Optimisation using prediction models

air cyclones’ body diameter/ pressure drop

aan Yetilmezsoy of the Yildiz technical university (Turkey) presents a new empirical model to predict the optimum body diameter of air cyclones, and the results of a MATLAB algorithm to control pressure drop problems for various operating conditions.

Introduction

With growing concern for the environmental effects of particulate pollution, it is becoming increasingly important to be able to optimise the design of pollution control systems; the separation of solid particles is also required in many industrial processes. For this purpose, cyclone separators are widely used as the most common devices.

Conventionally, cyclone separators have been used as pre-cleaning devices for the removal of particles bigger than 10 µm from the carrier gas in both air pollution control and other processes. Because of their adaptability, simple design and low costs in terms of maintenance, construction and operation, those properties make cyclones ideal for use in the various stages of industrial applications.

Cyclones are also used as bio-aerosol samplers in air quality applications and hospitals in addition to the chemical, metallurgical and petroleum industries. In extreme conditions, a cyclone separator can be used as a spray dryer or a gasification reactor.

There are a number of different designs of cyclone that are in use for different purposes, such as straight-through, uniflow, and reverse-flow cyclones. It is generally known that the most common cyclone design has a tangential inlet and reverse flow. In cyclone separators, a centrifugal force generated by a spinning gas stream is employed for the separation of dispersed particles. A certain number of revolutions is made by the gas as its spirals increase the inlet velocity. For a given design, higher inlet velocities give higher collection efficiencies, but this also increases the pressure drop (DP) across the cyclone.

The design and performance of a cyclone separator are generally characterised by two parameters: the collection efficiency of particles, and the pressure drop through the cyclone. Pressure drop and collection efficiency are the two major criteria used to evaluate cyclone performance. Because of the relationship between these parameters and operating cost, an accurate prediction needs to be made to achieve more benefits in cyclone design. Due to the pressure drop problem across the cyclone, an optimisation between collection efficiency and pressure drop becomes inevitable in air pollution control. Hence, a number of modification steps can improve the collection efficiencies of particles and reduce the pressure drop problem generated in conventional cyclones.

This article presents a new empirical model, and the results of a MATLAB algorithm used to predict the optimum body diameter of air cyclones and to control the pressure drop problem.

Summary

This article presents a new empirical model to predict the optimum body diameter of air cyclones, and the results of a MATLAB algorithm to control the pressure drop problem for various operating conditions. The proposed model was solved computationally by a MATLAB algorithm for 102 different scenarios given by a range of operating conditions – and the results were compared with values obtained from the computational solution of the optimum diameter equation given by Kalen and Zenz. The computational analysis showed that the predicted model agreed with Kalen and Zenz's model, and all the predictions proved to be satisfactory with a maximum – and average deviation – of 2.99% and 0.65% from Kalen and Zenz's model respectively. In addition to the predicted model, the pressure drop problem was controlled using a MATLAB algorithm and the results were obtained rapidly and practically for varying data used in cyclone design.