一种新的变径式秸秆粉碎机抑尘特性研究

张 俊,干蜀毅,马培勇

(合肥工业大学机械工程学院,安徽 合肥 230009)

摘 要:秸秆粉碎机是实现生物质能源优质开发利用的基础设备,其抑尘结构的设计优化则是实现粉碎机安全环保运行的关键。本研究设计了一种变径式粉碎机,通过转子刀片高速旋转与变径结构产生低真空区域,在粉碎机进料口产生向内压差,增加粉碎机内颗粒逃逸阻力,实现抑尘作用。首先,采用理论分析得到了变径式粉碎机内颗粒逃逸阻力压差值;其次,采用 MRF 方法和 DPM 模型对粉碎机内气固两相流进行 CFD 模拟,结果表明变径式粉碎机可降低进料口逃逸粒子数约 30%,抑尘效果显著;而后,本研究对变径式粉碎机的工作转速在(500~6000)r/min、颗粒尺寸在(1~5000)μm、变径比在 1~1.2 范围内参数进行优化分析,获得抑尘率可达 57%的变径式粉碎机结构及工作参数,为秸秆粉碎机抑尘结构设计及安全环保运行提供理论基础。

关 键 词:秸秆粉碎机;变径式;气固两相流;抑尘特性

中图分类号:TK6 **文献标识码**:A **文章编号**:1002-0322(2019)05-0040-07

doi:10.13385/j.cnki.vacuum.2019.05.08

Study on the Dust Suppression Performance of a New Straw Pulverizer with Variable-Diameter

ZHANG Jun, GAN Shu-yi, MA Pei-yong

(*School of Mechanical Engineering, Hefei University of Technology, Hefei 230009, China*)

Abstract: As a basic equipment for the high-quality utilization of biomass energy, the design of dust suppression structure plays a critical role in the safe and environment friendly operation of straw pulverizer. In this study, a new type of pulverizer with variable diameter was designed. In this pulverizer, the rotating rotor blade and shell with variable diameter help to produce a low pressure zone, resulting in an inward pressure difference at the inlet. Therefore, the escape resistance of the particles is increased and the dust is suppressed. Firstly, the pressure difference of the particle escape from diameter-variable pulverizer was obtained by theoretical analysis. Secondly, the MRF (moving reference frame) method and the DPM (discrete phase model) were used to simulate the gas-solid two-phase flow in the pulverizer. The results show that the number of the particles escaping from inlet in diameter-variable pulverizer is reduced about 30% compared with that of the previous pulverizer, which means the dust suppression effect is remarkable. Then, the working parameters of pulverizer with variable diameter were further optimized and analyzed within a rotating speed range of (500~6000)r/min, particle size of (1~5000)μm, and the variable diameter ratio of 1~1.2. Finally, the optimized pulverizer with dust suppression performance of 57% improved is obtained. This work provides a theoretical basis for the structure design as well as safe and environment friendly operation of straw pulverizer.

Key words: straw pulverizer; variable-diameter structure; gas-solid two-phase flow; dust suppression

生物质能源开发利用是缓解环保压力,优化能源结构的重要组成部分,我国作为农业大国提供了丰富的秸秆资源,对其进行粉碎加工处理则是实现优质开发利用的必要前提。因此,秸秆粉碎机的结构设计和深入研究对实现生物质能源高效开发利用,保障与促进我国环保事业发展具有重要意义。

为实现粉碎机的高效设计与优化,国内外学者提出了三种破碎理论:1.面积学说:粉碎物料所消耗的能量与物料新生表面积成正比;2.体积学说:粉碎所消耗能量与颗粒体积成正比;3.裂缝假说:破碎所需的功与裂缝长度成正比,而裂

收稿日期:2018-12-20

作者简介:张俊(1989-),男,河南省义马市人,博士,讲师。 **通讯作者**:马培勇,副教授;干蜀毅、教授。

基金项目:安徽省科技重大专项资金资助(JZ2017AKKZ1176)与中央高校基本科研业务费专项资金资助(JZ2017HGBZ0946)