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DEVELOPMENT OF AUTONOMOUS HUMIDITY CONTROLLING BUILDING MATERIAL BY USING MESOPORES.

Osamu Watanabe and Hiroshi Fukumizu, INAX Corporation, JAPAN
Hideki E. Ishida and Hirotaka Maeda, Tohoku University, JAPAN

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E-mail: osamu-w@i2.inax.co.jp

Japan is located at the northern east end of the Asia monsoon area, so it is very sultry in the summer and biting cold in the winter. Current Japanese houses are highly airtight and thermally insulated in order to save energy. As a result, problems related to increased moisture in the indoor air have occurred, for example, excessive dew formation, etc. To solve these problems without energy, it is proposed that autonomous humidity controlling building materials are used indoors. We developed interior wall tiles which control the indoor humidity and introduced them to the Japanese market ten years ago. The name of product is "ECOCARAT". We have also presented them at CERSAIE (International Exhibition of Ceramic Tile and Bathroom Furnishings) in Italy three years ago, and have proposed their use in countries in which there are similar problems of indoor moisture in Europe, North America and Asia.

The physical properties of ECOCARAT are as follows: dimensions: 300x300x5.5mm, bulk density: 1.7g/cm^3, flexural strength: 5MPa and porosity: 40%. The moisture adsorption isotherm was measured. When the relative humidity is higher than 50%, the amount of adsorbed moisture increases and reaches 650g/m^2 at 90% that is three times higher than cedar. Closed vessels with a volume of 12liters, were used and 56cm^2 of ECOCARAT was placed in the vessels. The vessels without cover were placed in an incubator, and kept at 25^{o}C and 60%. The cover was then closed, the temperature in the incubator was varied from 25 ^{o}C to 5 ^{o}C over 12hours and their heated to 25 ^{o}C for 12hours. At that time, the relative humidity in the vessel was measured with and without the ECOCARAT. Without ECOCARAT, the relative humidity in the vessel increased and reached the dew point. Even though placed ECOCARAT in the vessel, the relative humidity was in the range of 60 to 70%. When the humidity in the vessel rose, the pores adsorbed the extra moisture. Conversely, when the humidity decreased, the pores released the moisture that they had adsorbed. Thus, it maintained a comfortable humidity range (40 to 70%) which was gentle to the skin and throat.

The capillary condensation phenomenon is utilized for obtaining the autonomous humidity control ability. The relation between the pore size and relative humidity is expressed by Kelvin's equation. From this equation, it is important that capillary condensation occurs in the pores of around 10nm in diameter from 40 to 70% in relative humidity. Allophane, which is a clay mineral originating from volcanic ash and contains mesopores and gibbsite, which forms mesopores by heating at around 400^{o}C are used as the material that forms mesopores of about 10nm. ECOCARAT consists of these mesopore materials and plastic clays.

ECOCARAT also has a good adsorption property of formaldehyde which is one of the allergens of the sick house syndrome.