METHOD FOR DETERMINING THE EXPLOSION PRESSURE OF A GAS–AIR CLOUD DURING THE RELEASE OF LIQUEFIED NATURAL GAS INTO OPEN SPACE

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Abstract: On March 16, 2021, the Government of the Russian Federation approved a long-term program for the development of liquefied natural gas (LNG) production. A roadmap for the development of the small-tonnage LNG market was also approved, in particular, a number of tasks were set by the Russian Emergencies Ministry, including: increasing the maximum permissible storage volume of LNG; reducing the minimum distances between process units at facilities for the production, storage, and use (sale) of LNG; reducing fire distances to buildings and structures not related to the facility; and harmonization of fire distance requirements in force in the Russian Federation with the corresponding requirements of foreign states. An analysis of domestic and foreign literature shows that the explosiveness of natural gas depends on the ignition conditions: the nature of the ignition source and the surrounding space. The disadvantage of the existing methodology for determining the explosion hazard of LNG is the inability to take into account different compositions of LNG which can vary within the main combustible components: methane, ethane, propane, and butane. Based on the previously experimentally obtained linear dependence of the change in explosion pressure on the composition of the main combustible components of LNG, a methodology for determining the explosion hazard of LNG in the event of its emergency release into an open space has been developed. The calculation performed using the developed methodology demonstrated that the most fire and explosion hazardous composition of LNG belongs to class 3 in terms of sensitivity to the initiation of explosive processes. This fact allows one to consider LNG without taking into account the component composition according to class 3; however, this approach increases safety costs, since the component composition of LNG can vary up to class 4, as a result of which, it is recommended to make the calculation based on the composition of LNG at the facility.

Keywords: liquefied natural gas; alkanes; methodology; explosion pressure

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Figure Captions

Figure 1 Achieving excess explosion pressure when calculating based on existing methods and differentiated ones (clutter class 4, $Z = 0.1$, and $V = 18$ m^3)

Figure 2 Achieving excess explosion pressure when calculating based on existing methods and differentiated ones (clutter class 3, $Z = 0.1$, and $V = 18$ m^3) taking into account changes in the methodology of the EMERCOM of Russia

Figure 3 Achieving excess explosion pressure when calculating based on existing methods and differentiated ones (clutter class 2, $Z = 0.1$, and $V = 18$ m^3), minimum flame front speed

Table Captions

Table 1 Characteristic size of the detonation cell and ignition energy during combustion and detonation of some stoichiometric fuel–air mixtures [5]

Table 2 Expected cloud combustion mode

Table 3 Model composition of combustible components of LNG

Table 4 Maximum explosion excess pressure $\Delta P_{\max}$ ($Z = 0.1$ and $V = 18$ m^3) for different grades

Table 5 Distance to reach excess pressure of 5 kPa ($Z = 0.1$ and $V = 18$ m^3) for different grades

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