Safety Science

Volume 50, Issue 4, April 2012, Pages 873 – 877

First International Symposium on Mine Safety Science and Engineering 2011

Special Issue Article: The First International Symposium on Mine Safety Science and Engineering

Feasibility study of decomposing methane with hydroxyl radicals ☆

Jianping Wei, Bensheng Yu, Juan Yang, Jun Dai

State Key Laboratory Cultivation Base for Gas Geology and Gas Control, No. 2001, Century Avenue, Jiaozuo 454003, People's Republic of China

Henan Polytechnic University, No. 2001, Century Avenue, Jiaozuo 454003, People's Republic of China

http://dx.doi.org/10.1016/j.ssci.2011.08.015, How to Cite or Link Using DOI

Abstract

Coal-mine gas disaster is one of the most serious coal-mine disasters in China. The main component of coal-mine gas, methane is chemically stable and very difficult to be degraded by conventional methods. Hydroxyl radical (•OH), due to strong oxidizing ability and high electro-negativity, is the primary degradation source of atmospheric methane. In the present study, methane degradation using hydroxyl radicals generated by Fenton's reagent, Fe^{2+}/H_2O_2, has been carried out in the self-designed bubbling reactor. The effects of H_2O_2 concentration, dosage of $FeSO_4 \cdot 7H_2O$ and initial pH value on methane removal efficiency were investigated respectively. It has been found that the optimal reaction conditions were 100 mM of hydrogen peroxide, 2.00 mM of ferrous ion and initial pH value of 2.5. Under optimal conditions, the removal efficiency of methane reached 25% after 30 min. The preliminary experimental results unambiguously demonstrate that the degradation of methane using hydroxyl radicals generated by Fenton's reagent is feasible.

Highlights

► In coal-mine gas, methane is stable and difficult to be degraded by common methods. ► Methane degradation using hydroxyl radicals was conducted in the bubbling reactor. ► The primary factors, which would influence the methane removal, were investigated. ► The removal efficiency of methane reached 25% under the optimal conditions. ► The results show methane degradation *via* hydroxyl radical oxidation is feasible.

Keywords

Methane; Hydroxyl radical; Degradation; Fenton's reagent

Figures and tables from this article:

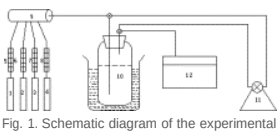

Fig. 1. Schematic diagram of the experimental setup. 1 – Methane cylinder; 2 – O_2 cylinder; 3 – N_2 cylinder; 4 – CO_2 cylinder; 5, 6, 7, 8 – rotameter; 9 – gas mixer; 10 – bubbling reactor; 11 – vacuum pump; 12 – GC.

Figure options

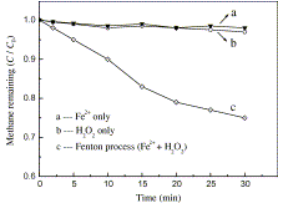

Fig. 2. Methane removal efficiency by various methods. Experimental conditions: 1.50 mM Fe^{2+}, 100 mM H_2O_2, pH 2.5, T = 25 ° C.

Figure options

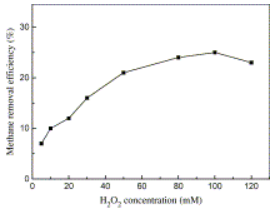

Fig. 3. Effects of H_2O_2 concentration on methane removal efficiency by hydroxyl radical oxidation *via* Fenton reagent. Experimental conditions: 2.00 mM Fe^{2+}, pH 2.5, T = 25 ° C.

Figure options

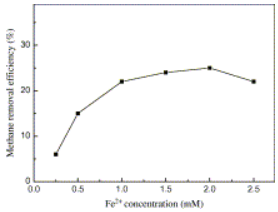

Fig. 4. Effects of ferrous ion concentration on methane removal efficiency by hydroxyl radical oxidation through Fenton reaction. Experimental conditions: 100 mM H_2O_2, pH 2.5, T = 25 ° C.

Figure options

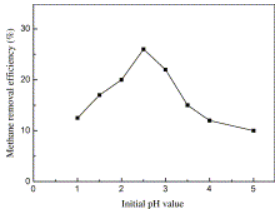

Fig. 5. Effects of initial pH value on methane degradation efficiency by hydroxyl radical oxidation *via* Fenton process. Experimental conditions: 2.00 mM Fe^{2+}, 80 mM H_2O_2, T = 25 ° C.

Figure options

☆

The First International Symposium on Mine Safety Science and Engineering (ISMSSE2011) will be held in Beijing on October 26 – 29, 2011. The symposium is authorized by the State Administration of Work Safety and is sponsored by China Academy of Safety Science & Technology (CASST), China University of Mining & Technology (Beijing) (CUMTB), Datong Coal Mine Group, McGill University (Canada) and University of Wollongong (Australia) with participation from several other universities from round the world, research institutes, professional associations and large enterprises. The topics will focus on mines safety field: theory on mine safety science and engineering technology, coal mine safety science & engineering technology, metal and nonmetal mines safety science & engineering technology, petroleum and natural gas exploitation safety science & engineering technology, mine safety management and safety standardization science & technology, occupational health and safety in mine, emergent rescue engineering technology in mine, etc.

Corresponding author at: State Key Laboratory Cultivation Base for Gas Geology and Gas Control, No. 2001, Century Avenue, Jiaozuo 454003, People’s Republic of China. Tel.: +86 391 3987885; fax: +86 391 3987881.