPS packaging foam as an insulator in wall panels systems.

1.6 Outline of the Thesis

This thesis was organized into the following parts:

• Chapter One: Introduction: Provides the statement and significance of the problems. It also includes question, significance, and objectives of research.

• Chapter Two: Theory and Literature Review: This chapter, a review of literatures is summarized by focusing on EPS packing foam and physical properties of EPS. Thermal comfort condition and requirement of insulating values in hot and humid climate for energy efficiency were reviewed. It also included the knowledge of heat transfer characteristics, thermal resistance and conduction. Finally, the idea to used packaging EPS foam as thermal insulation for exterior wall was proposed.

• Chapter Three: Research Objectives and Methodology: The research objectives were identified and research process was designed. Previous researches and methods related to thermal insulation and their results were reviewed. Those test methods provided a great idea to design a new one as used in this study.

• Chapter Four: Experiments and Results: This chapter reviewed the process of breaking down packaging EPS foam with time and cost estimated. Test apparatus, method, experimental processes and results were described in detail. Finally, the most effective size of packaging EPS foam relatively high thermal performance could be determined.

• Chapter Five: Application: The selected insulation in Chapter IV was applied with conventional structure of wall systems and tested for thermal performance whether it reached a desired level or not.

• Chapter Six: Discussion and Conclusion: Refer to literature review in Chapter II, research methodology in Chapter III, results from the experiment in Chapter IV and application in Chapter V, conclusion of the research can be drawn.