UNIVERSITI TEKNOLOGI MARA

MODELLING AND SIMULATION OF AIR TURBULENT IN A ROTARY KILN INCINERATOR USING REYNOLDS STRESS AND k-ε MODEL

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ABSTRACT

Rotary kiln incinerator (RKI) is widely used in the treatment of hazardous wastes. However, the use of RKI in municipal solid waste (MSW) treatment is a new approach especially to use it for treatment of Malaysian MSW which typically contains more than 60% moisture and the waste is highly organic. Nevertheless, a research team at the Universiti Teknologi MARA (UiTM) has performed investigations on the potential use of a locally designed rotary kiln incinerator for MSW treatment.

A pilot plant rotary kiln incinerator of capacity 25 ton/day was installed in UiTM Shah Alam campus. The rotary kiln incinerator which is the heart of the MSW treatment process is a 7.62 m long, with internal diameter of 1.524 m horizontal rotating cylinder and designed to operate in a countercurrent flow between air and waste to gain better combustion.

The efficiency of combustion is directly related to the temperature, residence time of the combustion and the air turbulence inside the RKI. With the aid of computational fluid dynamics (CFD), this study presents the effort performed in modeling work on the air turbulence using unique design of the RKI. The prediction of air flow inside the incinerator based on k-ε turbulence and Reynolds stress models are used since it is widely applied in industries and education sectors. The comparison with real time observation, the result are agreeable. The air distribution in the chamber while combustion is in progress will also be discussed.

Keyword: Rotary kiln incinerator (RKI), Modeling and Simulation, Air Turbulence.

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INTRODUCTION

1.0 Problem of Municipal Solid Waste in Malaysia

In many less-developed countries, uncontrolled dumping is used for the disposal of solid wastes. These dumps are frequently allowed to burn - either deliberately, as a means of volume reduction, or accidentally. The emissions from this type of solid burning can be noxious and harmful. Typical materials found in the Malaysian waste which contribute to these harmful emissions include plastics, papers, domestic chemicals, pharmaceuticals and many industrial wastes.

Approximately 98% of the total MSW in Malaysia are disposed to landfills (Fauziah et. al, 2004). Rapid development and industrialization cause the current disposal method of land filling as an ineffective method. Landfill needs to be improved by increasing its life span and at the same time minimizing the problem of land scarcity. MSW generation also depends on the size of the population.

On average Malaysian citizen produces 0.5 – 0.8 kg of MSW/person/day and has increased to 1.7 kg of MSW/person/day in major cities (Sivapalan et. al, 2003). Main composition of Malaysian MSW consists of plastic, paper and also food waste. These components are up to 80% of the total waste by weight. The waste generally consists of high moisture content of 55% and has a calorific value between 1500 to 2600 kcal/kg. For an incinerator plant with an operating capacity of 1500 ton of MSW/day, it is expected that the potential energy output to be at 640 kW/day (Sivapalan et. al, 2003).

A more recent study observed that the as-received calorific value of MSW for Kelang Valley was 1514 kcal/kg using ASTM E791-90 (Sulaiman et. al, 2005). The average