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Application problems and potential for utilization of industrial outage of liquid natural gas for foundation soil thermostabilization

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In the permafrost propagation areas thermal interaction between constructions and foundation soil leads to the thawing of soil and, therefore, to the loss of soil bearing capacity. One way to solve this problem and to minimize such negative influence is to use facilities for foundation soil thermostabilization: the seasonal cooling devices working during period of air temperatures below zero; machine methods of cooling with compulsory ventilation of coolant. Liquefaction of natural gas is important and even priority technology of gas import and usage. At the stages of designing and operation of gas-condensate fields infrastructure the problem of termostabilization of foundation soils appears. Thus, one of the perspective decisions could be potential possibility of partial utilization of the liquefied natural gas cooling. Technological norm of liquid natural gas (LNG) storage is estimated by value of liquefied gas in the tank storage daily evaporability, which is approximately 0.1% of the mass of the liquefied gas in one tank. These losses are formed due to heat inflows of environment to the tank, where the liquid natural gas is kept under the temperature about -163°C. There is provided to use these technological outages with low freezing temperature for foundation soil termostabilization, using for this purpose recuperative heat-exchanging facilities. In that way, in line with ensuring competence of constructions foundation, this technology allows to utilize these outages of gas effectively. In contrast with usually applied seasonal thermostabilizers (TS), use of cooling capacity of the LNG complex allows: to provide reliable operation of a construction all the year round and irrespective of climatic conditions; to utilize selected gas for cooling of the foundation soil; to provide much higher rate of the soil frost penetration; to minimize effect of the frost heaving (the high rate of frost penetration provides minimization of volume of water migrating to the freezing front); to freeze cryopegs with various degree of a mineralization. Besides obvious advantages of LNG utilization as a refrigerant liquid for soil termostabilization it can lead to appearance of negative processes, such as frost cracking caused by emergence of big gradients of temperature near the wall of thermostabilizer tube. For that matter, it is required to pay special attention to the determination of optimum value of LNG-inlet temperature and the constructive solution of TS, for the purpose of prevention (minimization) of process of frost cracking. The task description and software products used for mathematical modeling are given in this article, and also results of calculations of frost penetration process of surrounding soil with various grain size compositions and salinity degree, and cryopegs with different mineralization are presented. The estimates of tension arising during the rapid frost penetration which allow us to find optimum values of LNG-inlet temperature and constructive solutions of TS, for the matter of minimization of process of frost cracking are given.

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