

## **Fugitive emissions at gas distribution networks: mitigation options**

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### **Background**

Bearing in mind the recent disaster at the nuclear power station (NPS) in Japan, people all over the world start to express disapproval and protest against satisfaction of the increasing demand for power by NPS. That is why natural gas being the most safe, clean, reliable and effective power source will strengthen its positions in the industry. Resource saving and mitigation of environmental impact of natural gas along the whole process chain from production to distribution will promote the image of natural gas as the most environmentally friendly hydrocarbon fuel. Mitigation of fugitive emissions of natural gas generated during process activities in gas industry will contribute significantly into search for solutions for this problem.

Fugitive emissions in this work mean emissions from production, storage, processing, transmission, distribution and consumption of gas, and emissions from combustion of fuels, when such energy is not further used (for example, gas flaring).

Gas distribution networks typically have fugitive emissions caused by scheduled works at gas pipelines and gas control points as well as process losses in gas distribution networks and losses related to accidents and repair works after accidents and gas transmission interruption.

Thus, the main source of fugitive emissions at gas distribution networks is natural gas that contains up to 98% of methane. Methane has a negative impact on the environment as a greenhouse gas. Rarely, for example during accidents with ignition, it is possible that emissions of carbon oxides and dioxides, nitrogen oxides, non-methane volatile organic compounds, sulfur dioxide that are produced during natural gas combustion will occur.

2010 saw 314,8 BCM of gas supplies to domestic consumers in Russia. Gas is delivered by about 400 regional gas distribution organizations (GDO), 183 of which are subsidiaries or associated companies of Gazprom. The total length of surface gas pipelines in Russia amounts to 744,4 thousand km, 611,8 of which are operated by JSC Gazprom. According to data from the national emissions inventory of greenhouse gases prepared by the Federal Service for Hydrometeorology and Environmental Monitoring (Roshydromet), in 2009 the volume of fugitive emissions from gas distribution via average and low pressure networks and consumption amounted to 27,7 % and 23,7 % correspondingly from the total volume of methane emissions when operating with natural gas (Figure 1).

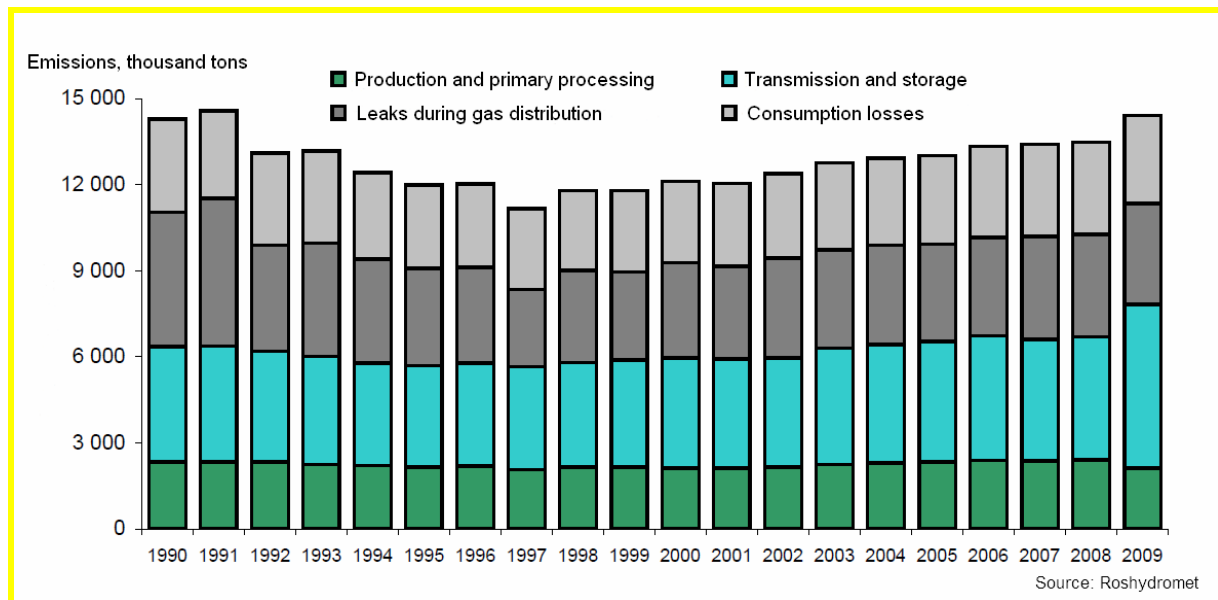


Figure 1: Methane fugitive emissions, including emissions related to gas distribution and consumption

Such a significant contribution of methane fugitive emissions from gas distribution networks means that the volume of emissions from a single process gas distribution facility ( gas distribution station, gas control point, section of distribution gas pipeline, shutoff valves) is not large, but a great number of such facilities makes a significant cumulative volume of fugitive emissions.

This report considers gas distribution stations together with gas distribution organizations facilities as a significant emission source. Gas distribution stations belong to gas transmission networks but are sources for gas distribution networks.

### Aims and methods

The aim of the work is to substantiate the development of the system for accounting, monitoring and management of fugitive methane emissions from gas distribution network facilities to mitigate them.

Methods of studies include systematization, generalization, calculation and analysis of data from measurement studies to determine sources and volumes of methane emissions from different process equipment, and processing of data by mathematical statistics methods.

### Regulatory and technical base

Main drivers for measurement and mitigation of methane fugitive emissions in Russia comprise:

- safety of gas distribution network operation



- sharp increase of penalties for methane emissions since 1 June 2005 in compliance with the decree of the Government of the Russian Federation on fee ratio for contaminant emissions into the atmosphere, which now amount to 50 RUB/t (about 1,8 \$) if emissions stay within accepted limit, and 250 RUB/t (about 9 \$) for extra emissions.
- fulfillment of obligations on corporate reporting (greenhouse gas emissions inventory) in the light of Kyoto Protocol provisions and United Nations Framework Convention on Climate Change (UN FCCC). In case of non-fulfillment Gazprom will not be able to take part in joint implementation projects (JIP), which is one of the mechanisms that allows countries listed in Annex I of Kyoto Protocol jointly develop projects aimed at reduction of greenhouse gas emissions.
- federal law No.261-FZ dd. 23.11.2009 "On energy saving and enhancement of power efficiency".
- fulfillment of obligations on implementation of principles of the Concept of the Russian Federation transition to sustainable development approved by Decree No. 440 of the President of Russia dd. 1 April 1996, and Environmental Policy of JSC Gazprom, including resource saving, mitigation of the negative impact on the environment, improvement of energy performance of industrial processes at all stages. Energy saving Program of Gazprom is approved and implemented every three years.

## Results

In Russia gas is supplied to consumers according to the following pattern. Gas metering point is owned by a gas transmission operator (JSC Gazprom). At the end point of operator's gas distribution station gas is measured and transferred to regional gas distribution companies-operators that supply gas to consumers (industrial, commercial and household sectors). Gazprom Mezhrefiongaz (100% subsidiary of Gazprom) sells gas to consumers. Service maintenance of the network is fulfilled by regional companies, more than one half of which pertains to Gazprom group.

The basic research and methodical support of Gazprom's activities is provided by R&D companies Gazprom VNIIGAZ and Gazprom Promgaz. These companies carry out investigations on a permanent basis to establish the system of assessment of the volume of unaccounted gas from gas transmission and gas distribution networks, including:

- assessment of the volume of unaccounted gas;
- development of regulations, methods of control and accounting of unaccounted gas;
- development of technical solutions aimed at reduction of gas losses;
- taking best decisions for management of unaccounted gas.

One of the less studied component of gas losses is fugitive emission related to leaks from a poor sealing of shutoff valves of the main and auxiliary equipment of gas distribution stations (GDS), gas control points (GCP) and linear sections of gas pipelines. Main types of methane losses during gas distribution include:

- 1 Scheduled (planned) operations at gas pipelines, GCP:
  - Gas release from gas pipeline during shutdown for repair;
  - Air displacement during gas pipeline filling by gas after repair;
  - Gas pressure reduction in gas pipeline by gas release to the atmosphere through the stand for welding operations;
  - Gas release from GCP gas pipelines during shutdown for repair
  - Air displacement during GCP gas pipelines filling by gas after shutdown for repair or filling of new commissioned pipelines;



- Set-up and commissioning of GCP process equipment and inspection of safety valves parameters.
  - Start-up and commissioning of new gas pipelines.
- 2 Losses during gas distribution network operation
- Network leaks
  - Release to GCP during pressure increase
  - Corrosion
- 3 Losses during accidents and emergency recovery operations

Figures 2 and 3 provide data on the quantity and properties of accidents related to gas losses at GCP, cabinet-type gas control points (CCP) and the linear sections of gas distribution networks respectively.

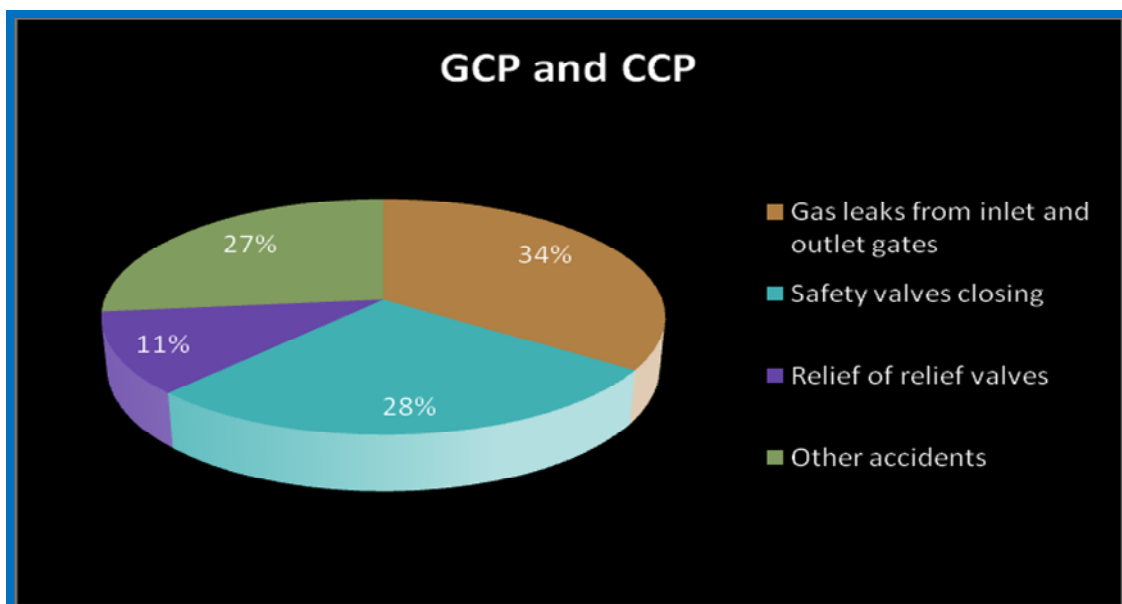


Figure 2: Quantity and properties of accidents related to natural gas leaks at GCP and CCP

Major number of accidents at GCP and CCP are caused by gas leaks from inlet and outlet gates (34 %) and closed safety valves (28 %).

Main leaks at the linear section of gas distribution networks are caused by faulty sealing of connections (23%), stuffing box packings (20 %) and condensate tanks (22%).

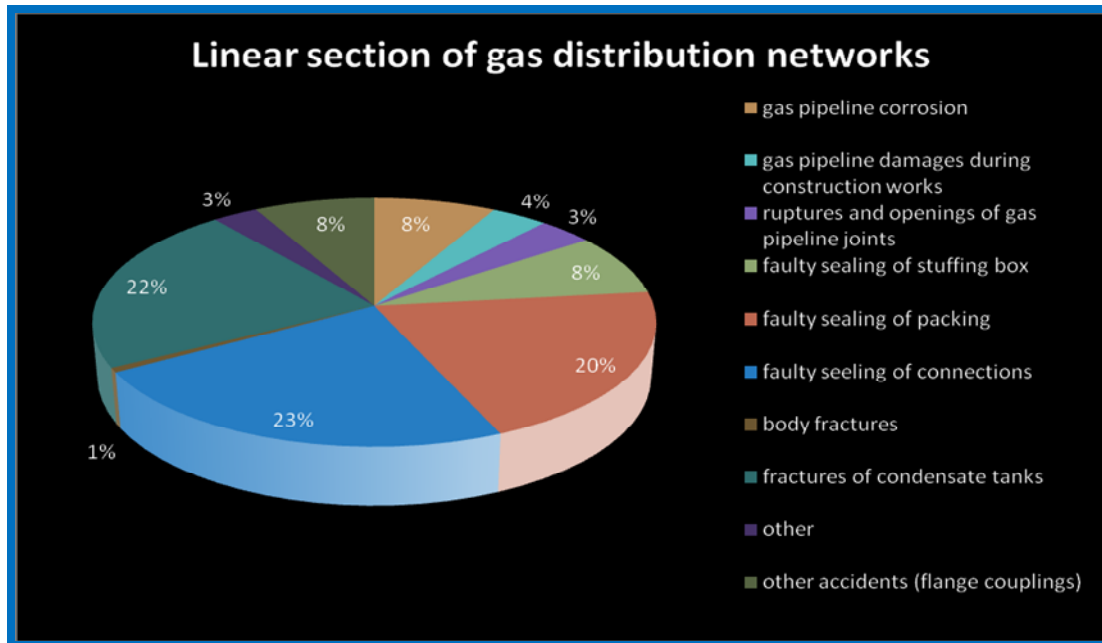


Figure 3: Quantity and properties of accidents related to natural gas leaks at the linear section of gas distribution networks

Gazprom carries out special instrumental inspections on leaks measurement at its facilities aimed at detection of methane leak sources in surface equipment and thorough assessment of their volumes. All operating process equipment that may produce atmospheric methane emissions was subject to screening (figure 4a, 4b).



Figures 4a, 4b – Inspection of surface equipment, detection of leaks

Results of this study helped to detect the main leak sources, assess their volumes at gas distribution stations of different operation age and capacity.

Analysis of results of measurements showed that 83 % of the cumulative methane emissions result from poor sealing of vent valves. Leak points in this case are mouths of vent stacks. Fittings give only 17 % of the total methane emissions with leaks (Figure 5).

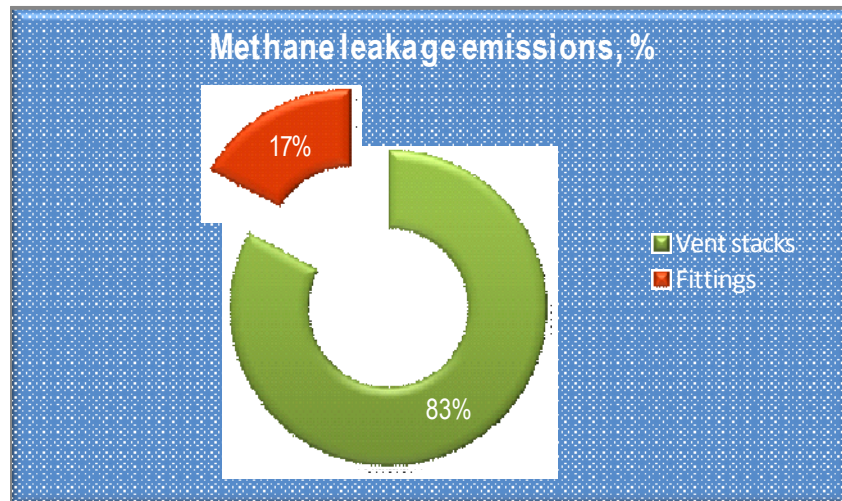


Figure 5: Breakdown of methane leaks from surface equipment

The maximum volume (51%) of such leaks is produced by small shut-off and control valves (needle valves, threaded couplings of pulse tubes, etc.). Methane emissions from taps amount to 25 %. Flange connections and valves give 10 and 7 % accordingly from the total volume of emissions from GDS and gas measurement and reduction points (Figure 6).

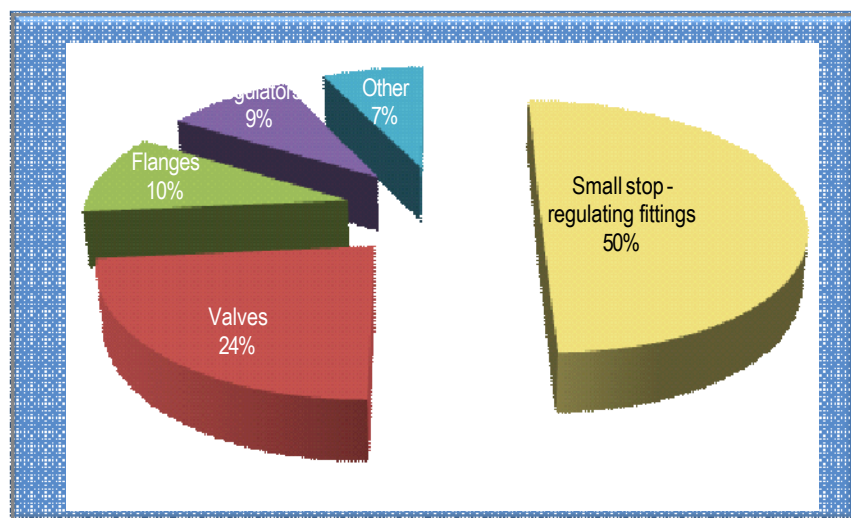


Figure 6: Breakdown of methane leaks by the type of fittings

Results of performed measurements form the basis for development of quantitative assessment procedure for methane fugitive emissions resultant from leaks from GDS process equipment.

Inventory of sources of methane fugitive emissions from scheduled blowdowns and venting is based on processing and analysis of statistical process data. Volumes of such emissions are calculated in compliance with requirements of corporate standards. Results of the comprehensive analysis showed that the largest volume of fugitive methane emissions



occurs during venting operations at gas pipelines under repair and accidents. To reduce them the company carries out a range of technical, engineering and other measures ensuring pipeline repair without gas venting to the atmosphere, and namely:

- application of “hot tapping” technology at repairs and commissioning of new pipelines;
- use of modern sealing materials;
- improvement of flows and modes of gas transmission via gas distribution systems, including development of inter-system and intra-system connections;
- reduction of natural gas process consumption during operation and repair;
- application of new efficient methods and development of the best workover schedules for the facilities of the linear section of gas pipelines.

Since 2007 the Program on upgrading and automation of commercial gas metering systems in gas distribution networks has been carried out under the auspices of Gazprom. Main solutions that this Program suggests include:

- construction of gas metering points,
- equipment of gas metering points with telemetry systems,
- construction of chromatographic complexes,
- creation of dispatching stations.

Building of metering points under the Program first of all means construction by the Company of own metering points for consumers that do not have such facilities or for whatever reason do not have the possibility of their reconstruction, as well as construction of modern metering points at the expense of consumers. Special attention in the Program is paid to large industry consumers and facilities, where there are often disagreements on correctness in the evaluation of the volume of supplied gas. Implementation of the Program must result in construction of about 4000 modern metering points with telemetry.

Equipment of gas metering points with telemetry systems means installation of controlled telemetry stations at gas metering points already equipped with modern gas measurement device. Installation of telemetry systems will provide the on-line real-time control over gas flow and main process parameters of gas supply and gas consumption. First of all, it is planned to install controlled telemetry stations at gas metering points of large consumers and GDS of external organizations. Gas transmission operators will transmit the information from GDS using control rooms of the linear section of the trunk gas pipeline and existing telemechanic systems and by installing the GDS telemetry system in own controlled stations, not included into Gazprom’s program on telemechanic system upgrading. The Program should provide 1100 gas metering points with telemetry systems. By 2010 over 76% of gas metering points were equipped with telemetry systems (Figure 7).

The Program on upgrading and automation of commercial gas metering systems will:

- improve measurement precision;
- allow to quickly detect defects and unauthorized changes of gas metering equipment settings;
- allow to issue invoices and receive money for actual volume of gas supplied to consumers;
- allow to control “daily excess supplies”;
- minimize the impact of the “human factor” on the precision of gas metering.

To reduce the volume of possible leaks during accidents the Program of reconstruction and technical re-equipment of gas industry facilities envisages installation of telemetry shut-off valves on the most important sections of distribution gas pipelines, which will stop operation of the emergency section within a minimum period of time.

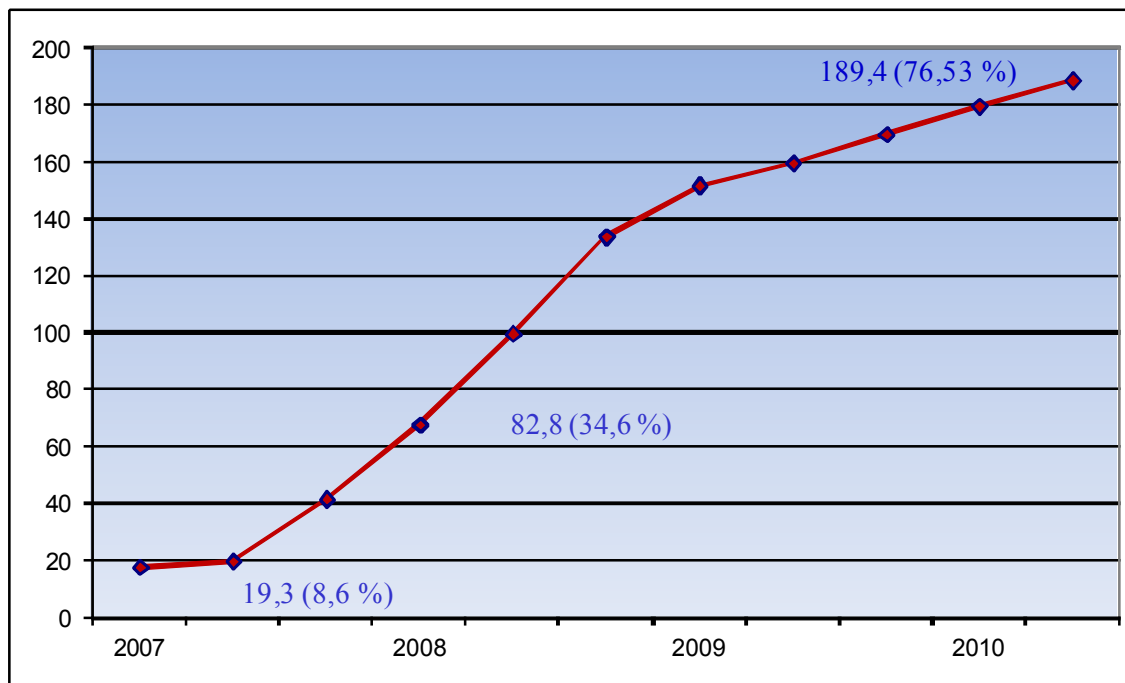


Figure 7: Supplied gas controlled by automated commercial gas metering system (BCM)

Introduction of remote control devices for natural gas leaks (laser devices, thermal imagers) will also help to timely detect and eliminate leaks on the linear section of distribution gas pipelines.

Knowledge of unbiased estimates and forecast of methane emissions, which is the main greenhouse gas, is the key to corporate solutions related to taking necessary measures and achieving final targets to stabilize and reduce emissions.

### Conclusions

Due to increasing role of natural gas as an energy source, it is important to pay attention to resource saving and reduction of the environmental load on gas industry activities. This is facilitated by actions taken by gas companies and aimed at studying and reduction of fugitive emissions of natural gas from gas distribution facilities.

Continuous monitoring, including by specially developed software systems, allows to automatically identify “challenging” zones of gas consumption (gas distribution), reduce the volume of unaccounted gas and improve the efficiency of gas supplies.

Results of investigations performed by Gazprom confirm importance of measurements, which is the most reliable method to define fugitive emissions of methane due to leaks from surface process equipment at gas distribution facilities. They are used for control, management and development of measures intended for reduction of fugitive methane emissions at Gazprom’s gas distribution facilities and assessment of measures efficiency.





Installation of advanced control and measurement equipment will allow to organize systematic registration and quantitative control of methane emissions and take managerial decisions to reduce them.

One of the effective measures to eliminate leaks is to replace aged sealing material of shut-off and control valves, which is currently used at gas distribution facilities, with modern fluoroplastic material. This will reduce the probability of leaks almost to zero.

Today many companies pay much attention to the issues of management of unaccounted gas, including fugitive emissions at gas transmission and gas distribution facilities due to their high importance. Exchange of research and practical experience in this field will help to make unaccounted gas balance item more transparent and registration of losses more detailed, which in turn will enable to develop cost-effective measures aimed at reduction of lost volumes and increase of resource saving during gas distribution.

Some methane leak reduction measures may be included in joint implementation projects to fulfill Kyoto Protocol provisions.