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基于Mixture模型的叶片式抛送装置内气固两相流模拟

Simulation of solid-gas two-phase flow in an impeller blower based on Mixture model

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中文摘要:

为了揭示叶片式抛送装置抛送物料时内部气流和物料复杂的流动特性以优化设计和指导运用，应用计算流体力学软件Fluent中的Mixture多相流模型、标准k-ε湍流模 IMPLEC算法，对抛送装置内气固两相流动进行了数值模拟，并将计算结果与抛送装置内物料运动的高速摄像试验结果进行了比较，物料速度的模拟值和高速摄像实测 本吻合。在分析了物料运动规律基础上，对其叶片数、进料速度以及物料体积浓度的不同变化作了对比模拟。研究结果表明：数值模型可预测叶片式抛送装置的输送性 以及最佳喂入量；4叶片较3和5叶片更有利于抛送；进料速度对物料在叶轮区的体积分布规律影响较大，在最佳喂入量范围内，进料速度越大，出口处物料浓度越大， 速度也越大，装置输送性能越好；超过此范围时，随进料速度增大，进料口处物料浓度增大而出口处物料浓度减小，装置极易堵塞；进料口物料体积浓度的变化只影响 送叶轮内以及圆形外壳出口区域的物料体积浓度，而对其物料速度分布规律及速度大小影响不大。该研究可为叶片式抛送装置工作参数优化提供参考。

英文摘要:

Abstract: When an impeller blower is in operation, the materials in it are conveyed mainly by means of the paddle throwing and the airflow generated by a high-speed rotating impeller blowing. In order to reveal the influence of airflow in impeller blowers on material conveying, numerical models of the air flow in the impeller blowers using the computatio fluid dynamics software Fluent were developed by some scholars at home and abroad. Basic characteristics of the airflow field were obtained, which would be useful for predictin motion of the materials. However, the studies above mentioned aimed at airflow field only, without considering materials in it, so their conclusions were not accurate.To further st the solid-gas two-phase flow mechanism in an impeller blower, a three-dimensional simulation was performed for the solid-gas two-phase turbulent flow in the impeller blower by u FLUENT software with a mixture model and a standard k-ε turbulence model. In the numerical calculation, the finite volume method was used to discretize the governing equations SIMPLEC algorithm was applied for the solution of the discretized governing equations. For the calculated zones composed of rotating impeller and static housing, Moving Refer Frames (MRF) was used to simulate the two-phase flows in complex geometries. Comparisons between the simulated values and the measured values of materials velocity at the discharge vertical pipe by high-speed video in reference paper [4] were made, and the reliability of the numerical simulation was verified. Meanwhile, on the basis of the analysis c law of materials flow, contrast simulations on variations in working parameters such as paddle numbers, impeller's rotational speed, material-fed speed, and volume fraction of soli phase were carried out. It was concluded that: 1) The mixture model was successfully applied to simulate the turbulent particle-gas two-phase flows in an impeller blower, and pred the conveying property of the impeller blower. 2) Impellers with 4 paddles were more favorable for throwing/blowing materials than 3 and 5 paddles, because the materials velocity distribution of the middle plane (Z=0) of the impeller and the discharge pipe with 4-paddle was more even than that of 3-paddle and 5-paddle ones, and fewer vortex flows were generated. Besides, the axial symmetry of 4- paddle impeller blower was better than that of 3-paddle and 5-paddle ones, with a fine balance at a high speed, especially. 3) Distributi of materials velocity in the impeller blower did not change much with the impeller's rotational speed increasing, but the velocity of throwing/blowing materials changed much with and the higher the rotational speed was, the higher the velocity of throwing/blowing materials was. 4) An impeller's rotational speed and volume fraction of solid phase at the inlet being equal, feeding velocity determines the quantity of material fed into the impeller blower, and affects the distribution of volume fraction of solid phase at the impeller zone; In limiting feed quantity range, higher feeding velocity means a larger volume fraction of solid phase and a higher velocity of throwing/blowing materials at the outlet, and was more favorable for conveying materials. 5) The change of the volume fraction of solid phase at inlet has less influence on the distribution of materials velocity; it only affects the volum fraction of solid phase at the entire zone, and the volume fraction of solid phase at the entire zone increases with the increase of material volume fraction at the inlet.