Photocatalytic Reactor for Improved Water and Air Purification using UV Light

Patent Title: Light Transmitting Tubular Honeycomb Photocatalytic Reactor
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This invention describes a reactor that uses an immobilized photocatalyst in a light-transmitting tubular honeycomb structure for purifying contaminated water and air.

Market Opportunity

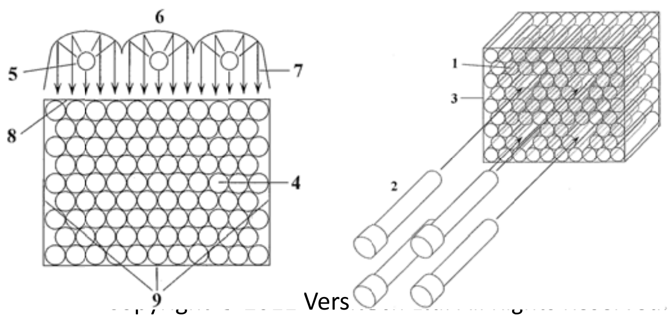
According to Market Research [1], about 900 million people worldwide lack access to clean water. Annually, over 3.3 million people die from water related diseases. Water purifying treatments have seen steady growth over the past decade, despite the global recession that began in 2008, because the market for products that can purify water continues to grow as the world's population continues to grow. Environmental Leader [2] reports that the U.S. corporate water treatment market is expected to increase from US$ 1.5 billion to US$ 2.5 billion from 2010 to 2015, representing a Compound Annual Growth Rate (CAGR) of 11.2%.

However, water treatment technologies need to improve. In 2010, Frost and Sullivan [3] stated in a technology alert that traditional water treatment methods are not effective enough to eliminate a wide range of pollutants. Moreover, they need a huge amount of energy to treat wastewater. Most of this energy demand is obtained by burning fossil fuels, thereby resulting in greenhouse gas emissions which are not sustainable. The technology presented here can use solar UV radiation for the purification process and thus provides a cleaner option.

The HKU Invention

The photocatalytic reactor described in this invention is capable of performing effective solar-assisted or artificial-UV-assisted photocatalytic purification of water and air. The purification mechanisms include both decomposition of toxic organic compounds and destruction of pathogenic microorganisms by free hydroxyl radicals. A known technique of water purification is to add TiO_2 powder to a tank of contaminated water. The slurry is then circulated through a UV-transparent photoreactor to induce the cleaning mechanisms. The TiO_2 powder can be recovered after sedimentation. The current invention offers an advantage in this process. Rather than recovering the used powder, it immobilizes the TiO_2 photocatalyst onto the inner surfaces of a photoreactor to form a coating. Therefore, there is no need to perform sedimentation and recovery. The invention also enables the purification of air in the same design since it is difficult to recover powder from an air stream.

The efficiency of the design has been improved using computational fluid dynamics (CFD) which show that tubular cells in a honeycomb structure yield more physical contact between airborne microbes and the immobilized photocatalyst than hexagonal, rectangular and triangular cells. One example of such a device is investigated in [4] and shows an efficiency of more than 90% in gaseous nitric oxide (NO) degradation in one single pass.



As an alternative to solar radiation, artificial UV light sources can also be used. Figure 1 shows the implementation of an external source and figure 2 shows a way to introduce an internal source by replacing some of the tubular cells with UV lamps. In addition, the process can be further enhanced by negatively charging the photoreactor. This will cause the polarization of airborne microbes which will then attach onto the cell walls. These microbes will be progressively oxidized until their complete destruction.

About the Lead Inventor

One of the lead inventors of this invention is Prof Dennis Y C Leung, who received both his BSc and PhD degrees from the University of Hong Kong and is now a Professor with HKU's Department of Mechanical Engineering. He has published more than 300 articles on his research which covers energy conversion and conservation, renewable energy, fuels, air and noise pollution control, wind engineering, air dispersion modeling, indoor air pollution, vehicular emission control and combustion engineering.

References

[1] http://www.marketresearch.com/browse.asp?categoryid=979

[2] http://www.environmentalleader.com

[3] http://www.frost.com

[4] M.K.H. Leung, C.W. Yiu, "*Design Optimization of Photocatalytic Glass Tubular Honeycomb Reactor for Air Purification*", Proceedings of ISES World Congress 2007 (Vol. I - Vol. V) 2009, 2, pp 441-445

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