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加工利用与安全环保

管状容器气体燃爆泄放过程的数值模拟

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摘要：

工业过程中管状容器气体爆炸事故时有发生，严重威胁着过程工业的安全生产。为预防这类事故，通常会在容器上安装泄压装置，这就要求对该类容器进行防爆泄压设计。对管状容器气体爆炸泄放过程进行分析，特别是容器内压力发展特性的分析是进行防爆泄压设计的关键。为此，首先分析了管状容器内气体爆炸泄放过程，根据其燃爆发展规律建立了描述整个泄爆过程的物理模型。从能量守恒方程和质量守恒方程出发，结合气体状态方程、绝热压缩方程和气体泄放速率方程建立了泄爆过程的数学模型，利用四阶龙格—库塔方法对该过程进行了数值模拟，得到了不同时刻燃爆压力、压力上升速率、火焰位置和火焰传播速度。另外还讨论了泄压面积和泄爆压力对泄爆过程的影响，对于该类容器的防爆泄压设计具有指导意义。

关键词： 管类 容器 可燃气体 燃烧 爆炸 泄放 过程 数值模拟

NUMERICAL SIMULATION OF GAS DEFLAGRATION AND DISCHARGE IN CYLINDRICAL VESSEL 1)

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Abstract:

Gas explosion accident of cylindrical vessels happens from time to time in industries, which severely threatens the safe operation of the industries. To prevent such accidents, the pressure relief devices are usually installed on the vessels. So, the anti explosion and pressure relief design has to be conducted for the vessels. It is the key to analyze the process of gas deflagration and discharge in cylindrical vessels, especially the features of pressure development in cylindrical vessels, for the anti explosion and pressure relief design. First, the process of gas deflagration and discharge is analyzed in cylindrical vessels. According to the law of deflagration development, the physical model is set up to describe the whole process. Based on the energy conservation equation and the mass conservation equation, integrating the gas state equation, the isentropic compression equation, and the gas discharging rate equation, the mathematical model is developed for the process. Using the 4 order Runge Kutta method, the numerical simulation is conducted for the process. The deflagration pressure, pressure rising rate, flame position, and flame propagating rate are known at different time. The influence of the pressure relief area and the discharging pressure on the process is discussed, which has guiding significance for the anti explosion and pressure relief design of such vessels. (Financed by the National Project of Natural Science Fund, No. 29936110)

Keywords: Pipes, Vessel, Combustible gas, Combustion, Explosion, Discharge, Process, Numerical simulation

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