



## Automobile adsorption air-conditioning system using oil palm biomass-based activated carbon: A review

Mohammad Omar Abdullah<sup>a,\*</sup>, Ivy Ai Wei Tan<sup>a</sup>, Leo Sing Lim<sup>b</sup>

<sup>a</sup> Department of Chemical Engineering and Energy Sustainability, Faculty of Engineering, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Malaysia

<sup>b</sup> Energy Research Group Laboratory, Faculty of Engineering, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Malaysia

### ARTICLE INFO

#### Article history:

Received 27 October 2010

Accepted 24 January 2011

#### Keywords:

Adsorption

Air-conditioning

Automobile

Exhaust gas

Coefficient of performance (COP)

### ABSTRACT

Refrigeration and air-conditioning technology are required to evolve in accordance to Montreal Protocol adopted in 1987 and Kyoto Protocol in 1997. This regulation concerns about the climate change in an attempt to phase-out chlorofluorocarbons (CFCs), followed by hydro-chlorofluorocarbons (HCFCs) and then moving to 1,1,1,2-tetrafluoroethane (HFC-134a) starting 2011. This trend leads to a strong demand of new systems for air-conditioning, especially in automobile. Adsorption cooling system, among other proposed cooling technologies, has a very good potential for automobile applications. Hence, there exists a need for a creative design and innovation to allow adsorption technology to be practical for air-conditioning in automobile in a near future. Oil palm shell-based activated carbon has been widely applied in various environmental pollution control technologies, mainly due to its high adsorption performance yet low cost. However, limited studies have been carried out on the characteristics and application of oil palm shell-based activated carbon in adsorption air-conditioning system. This paper is to present a comprehensive review on the past efforts in the field of adsorption air-conditioning systems for automobile. This work also aims to investigate the physicochemical properties of oil palm shell-based activated carbon and its feasibility for application in adsorption air-conditioning system. Some of the limitations are outlined and suggestions for future improvements are pointed out.

© 2011 Elsevier Ltd. All rights reserved.

### Contents

1. Introduction.....	2062
2. Activated carbon.....	2062
2.1. Properties and structures of activated carbon.....	2063
2.2. Types of activated carbon.....	2063
2.3. Oil palm shell-derived activated carbon.....	2063
2.4. Preparation and characterization of activated carbon.....	2063
2.4.1. Surface area and pore characteristics.....	2064
2.4.2. Particle size distribution.....	2064
2.4.3. Surface morphology.....	2064
2.4.4. Proximate analysis.....	2064
2.4.5. Surface chemistry.....	2064
2.5. Classification of adsorption.....	2065
2.6. Adsorption isotherms.....	2065
2.7. Adsorption kinetics.....	2065
2.8. Adsorption thermodynamics.....	2065
3. Adsorption versus vapour compression systems in automobile.....	2065
4. Theoretical consideration of adsorption air-conditioning.....	2066
4.1. Adsorption cycle.....	2066
4.1.1. Basic of adsorption.....	2066

\* Corresponding author. Tel.: +60 82 583280.

E-mail addresses: [amomar@feng.unimas.my](mailto:amomar@feng.unimas.my), [amomar13@gmail.com](mailto:amomar13@gmail.com) (M.O. Abdullah).