мо, сказывается только для паров бензина.

Проведенный анализ позволяет считать, что необходимо уделять большее значение вопросам искрообразующей способности материалов, так как из-за вероятных нарушений технологии и правил безопасности возникновение искры может привести к аварийным ситуациям. Опасность образования искр наиболее существенна для паров бензина, поэтому во взрывоопасных зонах следует предусмотреть отсутствие потенциально возможного источника зажигания.

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ANALYSIS OF EXPLOSION HAZARDOUS AREAS WHILE FILLING TANK-WAGONS WITH OIL CARGOES

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ABSTRACT

In the article the authors esteem the likelihood of accidents› emergence during the use of tank-wagons with highly inflammable and flammable liquids. Calculation data of explosion hazardous areas sizes are given, which are formed during loading (bulk) operations. The authors provide an analysis of relevant parameters for different environments. Additionally, options are considered to strengthen measures to prevent emergency situations caused by ignition of vapors of liquids, contained in tank-wagons, as well as prevent the presence of a potential source of spark formation.

ENGLISH SUMMARY

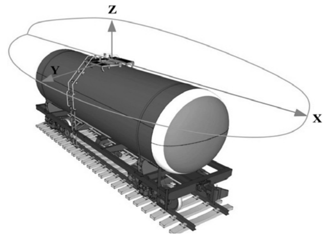
Background.

Increase in oil production and its refining sets to rail transport increased requirements for the development of the growing volume of oil cargo transportation by accelerating the turnover. Intensification of hazardous processes, productivity growth in order to obtain greater profits requires strengthening measures to prevent emergency situations.

Fires and explosions associated with the transportation of highly inflammable (HIL) and flammable (FL) liquids occupy a special place in the list of emergency situations on rail transport. During loading and unloading of oil cargo potentially hazardous situations occur at railway stations associated with vapors of HIL in open space. This happens because the tank-wagon's manhole, which is spotted to overhead crossing in order to be loaded with light oil products using open method, is in the open state for a long time, which under unfavorable climatic conditions leads to the rapid formation of the explosive zone.

Evaporation of HIL's vapors is also possible in the room during special operations at railcar wash facilities for cleaning and preparation of oil cargo tank-wagons for transportation. At such enterprises violation of fire prevention rules leads to formation of frictional sparks, which can lead to ignition of HIL and FL and emergency situations.

Pic. 1. Schematic view of the size of explosion hazardous area on three axes.



Objective.

The aim of the article is to assess the size of explosion hazardous areas, which will make it possible to analyze measures of emergency situations' prevention.

Methods.

The authors use methods of analysis, comparison and mathematical calculations.

Results.

To ensure fire-explosion safety during operation, transportation, refueling, maintenance of bulk tanks it is necessary to be aware of the presence of explosion hazardous areas, their parameters and combined extract-and-input ventilation's features. Zone sizes, limited by lower flammability limit (LFL) in case of emergency admission of HIL's unheated vapors in open space for stationary air environment depend on several factors: the physicochemical properties of HIL, climatic conditions, time and area of evaporation, mass of vapors received in open space. Method of calculating the hazardous area by LEL [1] is known, but systematic data to characterize the hazardous zones around the tank-wagons during various processes are absent. Therefore, the aim of the article is to assess the size of explosion hazardous areas, which will make it possible to analyze measures of emergency situations› prevention.

The calculations considered tetraaxial oil and petrol tank-wagon for transportation of oil and light oil products, model TS863–15. The worst in terms of the formation of explosive zones climatic and other conditions were used that determine the outcome of an emergency situation.

Schematic view of the extent of the explosion hazardous zone is shown in Pic 1.

Pic. 2. Scheme of overlapping adjacent explosion hazardous areas.

For the calculations the following dependencies were used:

Evaporation rate W:

$$W = 10^{-6} \cdot \eta \cdot \sqrt{M} \cdot p_н\,, \qquad (1)$$

Mass of petroleum's vapors, generated during evaporation:

$$m_a = W \cdot F \cdot T \text{ , кг,} \qquad (3)$$

Distances $X_{нкпр}$, $Y_{нкпр}$, $Z_{нкпр}$, for HIL, limiting the scope of concentrations exceeding LEL:

$$X_{нкпр} = Y_{нкпр} = 3{,}2\sqrt{K}\left(\frac{p_н}{C_{нкпр}}\right)^{0,8} \cdot \left(\frac{m_п}{\rho_п p_н}\right)^{0,33},$$

$$м; \qquad (4)$$

$$Z_{нкпр} = 0{,}12\sqrt{K}\left(\frac{p_н}{C_{нкпр}}\right)^{0,8} \cdot \left(\frac{m_п}{\rho_п p_н}\right)^{0,33}, \text{ м,} \qquad (5)$$

The results of calculations of explosion hazardous areas in the case of considered HILs are summarized in Table 2.

Schematic view of overlapping adjacent explosion hazardous areas during petroleum loading is shown in Pic 2.

Schematic view of explosion hazardous areas, which are not overlapped at loading, is shown in Pic 3.

To estimate the size of explosion hazardous areas, limited by LEL in case of emergency admission of HIL's vapors in the room, the following dependencies were used:

Distances $X_{нкпр}$, $Y_{нкпр}$ and $Z_{нкпр}$ for petroleum:

$$X_{нкпр} = K_1 l (K_2 \ln \frac{\delta C_0}{C_{нкпр}})^{0,5} \text{ , м;} \qquad (7)$$

$$Y_{нкпр} = K_1 b (K_2 \ln \frac{\delta C_0}{C_{нкпр}})^{0,5} \text{ , м;} \qquad (8)$$

$$Z_{нкпр} = K_3 h (K_2 \ln \frac{\delta C_0}{C_{нкпр}})^{0,5} \text{ , м,} \qquad (9)$$

The results of calculations for explosion hazardous areas for HIL's vapors indoor are presented in Table 4.

Important conclusions

1. Significant explosion hazardous areas in an open space at evaporation of HIL's vapors occur only for petroleum and spirit.

2. In case of petroleum explosive hazardous zones may be overlapped, that will lead to a cascading flame spreading.

3. Emergence of explosive hazardous areas of small sizes for the most considered HILs is justified by the use of an open method for tank-wagons› loading and physicochemical properties of HILs. Such zones are formed only over the manhole and are not overlapped with neighboring zone.

4. Calculations show that if ventilation functions proper, explosive hazardous areas will not be formed in the room, and in the absence of mobility of an air environment explosive hazardous area arises not only for petroleum and is comparable with the dimensions of the room. Thus, the presence of functioning ventilation, the use of which is necessary, affects only petroleum vapors.

Conclusion.

The current analysis makes it possible to suggest that it is necessary to give greater emphasis to the issues of spark forming ability of materials, since due to a number of safety regulations breaches of technological processes, spark formation can lead to an emergency situation. Danger of spark formation is the most essential for petroleum vapors, so it is necessary to provide in explosion hazardous areas absence of potentially possible source of ignition.

Keywords: transportation of dangerous goods, tank-wagons, flammable liquids, explosion hazardous areas, spark formation, emergency situations, prevention of threats.

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