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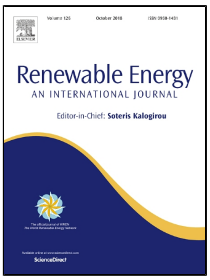

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OBSERVATION AND MODELING OF DUST DEPOSITION ON GLASS TUBE OF EVACUATED SOLAR THERMAL COLLECTORS IN MONGOLIA

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Abstract: The present study investigated the effects of dust deposition on transmittance of glass tubes of a solar thermal collector in Ulaanbaatar during the cold period and presents the results based on real exposure tests conducted between October 2015 and May 2016. In addition, the dust deposition on glass tubes was empirically modeled using the test results and the environmental data such as wind speed and direction, daily average airborne dust rate, snow, and rain. Based on observation of long- and short-term tests, snow was deduced to be able to clean dust accumulation on the glass tubes even if the ambient temperature is below zero. Also, the snow was found to be more effective in decreasing dust accumulation than rain according to the estimation.

Keywords: Dust deposition, dry and cold region, transmittance, dust model, solar-evacuated glass tube

1 INTRODUCTION

The cold climate and poor infrastructure in cities in Central and East Asia lead to air pollution from coal firing by detached houses, which is one of the major issues during the winter season. Since the detached houses that have been spread out throughout the vast area cannot connect to the heating network of districts, raw coal remains the dominant heating source for householders as it is cost-effective.

Solar thermal devices are suitable for domestic applications. Although solar thermal collectors are well applied in warm and coastal regioins, the application in cold regions is relatively low due to some challenges and lack of sufficient studies. One of the challenging issues is a prediction of the energy production during the winter season. The snow piles up behind and under evacuated tube solar collectors such that the reflected solar irradiance from the piled snow hits the collectors from the back side as an additional energy source. However, direct and diffused radiations might not be able to fully penetrate up to the inside of the glass tubes because of dust deposition from air pollution [1].

Ulaanbaatar Mongolia is one of the five cities with worst air quality and the coldest capital city in the world. In order to decrease air pollution, the Mongolian government has been implementing some measures of promoting and encouraging the use of eco-friendly technology, and established several monitoring stations for measuring air pollution with the assistance of international organizations such as The World Bank, Asian Development Bank, and Japan International Corporation Agency, since 2001. These stations continuously measure and report the data on air pollution and weather during the cold season [2-6]. The air pollution of the city is composed of smoke from thousands of coal stoves, waste, smoke from factories and plants, and fuel combustion of vehicles. The city is divided into two sectors: city center and Ger areas. The pollution of small particulate matter (PM) emitted by coal stoves accounts for >50% during the cold period in the city center, while it accounts for the vast majority of the Ger area as the factories and basic lines of traffic are distant from the Ger districts [2-3].

In recent years, the installation of evacuated tube collectors ETC is increasing in Ger districts in Ulaanbaatar Mongolia; a few of them have been investigated since 2013 [1]. Owing to abundant dust