A comfort natural classroom design for hot-humid climate

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Abstract

Today, most classrooms in Thailand have many problems interfering learning activities. These factors are thermal, lighting, visual, and acoustics properties of materials and room design. Thermal comfort is the most influence factor in learning activity and help user ready to study. Using mechanical system in building is a very common way for designer and owner, which consumes a lot of energy. The use of natural elements can improve classroom thermal quality. These techniques found in this research are using evaporative cooling to reduce the ambient temperature. Using land form to enhance a wind velocity and selecting low surface temperature to create low Mean Radiant Temperature (MRT). The real natural classroom was constructed at Thammasart University to illustrate those techniques. During summer peak day, thermal comfort condition inside natural classroom is 36% (9 hour per day) better than conventional one. Applying causal activity in classroom can expand thermal comfort up to 72% during daytime and up to 83% in average all day. Low MRT surfaces with ground contact can increase comfort especially during high air temperature as indicate outside comfort zone. Combined low ambient temperature and low MRT still have some hours left outside comfort condition during the day, then low speed wind will be introduced just enough to bring human sensation in comfort zone.

Key Word: *Classroom, Natural elements, Thermal comfort, Learning, Evaporative cooling, Wind velocity, Mean radiant temperature (MRT)*

1. Introduction

Hot humid climate characters are high air temperature and high humidity, mostly uncomforted for human body. "Thermal Comfort is that condition of mind that expresses satisfaction with the thermal environment" (ASHRAE, 2001). Climate in Bangkok has only 7% in comfort zone (Boonyatikarn, 1999).

Comfort condition is necessary for learning activities. Classroom should provide basic physical human comfort to help user ready to learn. Classroom environment should enhance human perception capacities, as lighting visual and acoustics comforts.

Comfort environment condition is needed for classroom design in hot humid climate.

Typical classroom construction with unmodified surrounding, increases inside air temperature exceed comfort zone. Therefore, most classrooms use air condition system to modify comfort condition which consuming a lot of energy. Energy consumptions in typical building are 105 watts per square meter for air conditioning and 16 watts per square meter for lighting (Boonyatikarn, 2002).

2. Method

Human comforts in classroom consist of thermal, lighting, visual, and acoustics comforts. This paper focuses only on thermal comfort since it influence the energy consumption in typical building.

There are four thermal comfort factors as air temperature, relative humidity, wind velocity, and mean radiant temperature (MRT) (Fanger, 1970). Comfort zone in Bioclimatic chart ranges between 21.1 – 27.8^{o}C (70 – 82^{o}F) for air temperature and 30% - 70% relative humidity (Olgyay, 1992).

A natural classroom uses environmental factors to aid learning condition. The use of natural elements propose in these research are improve thermal comfort quality that use all four thermal comfort factors. First of all, create low ambient temperature which is in humidity range by using evaporative cooling technique at the classroom surrounding. Second, increase comfort condition by using low wind velocity that enhance by land form design. And finally, use the benefit of low mean radiant temperature by low surface temperature nearby user.

3. Results

The natural classroom, which uses these three natural modifying techniques, case study is design and builds at Thammasart University. This classroom creates low ambient temperature with low surface temperature and avoids high surface temperature from sunlit hardscape surfaces. Applying evaporative cooling technique from water spraying system around the classroom especially on ground cover grass surface will lower surface to 28.5^{o}C, while sunlit hardscape surface temperature will increase up to 43.5^{o}C.

Reducing air temperature using evaporative cooling, could relieve research comfort zone. If dry bulb temperatures are 35^{o}C, 32^{o}C, and 30^{o}C evaporative cooling will lower air temperature as 9.6^{o}C, 8.5^{o}C, and 7.4^{o}C respectively.

Fig 1. Evaporative cooling technique from water spraying system outside the natural classroom.

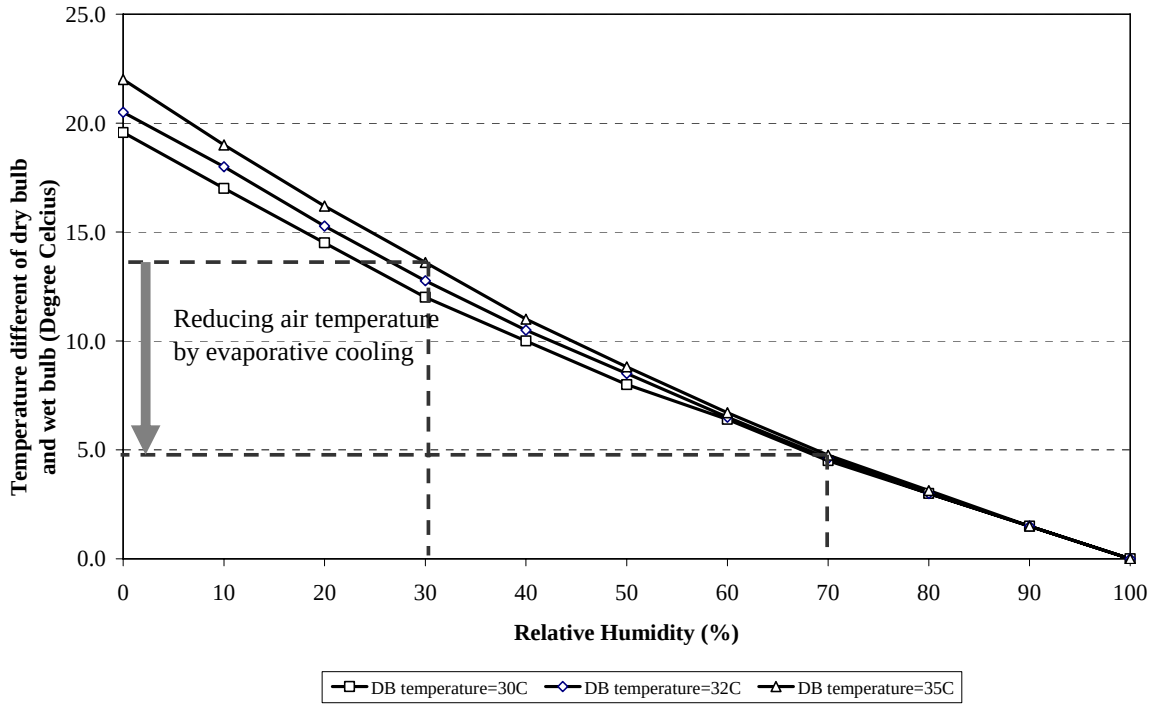

Fig 2. Relative humidity and temperature different of dry bulb (DB) and wet bulb (WB) temperatures.

Land form factor enhances wind velocity in varies direction should curve creates positive pressure at the classroom side negative pressure at classroom exit. When the wind direction flows from the back of classroom, the window shapes wind pass through the audiences and exit doors.

Fig 3. Natural classroom and land form design.

After creating low outside surface temperature and enhance outside wind velocity, human body should gain benefit from low mean radiant temperature (MRT). Every 1^{o}C of low MRT human body will feel cooler equivalent to 1.4^{o}C (Boonyatikarn, 1999).

Air temperature in natural classroom is 29^{o}C, and floor, seats, wall surface temperature are 28.1^{o}C influenced by ground contact. When seated, body skin (32^{O}C) would conduct hat through the ground surface as conduction. With evaporative technique in outside landscape, MRT will lower than landscape significantly. In the sample classroom ceiling temperature is 29.4^{O}C effecting from high insulated roof system while outside roof surface temperature is 60.2^{o}C.

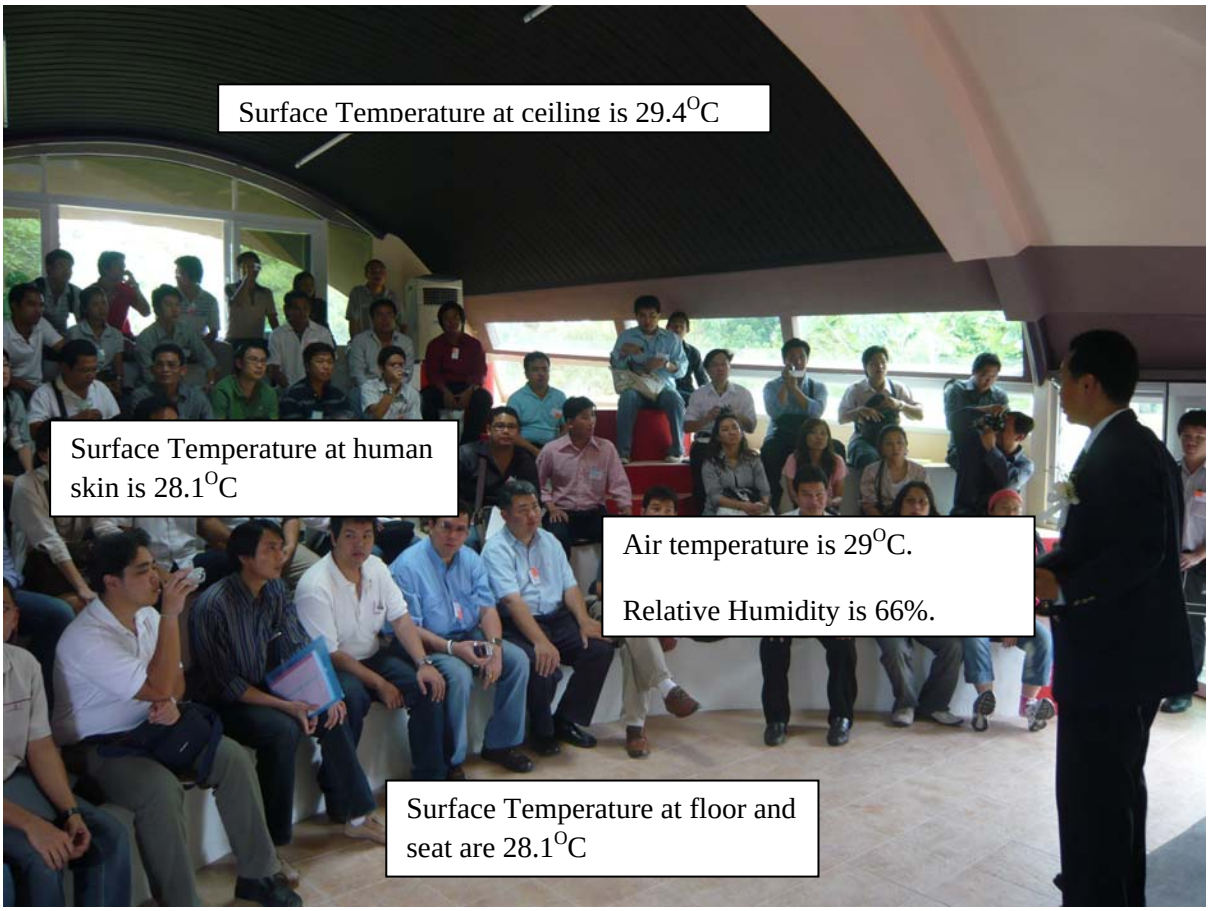

Fig 4. Inside air temperature and surface temperatures in natural classroom.

4. Conclusion

Thermal comfort modification consumes a lot of energy. The natural classroom with low ambient temperature using evaporative cooling surface, wind velocity by land form, and advantage of low MRT modify thermal condition in classroom close to comfort zone.

The thermal comfort simulation in summer peak day (19 April 2007) can be modified by using natural elements. Natural classroom increase 36% (9 hour per day) comfort better than conventional one. Applying causal activity in classroom can expand thermal comfort up to 72% during daytime and up to 83% in average all day without any mechanical system.

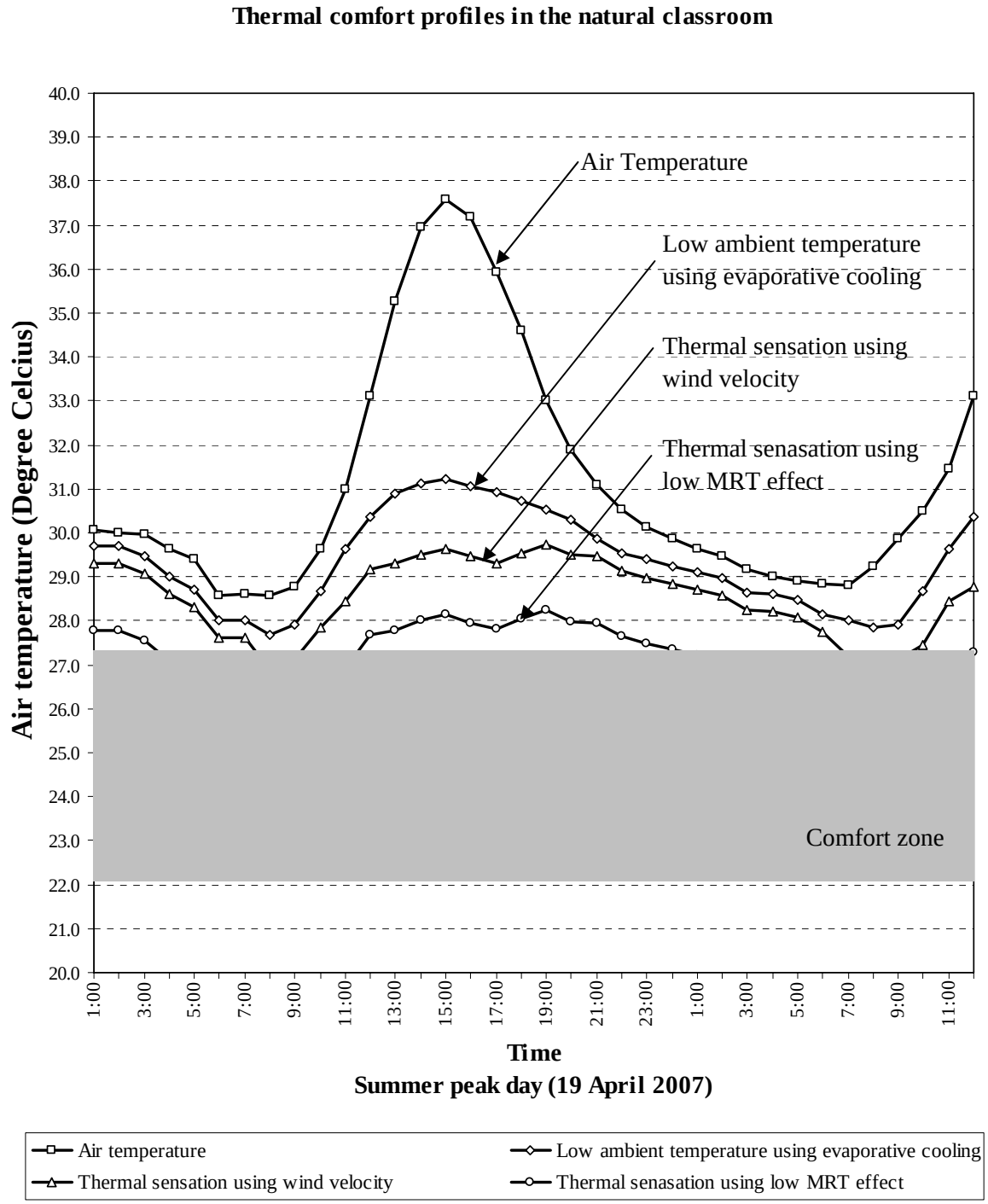

Fig 5. Thermal comfort profiles in natural classroom effected using natural elements.

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