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Geoinfor Geostat: An Overview 2017, 5:2 (Suppl)
DOI: 10.4172/2327-4581-C1-003

Numerical prediction of collection efficiency for a cyclone separator without barrel part

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Statement of the Problem: Cyclone separators are commonly used as a part of pneumatic transporting systems for the purpose of separating particles transported from air. A new cyclone separator design without barrel part has been studied numerically to predict its collection efficiency. The new cyclone design was modified by introducing the tangential inlet into the cone part directly, while the cone length (l_c) was increased to cover the absence of barrel length (l_d) with the same cone angle (α_c =constant). As a result the contraction ratio (D_x/D), which is defined as the ratio between the vortex finder diameter and the cone diameter, was decreased.

Numerical Procedure: The Reynolds stress model (RSM) and the discrete phase model were used to predict the gas flow field and the dispersed phase inside the cyclone respectively. The model was validated by comparing the numerical results with published experimental data.

Findings: Results show that the collection efficiency of the new design is significantly increased as a result of increasing the tangential velocity due to decreasing of contraction ratio, but also the pressure drop increases. The calculated data was used to derive a new correlation for Stk_{50} in terms of Re and dimensionless geometrical parameter D_x/D to help predicting the cut-off size, d_{50}. Also, a cyclone performance map was performed through dimensionless quantities relationship (Eu Vs. Stk_{50}) for cyclones without barrel part for different values of D_x/D.

Conclusion: The collection efficiency has been enhanced by introducing a new cyclone separator design without barrel part. This could help protect the surrounding environment from small particles that came out with air transporting systems but also the energy consumption increases due to increasing pressure drop.

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