Data Article

Data on species and concentration of the main gaseous products during sludge combustion to support the feasibility of using sludge as a flue gas denitrification agent for the cement industry

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ABSTRACT

The dataset presented in this article is the supplementary data for the research article Fang et al., 2019 [1] and provided detailed data profile to support that sludge is an effective NOX reducing agent, as reductive gas components produce during sludge combustion. The instantaneous concentrations of the main gaseous products during sludge combustion were detected by using Fourier transform infrared spectroscopy (FTIR, DX-4000, Gasmet Technologies). The results showed the distribution and concentration level of gaseous products during sludge combustion and evidenced the feasibility of using sludge as a deNOX agent in cement industry.

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Wastewater treatment plant generate large amount of sewage sludge. Typical sewage sludge options include landfilling, incineration and enrichment of soils [2–5]. The Chinese cement industry output is account for more than half of the cement output worldwide [6], thus the large quantities of NOX in the flue gas discharging from cement industry deserve special attention. In this dataset, the species and concentrations of gaseous products during sludge combustion were obtained to evaluate the feasibility of using sewage sludge as a deNOX agent in cement industry.

This dataset contains 1 figure and 1 table. Fig. 1 presents the schematic of the horizontal tubular furnace reactor system, which simulated the typical cement kiln reaction atmosphere conditions. Table 1 list the instantaneous concentrations of the main gaseous products during sludge combustion respectively.

2. Experimental design, materials, and methods

2.1. Collection and preparation of sample

The dewatered sewage sludge sample was collected from a municipal wastewater treatment plant located in Guangzhou, China. The preparation and characterization are shown in the research article Fang et al., 2019 [1].

2.2. Experimental procedure

Experiments were conducted in a custom-built horizontal tubular furnace reactor (Fig. 1), which was different from the vertical fluidized-bed reactor used in Fang et al., 2019 [1]. The reactor is composed of a simulated gas unit, a horizontal tubular furnace, a flue gas sampling and online
**Fig. 1.** Schematic of the horizontal tubular furnace reactor system.

**Table 1**
The instantaneous concentrations of the main gaseous products during sludge combustion.

| Reaction time(s) | CO (vol%) | NO (ppm) | NO₂ (ppm) | N₂O (ppm) | NH₃ (ppm) | CH₄ (ppm) | HCN (ppm) |
|-----------------|-----------|----------|-----------|-----------|-----------|-----------|-----------|
| 5               | 0.42      | 525.01   | 14.49     | 17.41     | 1086.87   | 388.31    | 103998    |
| 10              | 1.89      | 1230.04  | 26.76     | 3.62      | 8168.98   | 1007.6    | 8668.98   |
| 15              | 1.08      | 931.49   | 46.78     | 11.55     | 4408.18   | 1444.9    | 2076.87   |
| 20              | 0.41      | 296.70   | 30.98     | 26.65     | 11.55     | 4408.18   | 520.67    |
| 25              | 0.17      | 109.91   | 21.41     | 67.99     | 167.7     | 258.39    | 94.9      |
| 30              | 0.08      | 35.37    | 20.57     | 44.6      | 39.81     | 931.49    | 2076.87   |
| 35              | 0.05      | 11.99    | 8.5       | 31.66     | 8.23      | 43.86     | 139.87    |
| 40              | 0.04      | 6.30     | 7.47      | 29.79     | 4.27      | 7.08      | 139.87    |
| 45              | 0.03      | 7.92     | 6.61      | 27.48     | 1.86      | 14.34     | 139.87    |
| 50              | 0.03      | 11.09    | 5.64      | 23.24     | 0.97      | 13.94     | 139.87    |
| 55              | 0.03      | 7.97     | 8.44      | 25.35     | 0.31      | 7.08      | 139.87    |
| 60              | 0.02      | 8.39     | 6.57      | 23.11     | 6.16      | 139.87    | 139.87    |
| 65              | 0.02      | 12.29    | 3.15      | 24.26     | 4.11      | 139.87    | 139.87    |
| 70              | 0.02      | 9.53     | 3.16      | 22.45     | 6.9       | 139.87    | 139.87    |
| 75              | 0.02      | 4.47     | 2.6       | 21.16     | 6.33      | 139.87    | 139.87    |
| 80              | 0.02      | 3.21     | 1.94      | 19.92     | 5.2       | 139.87    | 139.87    |
| 85              | 0.02      | 0.99     | 1.61      | 139.87    | 2.49      | 139.87    | 139.87    |
| 90              | 0.01      | 0.91     | 1.36      | 17.81     | 0.89      | 139.87    | 139.87    |
| 95              | 0.02      | 1.59     | 1.12      | 18.59     | 139.87    | 139.87    | 139.87    |
| 100             | 0.02      | 2.23     | 0.9       | 16.74     | 139.87    | 139.87    | 139.87    |
| 105             | 0.02      | 4.54     | 0.62      | 16.32     | 139.87    | 139.87    | 139.87    |
| 110             | 0.02      | 0.17     | 1.93      | 17.59     | 139.87    | 139.87    | 139.87    |
| 115             | 0.01      | 4.34     | 2.17      | 14.94     | 139.87    | 139.87    | 139.87    |
| 120             | 0.01      | 0        | 1.84      | 14.68     | 139.87    | 139.87    | 139.87    |
| 125             | 0.01      | 3.72     | 2.06      | 16.26     | 139.87    | 139.87    | 139.87    |
| 130             | 0.01      | 3.11     | 1.92      | 14.82     | 139.87    | 139.87    | 139.87    |
| 135             | 0.01      | 0        | 1.56      | 14.89     | 139.87    | 139.87    | 139.87    |
| 140             | 0.01      | 2.88     | 0.79      | 14.53     | 139.87    | 139.87    | 139.87    |
| 145             | 0.01      | 3.03     | 0         | 14.65     | 139.87    | 139.87    | 139.87    |
| 150             | 0.01      | 1.12     | 11.82     | 139.87    | 139.87    | 139.87    | 139.87    |
| 155             | 0.01      | 2.23     | 12.77     | 139.87    | 139.87    | 139.87    | 139.87    |
| 160             | 0.01      | 4.54     | 10.48     | 139.87    | 139.87    | 139.87    | 139.87    |
| 165             | 0.01      | 0.17     | 12.09     | 139.87    | 139.87    | 139.87    | 139.87    |
| 170             | 0.01      | 4.34     | 11.91     | 139.87    | 139.87    | 139.87    | 139.87    |
| 175             | 0.01      | 0        | 8.79      | 139.87    | 139.87    | 139.87    | 139.87    |
| 180             | 0.01      | 3.72     | 10.8      | 139.87    | 139.87    | 139.87    | 139.87    |
| 185             | 0.01      | 0        | 8.2       | 139.87    | 139.87    | 139.87    | 139.87    |
| 190             | 0.01      | 0        | 10.37     | 139.87    | 139.87    | 139.87    | 139.87    |
detection unit, and an absorption unit. N₂, O₂ and CO₂ were obtained from cylinders and metered by mass flow controllers (Beijing seven-star electronics Co., Ltd., China). N₂ was selected as the equilibrium gas, O₂ of 3% (v/v), and CO₂ of 25% (v/v) were used to compose the reaction gas to simulate the typical cement kiln atmosphere [7]. The total simulated gas flow rate was 18 L/min. After mixed in the mixing tank, the simulated gas went through the horizontal tubular furnace (14 cm in diameter and 120 cm in length). 0.5 g dried sludge in the quartz boat was pushed into the 900 °C flat-temperature zone after the gas mixture introduced into the furnace for 5 min, instead of using a screw feeder in Fang et al., 2019 [1]. The species and instantaneous concentration of the gaseous products during the sludge combustion in the outlet of the furnace were measured by using a portable FTIR analyzer (DX-4000 Gasmet Technologies, Finland). All the data were collected by computer automatically every 5 s, which tabulated in Table 1.

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Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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