Indoor Air Quality Improvement by Novel Wall Covering Applying Photocatalysis

P124

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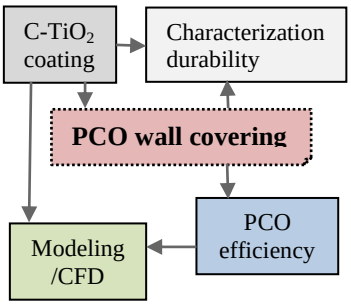

The present work shortly reviews indoor air quality (IAQ) and related European projects. It introduces a new research regarding a novel method of indoor air pollutant degradation by applying a visible light responsive photocatalyst, as final coating, on a wall covering. Part of this research is to investigate the optimal preparation and coating method of a modified titanium dioxide (TiO_2) onto a wall covering, the photocatalytic removal of both organic and inorganic indoor air pollutants experiments applying the developed air purifying wall covering on both laboratory and real scale and the modeling of the indoor air quality using Computational Fluid Dynamics software.

Introduction

The major sources of indoor air pollution worldwide include combustion of solid fuels, tobacco smoking, outdoor air pollutants, emissions from construction materials and furnishings, and improper maintenance of ventilation and air conditioning systems [1]. The impact of indoor air pollutants (IAP) on human being may consist of undesired health effects of different types, ranging from sensory annoyance or discomfort to severe health injuries. The public health relevance of the effects of IAP varies, not only from substance to substance, but also from country to country, depending on the presence of specific local sources and climatic influences [2].

First part of this article presents some IAQ related projects on the European level, followed by introduction of the experimental and modeling part and the summary of the project.

IAQ & EU

The purpose of this review is to introduce nowadays indoor air pollution issue and show the necessity of present research.

In 2002, four priority areas were identified in the EU's Sixth Community Environment Action Program. One of the priority areas is the Environment and Health and Quality of life [3]. In 2003, the European Commission adopted a new Strategy on Environment and Health with the overall aim to reduce diseases caused by environmental factors in Europe [4]. This strategy was followed by the EU Action Plan on Environmental and Health (COM (2004) 416). In this plan, the "action 12" intends to develop work on improving indoor air quality. These initiatives clearly recognize the importance of an integrated strategy on air pollution which considers both outdoor and indoor air pollutants.

A number of projects, regarding IAQ, were conducted within the EU. Some of the projects focused on the sources and/or exposure of the indoor air pollutants, some on the adverse health effects resulting from this exposure and some dealt with the risk assessment of the IAQ. A summary of these projects is listed in Table 1.

Table 1 EU projects regarding IAQ

Project/Study	year
EC AUDIT Study	1993-1994
EXPOLIS	1996-2000
MACBETH	1997-1998
THADE	2001-2003
IndEx	2002-2004
PEOPLE	2002-2004
HESE & HESEInt	2002-2005
HealthyAIR	2003-2008
AIRMEX	2004-2008
EnVIE	2004-2008
IAQ ranking/VITO	2004-2008
SCHER Opinion on risk assessment IAQ	2005-2007
BUMA	2006-2009
GERIE, RADPAR, HITEA, INTARESE, HEIMTSA	*

* Ongoing projects

Experimental

The main aim of this research is to develop a novel cost-effective and efficient product for degradation of indoor air pollution. The idea is to use a modified TiO_2, semiconductor catalyst

responsive to visible light irradiance, solution as a final coating applied to a wall covering.

The application methods and characteristics of the TiO_2 coating, such as thickness, surface morphology, will be studied by scanning electron microscopy (SEM) and the effect of TiO_2 dosage on those characteristics will be examined.

The influence of TiO_2 on acrylic coating, which is the top layer of the selected wall covering, will be observed and the durability of this novel wall covering will be tested and optimized.

This product will be tested initially on degradation of inorganic pollutant, using nitric oxide (NO) as a model pollutant with an indoor concentration level. Later on, degradation of organic indoor air pollutant, e.g. toluene, by photocatalytic oxidation (PCO) into harmless products (CO_2 and H_2O) will be investigated.

For the project purpose, an experimental setup was built. This experimental setup scheme is shown in Figure 1.

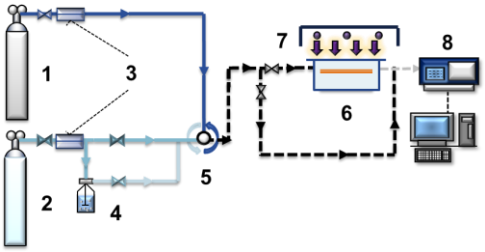

Figure 1 Experimental setup scheme: 1. Pollutant source; 2. Air source; 3. Mass controller meter; 4. Humidifier; 5. Temperature/Relative humidity sensor; 6. Reactor cell; 7. Visible light source; 8. Analyzer

To simulate the indoor air conditions, a batch reactor will also be developed in the present study. And both reactors will be employed to study the photocatalytic removal efficiency of both inorganic and organic pollutants.

Modeling

The essential part of this research will be degradation modeling of the air pollutants in the developed batch reactor. For this purpose the Computational Fluid Dynamics (CFD) software will be used. A CFD model was developed applying a proposed kinetic reaction rate model of NO degradation, proved that this method is effective and can be used for the prediction of NO degradation by photocatalysis [5, 6], as shown in Figure 2.

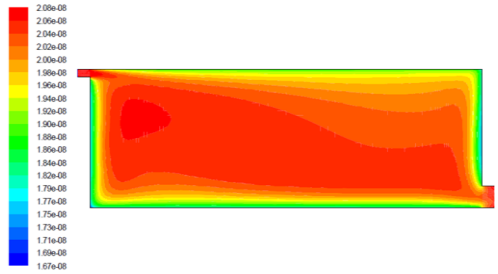

Figure 2 CFD model of NO degradation in a room containing photocatalytic wall covering

Summary

A review of EU projects related to the indoor air quality was performed. Further research is still necessary on the topic of IAQ and health. More research is also needed to determine the effects and costs of preventive and remedial measures.

The present research, dealing with the development of a photocatalytic active novel wall covering containing modified titanium dioxide coating, was introduced.

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