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微型流化床反应动力学分析仪的研制与应用

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摘要 本文首次研发了一种用于测定气固反应速度、求算反应动力学参数的微型流化床反应分析仪器（MFBK）。该仪器利用流化床强化反应过程的热量与质量传递过程，通过气体脉冲输送在给定温度下瞬时进样，根据在线监测的气体组分浓度变化，测试反应速度、推导反应动力学参数和分析反应机理。利用该仪器测定氩气气氛中碳酸钙的分解反应表明：其表观活化能与指前因子分别为142.73kJ.mol^{-1}和399777s^{-1}，活化能在文献报道范围之内，且小于热重分析仪测定的184.3kJ.mol^{-1}，并建立了反应模式函数f(α)=(1-α)0.86，对应的拟合线性相关系数达到0.99。测定煤和生物质热解反应过程表明：MFBK测试的反应完成时间在15s左右，且揭示了生成气关键组分具有不同的释放时间和生成量，为深入探讨热解反应机理提供了新的证据。

关键词

微型流化床 反应动力学 热分解 气固反应

分类号

Development and application of micro kinetic analyzer for fluidized bed gas- solid reactions

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Abstract

A novel micro kinetic analyzer (MFBK) for fluidized bed gas-solid reactions is developed With this MFBK analyzer, the reaction rate and kinetic parameters can be deduced *via* measuring the time dependent composition changes of its evolved gas.By using a micro fluidized bed reactor, it is expected to enable the on-line feed of particle reactant based on a pulse solid conveying mechanics and the effective suppression of external gas diffusion in the reactor.This MFBK analyzer is evaluated through the decomposition of $CaCO_3$ powder, giving an apparent activation energy of 142.73 kJ.mol^{-1} and a preexponential factor of 399777 s^{-1} .This activation energy value is much lower then the TG-measured one of 184.3 kJ.mol^{-1} and within the literature reported range of 120—280 kJ.mol^{-1}.The measurement also provides a kinetic- model function with a correlation linearity of above 0.99.With this MFBK analyzer, the pyrolysis of coal and biomass at 800℃ is studied.The measured pyrolysis reaction finished in about 15 s, which is very close to the theoretically anticipation.This pyrolysis measurement with the MFBK analyzer can also identify a definite gas release order for typical gas species contained in the pyrolysis formed gas products, which actually can provide a strong evidence for the deep insight in the pyrolysis reaction mechanism.

Key words

micro fluidized bed kinetics pyrolysis gas-solid reaction

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