Air Distributor Designs for Fluidized Bed Combustors: A Review

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***Abstract*—Fluidized bed combustion (FBC) has been recognized as one of the suitable technologies for converting a wide variety of biomass fuels into energy. One of the key factors affecting the successful operation of fluidized bed combustion is its distributor plate design. Therefore, the main purpose of this article is to provide a critical overview of the published studies that are relevant to the characteristics of different fluidized bed air distributor designs. The review of available works display that the type of distributor design significantly affects the operation of the fluidized bed i.e., performance characteristics, fluidization quality, air flow dynamics, solid pattern and mixing caused by the direction of air flow through the distributors. Overall it is observed that high pressure drop across the distributor is one of the major draw backs of the current distributor designs. However, fluidization was stable in a fluidized bed operated at a low perforation ratio distributor due to the pressure drop across the distributor, adequate to provide uniform gas distribution. The swirling motion produced by the inclined injection of gas promotes lateral dispersion and significantly improves fluidization quality. Lastly, the research gaps are highlighted for future improvement consideration on the development of efficient distributor designs.**

Keywords-Fluidized bed combustor; air distributor design; swirling distributor; perforated distributor

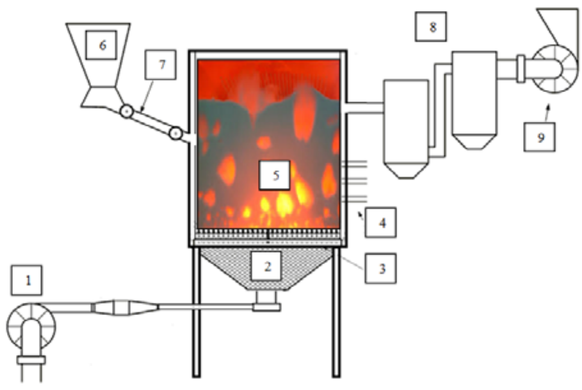
I. Introduction

Fluidized bed combustion has been recognized as a suitable technology for converting a wide variety of fuels into energy. One of the key features offered by fluidized bed combustion is the reduced emission of SO_2 and NO_x. The noxious combustion products released from the combustion of hydrocarbon fuels are captured by the calcined limestone for easy handling and disposal. Unlike many others energy conversion technologies such as gasification and pyrolysis, the combustion efficiency in a fluidized bed can reach up to 99% resulted from constant temperature distribution and adequate amount of oxygen supplied [1].

Depending on the distributors design in a fluidized bed, different types of particles with different sizes and shapes can be used. For instance, the fluidized bed combustor (Figure 1), which consists of the following: combustion chamber, distributor plate, bed pre-heater, gas outlet, and fuel feeding system, uses inert particles, usually alumina and river sands, as its bed materials. The inert materials are preheated to the operating temperature by the pre-heater, and this causes the particles bed to absorb and store high amounts of heat. Fluidizing air is passed through the distributor plate, and when the air velocity reaches a particular point on which the gravity, the weight of the particle and the overall weight of the bed are balanced, the bed is suspended and exhibits a fluid-like property. Then, the bed is said to be fluidized and the velocity at this particular point is the minimum fluidization velocity.

One of the key parameters that affect the successful operation of fluidized beds is the type of the distributor plate. It is known that the efficient and stable operation of a fluidized bed is sensitively controlled by the design of the distributor [2, 3]. The hydrodynamics of flow in the dense phase, quality of gas dispersion, bubble size and its behaviour, gas-solids contacting, gas hold-up, residence time distribution of gas, solid movement and mixing pattern are some of the aspects that are affected by the distributor design [4, 5].

The objective of this paper is to give an overview on past and present works related to the characteristics of different distributor designs in fluidized beds.



Legend

1	Blower	4	Pressure tapping	7	Screw feeder
2	Air plenum chamber	5	Bed/Combustion chamber	8	Cyclone
3	Distributor	6	Hopper of biomass solid fuel	9	Exhaust

Fig. 1. Schematic of FBC.