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Investigation of More Environmental Friendly Materials for Passive Cooling Application Based on Geopolymer

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Abstract

Evaporative passive cooling systems are considered as interesting technique to address the environmental and energy crises. Within this context, the development of new porous materials has attracted a lot of attention recently. The utilization of industrial and agricultural waste byproduct will also make this technology more environmentally friendly. This article reviews the application of byproduct, industrial wastes materials, and other agricultural residuals as raw materials for the preparation of geopolymers. It must also be taken into due consideration that many potential waste and residuals have not been extensively studied, and requires extensive investigations.

Keywords: Agricultural waste, Geopolymer, Passive Cooling

1. Introduction

The primary global energy demand will increase by almost 33 percent in the period between 2010-2035, and it is also projected that energy-related CO_2 emissions will increase by 20%, which adheres to a trajectory that is consistent with the rise of global temperature, by about 3.5 °C. Since the building sector account for about 40% of the total world's energy consumption, a lot of effort is made to reduce energy consumption in

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buildings[1]. The consumption comes in the form of heating, ventilating, and air-conditioning (HVAC) systems. Recently, important and significant developments in passive cooling techniques are propelled into the limelight. In this context, evaporative cooling is regarded as a passive technique that is not only limited to hot and dry regions, but is applicable in temperate and maritime settings as well [2].

2. Porous materials as passive cooling materials

There are currently quite a number of materials that are being analyzed for that very purpose. For example, ceramics is already under analysis for its perceived potential as a media for both direct and indirect evaporative cooling applications [3]. The majority of porous ceramics possesses excellent mechanical properties, increased chemical and abrasion resistance, and is thermally stable. It is a well-established fact that cooling is controlled by factors such as porosity, configuration, and supply-water pressure. In the cooling hierarchy, a high porosity evaporator provides the most cooling, followed by a medium-porosity evaporator, while the low-porosity prototype results in almost negligible levels of cooling. Okada et al determined that lotus ceramics demonstrated heightened capillary rise levels (about 1300 mm), which is a value beyond conventional porous ceramics [4]. The viability of passive cooling vis-à-vis lotus ceramics is fairly obvious, due to the areas surrounded by lotus ceramics being cooler than average [5]. As shown Fig. 1, the PECW is equipped with a shaded area that eschews both direct and reflected solar radiation, while its surface can itself be cooled via evaporation.

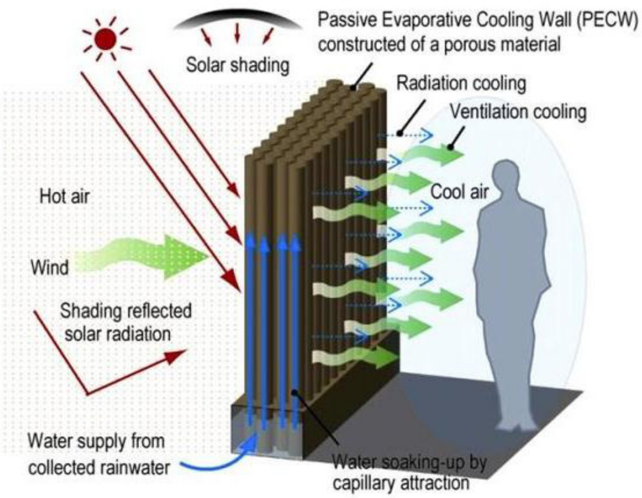

Fig. 1. Schematic description of a passive evaporative cooling wall constructed of a porous material with high water soaking-up ability.

Geopolymers, regarded as revolutionary within the materials community, has recently been grabbing headlines due to their purported potentials. Geopolymers are good candidates at low temperature (<100 °C) applications, and their manufacturing emits six times less CO2 compared to standard cements [6]. The materials used in geopolymer composition are mainly by-products and industrial wastes, which result in it being regarded as more environmentally friendly compared to other porous ceramics.

3. Application of by product and waste as raw materials

Geopolymer is usually sourced from coal combustion products, commonly known as fly ash. This is due to