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生物质制粒机环模的磨损机理分析

Wear mechanism analysis of ring die of pellet mill

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中文摘要:

环模是制粒机的核心部件，目前存在磨损快、寿命短等问题。该文对X46Cr13钢环模进行600 h实际生产状态下的磨损试验；对环模内壁和模孔内壁的磨损量与表面硬度进行测量；对磨损面进行表观形貌和微观磨损形貌观察；从宏观和微观角度对磨损机理进行分析，旨在通过研究环模磨损机理与磨损分布规律，对环模改进提出建议。结果表明：不同磨损位置起主导作用的磨损机制有所不同；环模内壁磨损十分严重，磨损机理为以微切削作用为主的磨粒磨损和疲劳磨损交互作用；模孔内壁磨损量较小，模孔入口附近以磨粒磨损为主，出口附近则以疲劳磨损为主，从模孔入口到出口磨损量呈指数形式逐渐减小，磨损由磨粒磨损为主逐渐向疲劳磨损为主过渡。研究结果可为改善环模耐磨性能和延长使用寿命提供参考。

英文摘要:

Abstract: A Rotating ring die pellet mill has been widely used in the feed, renewable biomass, and pharmaceutical industries, for its strengths such as high production efficiency, low transportation cost, and low energy consumption. A ring die is the core part of a pellet mill. At present, the granulating technology was seriously restricted due to the quick abrasion and short service life of the ring die. The purpose of this study was to provide a basis for improving the wear resistance and extending the working life of a ring die by wear mechanism analysis. In this paper, the working process of a pellet mill was studied, the distribution and change rule of the force state of a ring die were analyzed. A wear experiment of a ring die that was manufactured by a steel X46Cr13 with a quenching and tempering treatment was carried out under the practical production condition for 600 hours, the hardening depth was 3 mm, and the surface morphology was observed first. The abrasion depth of the ring die wall and the hole wall was measured by using a LK-G10 laser displacement sensor, the hardness of the wearing surface was measured with a HR-1500DT electric Rockwell apparatus, and the microscopic wear morphology of the wearing surface was observed by a JSM-6300 scanning electron microscope (SEM). The distribution of the abrasion and the wear mechanism of the wearing surface were studied from both macroscopic and microscopic aspects. The research results showed that the wear mechanisms of a ring die include polishing wear, abrasive wear, and fatigue wear, and different wear mechanisms play a leading role in different wear positions. The ring die wall was seriously abraded, the wear depth was around 3 mm and up to 3.4 mm was closed to the feeding side. With the depletion of the hardened layer, the hardness of the ring die wall descends slightly. The wear mechanisms of a ring die wall are fatigue wear and abrasive wear that is featured mainly as micro cutting. The material loss of a ring die wall would be rapid under the combination of micro cutting and fatigue wear, and that would result in the decrease of fatigue strength and the premature failure of ring die. The hole wall was abraded slightly, the wear depth of hole wall which closed the entrance was relatively large and the wear mechanism was mainly abrasion wear. The wear depth of the hole wall which closed the outlet was relatively small and the wear mechanism was mainly fatigue wear. The wear depth of a hole wall decreases according to the exponential law from entrance to outlet of the die hole. The wear mechanism of a hole wall changes from mostly abrasive wear nearing the entrance to the prominently fatigue wear nearing the outlet. Finally, some improving advices have been proposed to extend the service life based on the analysis above.

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