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粮食热风干燥热能结构与解析法

Thermal energy structure of grain hot air drying and analytical method

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中文摘要:

为了揭示粮食干燥系统客观作用效果，定量评价环境条件、粮食状态对干燥机效能的影响，分析了粮食热风干燥势场的来源与特征，建立了干燥特性函数、给出了粮食和介质状态参数解析图，分析了热量及效率，定量评价了热能结构，结果发现利用温度和相对湿度变化范围分别为26～35℃和40%～55%的自然空气直接干燥初期湿基含水率38.6%的高湿稻谷，平均小时降水率达1.2%，在5HP-3.5型循环干燥机上的热风干燥试验结果显示，稻谷的干基含水率由27.06%降至16.96%的过程中，单位气耗量由最初的113.0kg/kg 增加到了546.4 kg/kg，单位热耗量由最初的2548.9 kJ/kg增加到了16352.7kJ/kg，排气热损失由最初的6.2% 增加到了30.6 %。解析出了造成干燥效率偏低的主要原因是热能匹配性较差。指出了评价粮食干燥工艺及干燥机能量利用效果不能忽视客观干燥的作用。研究结果为指导干燥设计，形成粮食干燥系统公平的评价标准，提供了科学的解析方法。

英文摘要:

Abstract: The impact to grain drying involves a number of factors, such as environmental factors, grain physical properties, and flow characteristics, as well as the processing technology and equipment geometry. The change of environmental conditions and physical property characteristics, and differences in processing technology, which makes the system energy loss, was a major difference in the quantity and quality. To essentially illustrate these differences, to improve the comparability of dryer performance test results, and to form objective and fair evaluation standards, the researchers investigated state parameters of grain drying systems and energy transfer by taking moisture migration as a certain amount of energy transfer. Based on the exergy analysis and thermodynamics, the thermal structure of grain drying and its transformation and transfer were analyzed. Using the induced air, the experiment was studied under the conditions of temperature was 26 to 35 ℃, relative humidity was 40% to 55% of ambient air, and the initial temperature and dry basis moisture content of paddy was 36℃ and 38.6%, respectively. The results showed that the paddy temperature reduced 11℃ and the average drying rate was 1.2%/h in drying 2 hours. The paddy temperature picked up to 29℃ when the dry basis moisture content of paddy reduced to 17%. Another experiment was investigated on a 3100kg circulating paddy dryer with hot air, which the air volume was 9556.645 kg/h and the ratio of drying and tempering is 1:3.2. The results showed that the unit gas consumption increased 3.8 times from 113.0 kg/kg to 546.4 kg/kg, the unit heat consumption increased 5.4 times from 2548.9 kJ/kg to 16352.7 kJ/kg, and the exhaust gas heat loss of drying chamber increased 3.9 times from 6.2% to 30.6%, when the dry basis moisture content of paddy decreased from 27.06% to 16.96%. The main reason that the average exhaust gas heat loss was higher, the average heat rate and exergy efficiency of drying chamber was lower, was the poor performance of the energy matching in drying process. The change of energy efficiency in dryer chamber was from -3.9% to 59.9%, which indicated that the energy consumption of grain drying not only had subjective exergy, but also contained objective exergy. This paper pointed out that the evaluation of drying process and dryer energy utilization efficiency could not just stay on the subjective thermal efficiency, and must consider the effect of objective energy. The result provided the reference for reasonably evaluating energy matching of drying system and dryer energy utilization efficiency, and forming a fair evaluation standard.

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