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# Submerged rectangular air jets as a particulate barrier

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## ABSTRACT

In several technical applications, it is convenient to carry out physical separation between two neighboring zones with different physical characteristics (such as temperature or contaminant concentration), using a two dimensional gaseous jet, often called air curtain. In this paper, a submerged rectangular air jet, simulating an air curtain, has been investigated in order to infer the capability to reduce the transfer of dusty air between a "clean" zone and a contaminated environment (dusty zone). The investigated jet was generated by means of a rectangular nozzle with a discharge area of 0.02 square meters, while the dust has been simulated using atomized distilled water in a cloud of small droplets, sprayed transversally against the air curtain. Experiments have been performed running the air curtain at *Reynolds Number(Re)* ranging from 4500 to 25,500 while the *Sauter Mean Diameter* (SMD) of atomized water was equal to 6 microns. The water spray has been characterized using a TSI single component fiber optics Phase Döppler Particle Analyzer (PDPA), and the air curtain has been investigated by means of a Particle Image Velocimetry (PIV) technique. The amount, size distribution and velocity of the droplet cloud able to cross the air curtain was measured, obtaining as the main result, the dependence of the amount of droplets passing the barrier as a function of the *Re* of the air curtain. For a *Re* as high as 25,500, the curtain is able to interrupt the amount of surviving droplets, i.e. all the dust is rejected.

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## 1. Introduction

Air curtains are separation devices based on the discharge of a plane air stream to isolate one adjacent air volume with different climatic characteristics from another (in the broad sense of the term). The jet system provides a fluid insulation against heat, moisture and mass transfers between the separated areas without holding up traffic of people, vehicles, materials, objects etc. Thus, air curtains are particularly useful in situations where conventional physical barriers become unacceptable for practical, technical, economical or safety reasons. Applications for air curtains are many. Beside air conditioned areas, they include commercial entrances, refrigerated counters, clean rooms, testing chamber apparatus (e.g. thermal shock test chambers), industrial oven openings, tunnel fire safety systems, process line partitioning in the food or microelectronics industry, etc [1-9].

Most of the time, air-curtains consist of one or several jets blown vertically downwards, but upward applications are also not so unusual. In many cases, the geometrical aspect ratio of the rectangular discharge nozzle is that of an air curtain and it may be considered as two-dimensional plane jet. Furthermore, discharge air velocities commonly encountered in conventional devices are of

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the order of a few meters per second. Thus, in more academic terms, air curtains can be viewed as plane turbulent submerged jets.

Fair number of studies have been performed in order to infer and predict the performances of an air curtain. Several of them are based on computer simulations of the fluid dynamics of the jet (adopted in order to make the air curtain) and the environmental surroundings. In several applications, such as in gates of store workshops and cool warehouses, electronic industries and surgery units, the air curtain is used to keep the air quality high[10, 11 and 12]; for the safety in underground tunnels, and in case of fire in galleries, air curtains could reduce the moving of toxic smoke while preserving full access to emergency exits, that is an obstacle to the mass transfer. Robertson and Shaw [13], indicated that these devices could reduce chemical species, odors, bacteria, dust, insects, moisture or radioactive particle transfer. Grasmuk [14] and Powlesland [15] report that the air curtain's device is also applied to air stopping and flow regulation in mine airways. Guyonnaud et al. [16] and Havet et al. [17] also investigated the effect of external pressure perturbations on the performance of an air curtain adopted in order to separate two environments with different concentrations of gaseous pollutants. Gupta et al. [18] investigated smoke confinement in tunnels studying the air curtain by means of PIV measurement. Maurel e Solliec [19], have analyzed the jet development for various geometrical and cinematic configuration, using Particle Image Velocimetry (PIV) and Laser Döppler Velocimetry (LDV).

