Data Article

Data on emerging sulfur dioxide in the emission of natural gas heater in winter

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Abstract

Natural gas is a kind of fuel that is used in various heating systems for combustion processes. Combustion of natural gas produce such air pollutants as CO2, NOx, SOx, PM, CO, and HC. During cold days, total gas consumption in Iran goes up. Thus, in these days it is likely to make some changes in gas properties that can affect the emissions from gas heaters. Portable flue gas analyzer (LANCOM III) was used for SO2, NOx, and CXHY measurement from December 2012 to April 2013. Data show that emissions of pollutants from the gas heater were different during the cold seasons. On colder days, total gas consumption in the country increased, SO2 emerged in heater stack, and the concentration of hydrocarbons (CXHY) significantly increased as well. This emergence could be attributed to the changes in gas properties in the colder days. In these days, the transient flow and high changes of speed and pressure in the gas pipes could lead to release of some deposited sulfur in gas flow. Therefore, sulfur dioxide will be generated in the combustion process.

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**Specifications table**

| Subject area       | Environmental Science |
|--------------------|-----------------------|
| More specific subject area | Air pollutant emission of a natural gas heater |
| Type of data       | Table, text file, and figure |
| How data was acquired | Gaseous pollutant measurement was done by portable flue gas analyzer (LANCOM III) |
| Data format        | Raw and analyzed. |
| Experimental factors | Sampling site are located at least eight stack diameters downstream and two diameters upstream. the flow of inlet gas to the heater was fixed on 10 l/min. Measurement was done twenty minutes after heater ignition |
| Experimental features | Measurement of pollutants ($SO_2$, $C_2H_6$, and NOx) was done two or three days a week and three times in each day with LANCOM III. Daily ambient temperature and total daily network gas consumption data were obtained from Qom Meteorological Office and National Iranian Gas Company (NIGC), respectively |
| Data source location | Qom province, Iran. |
| Data accessibility | The data are available within this article. |
| Related research article | Ko and Lin [1] |

**Value of the data**

- Considering this research, sulfur dioxide emerges in the exhaust of gas heaters during among cold days.
- The data will be useful for finding the contribution of household sources to urban air pollution.
- The data of this research can be used by gas companies and the Ministry of Petroleum.
- The data obtained from this research can be used by the Environmental Protection Agency and the Ministry of Health and Medical Education.
- The data will be useful for researchers in fields of combustion, fuel, and air pollution.

**1. Data**

The presence of pollutants in breathing air could be as a matter of industrial activities, work places or domestic areas [2–5]. The Household gas heater is one of the most widely used domestic heating systems in Iran. Although household heaters are individually small in size, they can contribute significantly to production of greenhouse gases (GHG). Because of the large number of these devices, particularly in developing countries, the household use is a significant portion of the total fuel consumption [6]. Combustion of natural gas produce such air pollutants as CO$_2$, NOx, SOx, PM, CO, and HC [7]. These pollutants are the main air pollution problems in big cities [8,9]. The estimates show that in some very cold winter days, the level of total network gas consumption is more than 1.5 times as much as the daily average of warm and temperate months [10]. Due to fluctuations in gas consumption from difference in electricity generation, seasonal variations in consumption, short-term gas sales contracts, etc., it is not possible to analyze the gas network flow with a steady state circumstance [11,12]. Clogging and sedimentation of sulfur when the pressure and temperature are reduced in gas pipelines, well head facilities, dehydration unit, and gas sweetening unit are plausible [11]. During the cold days, when total gas consumption in the country has gone up, transient flow condition of the gas in the pipes occurs and changes of speed and pressure in the pipes increase. Therefore, in these days it is likely to make some changes (according to the deposition of sulfur in the gas pipes and possibly less purified gas) in gas properties that can affect the emissions of from gas...
Table 1
Data of daily average concentration of natural gas heater exhaust pollutants with total network gas consumption and average daily temperature.

| Date of sampling | Date of sampling | Total network gas consumption (Mm³) | Average concentration of SO₂ (micro g/m³) | Average concentration of NOₓ (micro g/m³) | Average concentration of CₓHᵧ (ppm) |
|------------------|------------------|-------------------------------------|------------------------------------------|------------------------------------------|-------------------------------------|
| 12/06/2012       | 9.70             | 353                                 | 0.00                                     | 9915.41                                  | 300.00                              |
| 12/09/2012       | 9.75             | 357                                 | 0.00                                     | 12,053.30                                | 333.33                              |
| 12/11/2012       | 9.85             | 356                                 | 0.00                                     | 13,020.00                                | 400.00                              |
| 12/12/2012       | 5.60             | 389                                 | 0.00                                     | 11,020.00                                | 333.33                              |
| 12/16/2012       | 5.00             | 388                                 | 0.00                                     | 11,020.00                                | 333.33                              |
| 12/18/2012       | 4.10             | 432                                 | 0.00                                     | 11,020.00                                | 333.33                              |
| 12/23/2012       | 9.00             | 388                                 | 294.79                                   | 11,762.66                                | 333.33                              |
| 12/25/2012       | 5.00             | 389                                 | 490.57                                   | 11,762.66                                | 333.33                              |
| 12/27/2012       | 2.00             | 422                                 | 913.35                                   | 11,762.66                                | 333.33                              |
| 12/30/2012       | 2.00             | 437                                 | 913.35                                   | 11,762.66                                | 333.33                              |
| 01/01/2013       | 2.50             | 443                                 | 0.00                                     | 11,762.66                                | 333.33                              |
| 01/02/2013       | 4.00             | 434                                 | 567.96                                   | 11,762.66                                | 333.33                              |
| 01/06/2013       | 5.00             | 425                                 | 0.00                                     | 11,762.66                                | 333.33                              |
| 01/08/2013       | 6.00             | 412                                 | 0.00                                     | 11,762.66                                | 333.33                              |
| 01/10/2013       | 7.00             | 403                                 | 0.00                                     | 11,762.66                                | 333.33                              |
| 01/13/2013       | 0.50             | 447                                 | 176.18                                   | 11,762.66                                | 333.33                              |
| 01/15/2013       | 4.50             | 459                                 | 0.00                                     | 11,762.66                                | 333.33                              |
| 01/17/2013       | 9.00             | 398                                 | 0.00                                     | 11,762.66                                | 333.33                              |
| 01/18/2013       | 4.30             | 432                                 | 0.00                                     | 11,762.66                                | 333.33                              |
| 02/01/2013       | 6.65             | 394                                 | 0.00                                     | 11,762.66                                | 333.33                              |
| 02/02/2013       | 6.60             | 410                                 | 0.00                                     | 11,762.66                                | 333.33                              |
| 02/04/2013       | 7.75             | 391                                 | 0.00                                     | 11,762.66                                | 333.33                              |
| 02/08/2013       | 12.00            | 343                                 | 0.00                                     | 11,762.66                                | 333.33                              |
| 02/11/2013       | 11.55            | 321                                 | 0.00                                     | 11,762.66                                | 333.33                              |
| 02/13/2013       | 8.35             | 351                                 | 0.00                                     | 11,762.66                                | 333.33                              |
| 02/16/2013       | 9.65             | 351                                 | 0.00                                     | 11,762.66                                | 333.33                              |
| 02/18/2013       | 9.85             | 353                                 | 0.00                                     | 11,762.66                                | 333.33                              |
| 02/20/2013       | 11.05            | 346                                 | 171.12                                   | 11,762.66                                | 333.33                              |
| 02/23/2013       | 7.60             | 355                                 | 1020.79                                  | 11,762.66                                | 333.33                              |
| 02/25/2013       | 9.45             | 369                                 | 0.00                                     | 11,762.66                                | 333.33                              |
| 03/04/2013       | 15.45            | 311                                 | 0.00                                     | 11,762.66                                | 333.33                              |
| 03/06/2013       | 12.65            | 336                                 | 0.00                                     | 11,762.66                                | 333.33                              |
| 03/09/2013       | 5.35             | 388                                 | 0.00                                     | 11,762.66                                | 333.33                              |
| 03/11/2013       | 13.00            | 370                                 | 0.00                                     | 11,762.66                                | 333.33                              |
| 04/06/2013       | 17.45            | 224                                 | 0.00                                     | 11,762.66                                | 333.33                              |
| 04/08/2013       | 20.45            | 207                                 | 0.00                                     | 11,762.66                                | 333.33                              |
| 04/10/2013       | 23.00            | 168                                 | 0.00                                     | 11,762.66                                | 333.33                              |
heaters. The data of SO₂ (micro g/m³), NOx (micro g/m³), and CₓHᵧ (ppm) in natural gas heater exhaust with total network gas consumption (Mm³) and average daily temperature (°C) are presented in Table 1. Fig. 1 demonstrates the relation between average daily temperatures data with total daily network gas consumptions. According to this figure, when the average daily temperature decreases, total daily gas consumption through the country arises. Pearson analysis shows that there is a highly significant reverse relation between these variables. (p-value < 0.0001). Table 2 shows the Pearson correlation statistics between gas heater exhaust pollutants (SO₂, CₓHᵧ, and NOx) with total network gas consumption and average daily temperature data. There are significant negative relations between SO₂ and CₓHᵧ with average daily temperature and total network gas consumption. On the days when the weather was too cold, total gas consumption in the country increased, SO₂ emerged in heater stack (p-value = 0.002), and the concentration of hydrocarbons (CₓHᵧ) significantly increased (p-value = 0.001). This emergence could be due to the changes in gas properties in the colder days. In these days, transient flow and high changes of speed and pressure in the gas pipes lead to release of some deposited sulfur in gas flow [12–14]. Although there are rumors that in the cold days, there is a shortage of sweet gas in the country, some less purified gas (containing sulfur or sour gas) are added to the network for compensating this shortage.

2. Experimental design, materials, and methods

A conventional household gas heater in the laboratory of Health Faculty of Qom University of Medical Science selected for the emissions analyses. Sampling was performed at a site (a hole drilled for sampling with analyzer probe) located at least eight stack diameters downstream and two diameters upstream [15]. A portable flue gas analyzer (LANCOM III) was used for pollutants (NOₓ, SO₂, and CₓHᵧ) measurement from December 2012 to April 2013. At the sampling period, the flow of inlet gas to the combustion chamber of the heater was fixed on 10 l/min (adjusted with the control valve). Calibrated flow meter (Platon model) was used for gas flow measurement. Measurements were done

| Exhaust pollutants | Statistics | Total network gas consumption | Average daily temperature |
|--------------------|------------|-------------------------------|---------------------------|
| SO₂                | r          | 0.340*                        | −0.502**                  |
|                    | p          | 0.040                         | 0.002                     |
| CₓHᵧ               | r          | 0.469**                       | −0.535**                  |
|                    | p          | 0.030                         | 0.001                     |
| NOₓ                | r          | −0.242                        | 0.080                     |
|                    | p          | 0.149                         | 0.638                     |

* Correlation is significant at the 0.05 level.
** Correlation is significant at the 0.01 level.
two or three days a week and three times in each day, twenty minutes after heater ignition. Daily ambient temperature and total daily network gas consumption data were obtained from Qom Meteorological Office and National Iranian Gas Company (NIGC), respectively. SPSS software (Ver.22) were used for data analysis.

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Transparency document. Supplementary material

Transparency document associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.dib.2018.09.030.

References

[1] Y.-C. Ko, T.-H. Lin, Emissions and efficiency of a domestic gas stove burning natural gases with various compositions, Energy Convers. Manag. 44 (19) (2003) 3001–3014.
[2] S. Dobadararan, F. Fazelinia, A.H. Mahvi, S.S. Hosseini, Particulate airborne fluoride from an aluminium production plant in Arak, Iran, Fluoride 42 (3) (2009) 228–232.
[3] M. Sarkhosh, A.H. Mahvi, M.R. Zare, Y. Fakhri, H.R. Shamsolahi, Indoor contaminants from Hardcopy Devices: characteristics of VOCs in photocopy centers, Atmos. Environ. 63 (2012) 307–312.
[4] A. Keramati, R.N. Nadehi, R.R. Kalantari, S. Nazmara, M. Zahedi, A. Azari, H. Bahramifar, A.H. Mahvi, TVOCs and BTEX concentrations in the air of south pars special economic energy zone, J. Mazandaran Univ. Med. Sci. 25 (133) (2016) 236–244.
[5] M. Dehghani, M. Fazlzadeh, A. Sorooshian, H.R. Tabatabaei, M. Mi, A.N. Baghani, M. Delikhon, A.H. Mahvi, M. Rashidi, Characteristics and health effects of BTEX in a hot spot for urban pollution, Ecotoxicol. Environ. Saf. 155 (2018) 133–143.
[6] J. Zhang, K. Smith, Y. Ma, S. Ye, F. Jiang, W. Qi, et al., Greenhouse gases and other airborne pollutants from household stoves in China: a database for emission factors, Atmos. Environ. 34 (26) (2000) 4537–4549.
[7] R.F. Fard, K. Naddafi, M. Yunesian, R.N. Nadehi, M.H. Dehghani, M.S. Hassanvand, The assessment of health impacts and external costs of natural gas-fired power plant of Qom, Environ. Sci. Pollut. Res. 23 (20) (2016) 20922–20936.
[8] M. Fazlzadeh Davil, R. Rostami, A. Zarei, M. Feizizadeh, M. Mahdavi, A. Mohammadi, et al., A survey of 24 h variations of BTEX concentration in the ambient air of Tehran, J. Babol Univ. Med. Sci. (2012) 50–55.
[9] M.H. Dehghani, S. Jarahzadeh, M. Hadei, N. Mansouri, Y. Rashidi, M. Yousefi, The data on the dispersion modeling of traffic-related PM10 and CO emissions using CALINE3; A case study in Tehran, Iran, Data Brief 19 (2018) 2284–2290.
[10] National Iranian Gas Company, 2014. 〈www.nigc.ir〉.
[11] G. Moradi, S. Daripoor, H.S. Mostafa, Dynamic behavior of gas pipeline by effect of flow rate changes. Flow and structure mechanic, 2, 2011, 91–9 [in persian].
[12] L.B. Ouyang, K. Aziz, Steady-state gas flow in pipes, J. Pet. Sci. Eng. 14 (3) (1996) 137–158.
[13] F. Ardeshirian, A. Afshar ebrahimi, F. Sh, Elemental sulfur and problems caused by the production of sour gas (from source to consumption point), Explor. Prod. Oil Gas 110 (2014) 18–26 (in persian).
[14] L.M.C. Gato, J.C.C. Henriques, Dynamic behaviour of high-pressure natural-gas flow in pipelines, Int. J. Heat Fluid Flow 26 (5) (2005) 817–825.
[15] C.F. Warner, W. Davis, K. Wark Jr., Air Pollution: Its Origin and Control, A Dun-Donnekey Publisher, 1997.