Evaporation and analysis of cryogenics vapors and droplets at emissions of liquefied natural gas

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The evaporation times t of freely falling liquefied natural gas (LNG) droplets with the diameter $d = 50$–5000 μm were calculated. The value of t was studied using the convection theory of the energy exchange between the falling cryogenics droplet and the vapors clouds-gas at temperature T from 112 up to 293 K and at Reynolds number $\mathrm{Re} = Ud\rho/\eta \approx 10^{-1}$–$10^5$ in the atmospheric air. The large-scale atmospheric emissions of the LNG with mass up to 10 t were created via the pulsed spraying of LNG with the formation of high-speed liquid flooded jets, their aerodynamic crushing at Weber number $\mathrm{We} = \rho(U - V)2d/\sigma \approx 10^1$–$10^3$, and the vaporization of droplets with the creation of clouds from mixture of air, droplets and vapors-gas hydrocarbons with volumes of up to 10^5–10^7 m^3. As result, the dependences of t upon the values of d and T were simulated. The fast-acting optical infrared gas sensors with time response $\tau \approx 10^{-2}$ s at the temperature about of 150–330 K for remote control and analysis of vapors-gas of LNG in the atmosphere with volume up to 10^7 m^3 were described. The measured results are in agreement with the numerical study the evaporation kinetics of the methane, ethane, propane and butane cryogenics droplets. It is shown that with large-scale emissions of the fuel liquid into the atmosphere or spills of the liquefied natural gas onto dry ground or water, conditions are created for long-term formation of flammable and explosive mixtures of air and hydrocarbons at volume concentration $C \leq 15$ vol %.