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现代应用光学

痕量N_2O气体检测系统的设计与实现

郑守国[1,2,3], 李淼[2], 张健[2,3], 张浩东[1,2], 胡泽林[2]

1. 中国科学院 安徽光学精密机械研究所, 安徽 合肥 230031;
2. 中国科学院 合肥智能机械研究所, 安徽 合肥 230031;
3. 无锡中科智能农业发展有限公司, 江苏 无锡 214105

摘要： 建立了基于光谱吸收技术的检测系统,用于快速、准确地测量N_2O气体浓度。首先,从理论上证明了二次谐波、一次谐波与N_2O气体浓度之间的关系;然后,设计了痕量N_2O气体浓度检测系统,利用光源调制、锁相放大等技术,实现了强杂波背景下气体浓度弱信号的解析;最后,实验测试了系统的检测性能、抗干扰能力及检测结果的可重复性。测试结果表明,系统能够在0~1%有效检测N_2O气体浓度,检测下限为5.0×10^{-5},相对检测误差为0.11%,检测结果线性方程为Y=192.699 09X-0.006 24,线性度为0.998 07。多次检测实验表明,系统相对标准偏差为0.137%,CO_2、O_2、水蒸气等常见气体对检测结果无影响。改变激光器的中心波长,该方法亦可用于CO_2,CH_4等其它温室气体的检测。

关键词： 谐波检测 光谱吸收 N_2O 气体浓度检测 分布反馈激光器

Design and implementation of trace N_2O detection system

ZHENG Shou-guo[1,2,3], LI Miao[2], ZHANG Jian[2,3], ZHANG Hao-dong[1,2], HU Ze-lin[2]

1. Anhui Institute of Optics and Fine Mechanics, Chinese Academy of Sciences, Hefei 230031, China;
2. Institute of Intelligent Machines, Chinese Academy of Sciences, Hefei 230031, China;
3. Wuxi Intelligent Agricultural Development Co., Ltd., Wuxi 214105, China

Abstract: A measurement system based on the spectral absorption was established to measure the N_2O concentration accurately.First, the relationship of the second-harmonic, the first-harmonic with N_2O gas concentration was demonstrated in theory. Then, a N_2O detection system for trace concentration was designed based on a Distribute Feedback Laser(DFB).By using the light modulation and lock-in amplifier technologies, weak gas concentration signals in the strong clutter background were analyzed. Finally, the detection performance, anti-jamming capability and the repeatability of test results were verified through experiments. Test results indicate that the system can offer the measuring range from 0 to 1%, detection limit of 5.0×10^{-5},and the relative detection error of 0.11%. Furthermore,the linear equation is Y=192.699 09X-0.006 24, the linearity is 0.998 07,and the relative standard deviation is 0.137%.It also proves that the CO_2, O_2, water vapor, *et al*. have no effect on the experimental results. By changing the centre wavelength of the laser,the system can be used in the detection of other greenhouse gases, such as CO_2 and CH_4.

Keywords: harmonic detection spectral absorption N_2O gas concentration detection Distributed Feedback(DFB) laser

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通讯作者: 李淼,E-mail:mli@iim.ac.cn

作者简介: 郑守国(1985-),男,安徽庐江人,博士研究生,2008年于合肥工业大学获得学士学位,2010年于哈尔滨工业大学获得硕士学位,主要从事温室气体在线监测技术的研究。E-mail:zhshg1985@163.com
作者Email: mli@iim.ac.cn

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