EXPLOSION RISK ANALYSIS IN GASIFIED RESIDENTIAL BUILDINGS

V. F. Martynyuk and P. N. Bugaev

National University of Oil and Gas "Gubkin University," 65-2 Leninsky Prosp., Moscow 119991, Russian Federation

Abstract: Risk analysis of accidental explosions in gasified residential buildings was carried out. The explosions were divided into four types: flash; external explosion; explosion in a kitchen; and explosion in an apartment. For each explosion type, according to available data, the corresponding probabilities were determined. The individual risk of death as a result of explosion was determined which was at an acceptable level. The hazard of in-house gas leakage sources was assessed according to the leakage frequency and its intensity and the most dangerous sources were identified. Ratios between the numbers of accidents of various levels and the numbers of violations of safety requirements were derived which were visually presented as an accident pyramid.

Keywords: safety requirements; gas leakage; explosive mixture; types of explosions

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Figure Captions

Figure 1 Consequences of the gas–air mixture ignition in a residential building: (*a*) view from outside; and (*b*) view from inside

Figure 2 Explosion video footage: (*a*) place where the explosion was initiated; (*b*) process development after 120 ms; (*c*) explosion after 180 ms; and (*d*) beginning of building destruction

Figure 3 Building general view after the accident (https://ru.wikipedia.org/wiki/Взрыв_бытового_газа_в_Ижевске_(2017))

Figure 4 Accident pyramid in gasified residential buildings

Table Captions

Table 1 Classification examples of accidental explosions (based on [8])

Table 2 Explosion probability (based on [8])

Table 3 Explosion or flash probability

Table 4 Time to reach explosive concentration in the room for various leaks

Table 5 Leak probabilities

Table 6 Ranking of leak sources according to the danger degree

References

1. Komarov, A. D. 2000. Prognozirovanie dinamicheskikh nagruzok pri avariynykh vzryvakh v pomeshcheniyakh [Prediction of dynamic loads in emergency explosions indoors]. *Mekhanizatsiya stroitel'stva* [Construction Mechanization] 6:21–26.
2. Mishuev, A. V. 2001. Osobennosti avariynykh vzryvov v zhilykh zdaniyakh [Peculiarities of emergency explosions in residential buildings]. *Seysmostoykoe stroitel'stvo. Bezopasnost' sooruzheniy* [Earthquake Engineering. Constructions Safety] 4:45–47.
3. Mishuev, A. V., V. V. Kazennov, A. A. Komarov, N. V. Gromov, I. V. Luk'yanov, and D. V. Prozorovskiy. 2012. Osobennosti avariynykh vzryvov vnutri zhilykh gazifitsirovannykh zdaniy i promyshlennykh ob"ektov [Peculiarities of emergency explosions inside residential gasified buildings and industrial facilities]. *Pozharovzryvobezopasnost'* [Fire and Explosion Safety] 3:49–56.
4. Orlov, G. G., and A. D. Korolchenko. 2016. Nagruzki, razrushayushchie stroitel'nye konstruktsii v rezul'tate avariynykh vzryvov [Loadings which destroy building structures in consiquence of emergency explosions]. *Pozharovzryvobezopasnost'* [Fire and Explosion Safety]. 25(3):45–56.
5. Martynyuk, V. Ph., and P. N. Bugaev. 2020. Analiz avariynykh vzryvov pri ispol'zovanii prirodnogo gaza v bytu [Analysis of emergency explosions when using natural gas in the domestic]. *Bezopasnost' zhiznedeyatel'nosti* [Life Safety] 2:11–16.

6. GOST R 56288-2014. 2014. Konstruktsii okonnye so steklopaketami legkosbrasyvaemye dlya zdaniy. Tekhnicheskie usloviya [Window constructions with double-glazed windows for buildings. Technical specifications].
7. Martynyuk, V. F. 2008. Avariynye vzryvy v sistemakh raspredeleniya i potrebleniya prirodnogo gaza [Accidental explosions in natural gas distribution and consumption systems]. *Neft', gaz i biznes* [Oil, Gas, and Business] 7:49–51.
8. Vzryvy bytovogo gaza v zhilykh domakh v 2017–2018 godakh [Domestic gas explosions in residential buildings in 2017–2018]. 01.12.2018. *RIA Novosti*. Available at: https://ria.ru/20181231/1548946218.html (accessed September 17, 2019).
9. O sostoyanii zashchity naseleniya i territoriy Rossiyskoy Federatsii ot chrezvychaynykh situatsiy prirodnogo i tekhnogennogo kharaktera v 2020 g.: gosudarstvennyy doklad [On the state of protection of the population and territories of the Russian Federation from emergencies of natural and man-made character in 2020: State report]. 2021. Moscow: MChS Rossii; FGBU VNII GOChS (FTs). 264 p.
10. Gordienko, D. M., ed. 2021. Pozhary i pozharnaya bezopasnost' v 2020 godu: Statisticheskiy sbornik [Fires and fire safety in 2020: Statistical collection]. Moscow: VNIIPO. 112 p.
11. Godovoy otchet AO "MOSGAZ" za 2020 god [Annual Report of MOSGAS JSC for 2020]. 2021. Moscow. 151 p.
12. ISO/TR 14121-2. 2007. Safety of machinery — risk assessment.
13. Kozhichenkov, V. S., T. N. Kiselyova, S. N. Fokin, V. Ph. Martynyuk, and P. N. Bugaev. 2018. Risk obrazovaniya vzryvoopasnoy smesi pri ispol'zovanii prirodnogo gaza v bytu [Risk of explosive gas–air mixture formation when using natural gas in domestic conditions]. *Bezopasnost' zhiznedeyatel'nosti* [Life Safety] 7:29–35.

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Contributors

Martynyuk Vasily F. (b. 1952) — Doctor of Science in technology, professor, Industrial Safety and Environmental Protection Department, National University of Oil and Gas "Gubkin University," 65-2 Leninsky Prosp., Moscow 119991, Russian Federation; anaopa@gmail.com

Bugaev Petr N. (b. 1994) — assistant, Industrial Safety and Environmental Protection Department, National University of Oil and Gas "Gubkin University," 65-2 Leninsky Prosp., Moscow 119991, Russian Federation; petr.bugaev94@mail.ru