Safety Improving of Cooling Unit of is Open Tane - Isoprene Charge Stock for Production of Isoprene Rubber

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Abstract. The main hazards of the isopentane-isoprene charge cooling unit of isoprene rubber production are analyzed. The conditions for the emergence and development of emergency situations were studied, and existing measures to ensure safety at work were considered.
The main initiating event in case of emergency situation in the shop is depressurization of equipment accompanied by the release of significant amount of hazardous substance with subsequent negative development of the accident.
Activities aimed at reducing the risk of an accident at the facility are: reducing the probability of depressurization of equipment; minimizing the quantity of hazardous substances entering the accident site; localization of the accident site; limiting the time spent in hazardous areas.
It is proposed to equip pipelines at the site boundaries with high-speed shut-off valves with a response time of 12 seconds. This measure allows minimizing the quantity of hazardous substances entering the accident sitethat leads to a significant reduction of environmental and economic damage because of accident.

1. Introduction

Industrial safety and labor protection are closely interrelated as they ensure the preservation of health and safety of employees. The main goal of industrial safety is to prevent and minimize the consequences of accidents at hazardous production facilities, i.e. destruction of structures and technical installations used at hazardous production facility, uncontrolled explosion and release of hazardous substances.

To ensure industrial safety, three main tasks must be solved:
- make a complete detailed analysis of the dangers formed in the activity under study;
- develop effective measures to protect human and habitat from identified hazards;
- develop effective measures to protect against the dangerous risk of this activity.

2. The urgency of the issue with a brief review of literature

The production of synthetic isoprene rubber is one of the most dangerous sources of accidents. The main hazards of production are the fire and explosion hazard of the products used. One of these sources of danger is the isoprene polymerization plant, in the technological process of which there is a cooling unit for the isopentane-isoprene charge stock.

Isopentane-isoprene charge is one of the main components that is used in the polymerization of isoprene. Before feeding the charge to the polymerization unit, it must be cooled to a temperature of -10 to +15 °C. The raw material used for cooling is propane, i.e. liquefied hydrocarbon gas. In the

technological process of obtaining isoprene rubber, material flows are processed, consisting of various organic substances: isopentane, isoprene, toluene, etc. Their vapors in mixture with air form flammable and explosive mixtures.

Formation of flammable and explosive mixtures inside equipment filled with products can occur when air enters it [1-11]. In the premises and on the territory of the workshop, the formation of flammable and explosive mixtures occurs when the product is passed or discharged from the apparatus, in sewer networks and wells, when draining into the sewer.

The main initiating event in the case of an emergency situation at the site and further development of the accident is depressurization of equipment with the release of hazardous substance with subsequent negative development of the accident.

The dangers associated with physical deterioration and corrosion are very relevant, since the hazardous substances used in the processes have increased corrosion properties (especially when the moisture content is elevated and at elevated temperatures). Under these conditions, the substances are able to interact with the wall material of the apparatus and pipelines, which reduce the service life of the equipment, can lead to emergency depressurization and release of hazardous substances into the environment, to explosions and fires in installations.

Termination of supply of energy resources can lead to violation of normal operating mode of the workshops and departments, to output of parameters behind the critical values and the creation of emergency situation.

Personnel errors pose a particular danger when starting up and stopping the equipment, conducting repair and maintenance work associated with unstable transient modes, with release and filling of equipment with hazardous substances. In the event of incorrect actions by maintenance personnel, it is possible to depressurize the system and cause a large-scale accident.

All listed reasons can lead to emergency situations, characterized by the destruction of propane evaporators, separators, tanks, heat exchangers, pipelines, pumps which can lead to spillage fire, explosion of gas-air mixtureor flaring of gas jet.

3. Theoretical part

The main measures aimed at reducing the risk of accident at the facility are: lowering the probability of depressurization of equipment; minimization of the quantity of hazardous substances entering the accident site; localization of the accident site; limiting the time spent in hazardous areas [12-19].

The main measures to eliminate the depressurization of equipment andprevent accidental releases of hazardous substances are:

- the structures and materials of the equipment and pipelines in operation must be designed to ensure their strength in the operating temperature and pressure range, as well as to ensure their corrosion resistance to the working environment;
- equipping thefacilities with the alarm system of limit values of adjustable parameters with their indication at the control panel;
- equipping the technological units with fast-acting shut-off equipment with remote control;
- ensuring a safe shutdown of the process according to a specified program to prevent emergency situations when deviating from the statutory maximum permissible values of process parameters.

The main measures to reduce the volumes and containment of emergency releases of hazardous substances are:

- process equipment must be installed on sites that have a solid impermeable coating and flanges; the slope of the concrete areas is designed towards the ladder to collect contaminated effluents;
- emptying of process equipment and pipelines is made in a closed system: the liquid phase merges into underground drainage tanks, and the gas phase is directed to the flare system;
- to cut off the damaged apparatus and pipeline section, fast disconnecting devices are used.

The main measures to limit the time spent in hazardous are:

- the time of personnel passage in hazardous areas is determined by the time necessary to carry out routine, preventive and repair work;

-in regular time, the staff is located in protected buildings (operator rooms);

- to minimize personnel presence in hazardous areas, rational routes for circumvention of the service area are identified.

4. Practical significance, proposals

As an action to improve industrial safety, it is proposed to install high-speed shut-off valves KVDO LG 150 NZ U (КВДО ЛГ 150 НЗ У) made by PNF L Gavtomatika and RUST 310-1 U (RUST 310-1 У) made by LLCRUST-95 (RUST -95) for the pipelines of liquid and gaseous propane of cooling unit of isopentane-isoprene charge in addition to manual reinforcement [20].

Shut-off valves are designed to fast shut off the part of the pipeline or the entire system. Disconnection may be required in case of abnormal situations or in accordance with the features of the technological process.

The main advantage of shut-off valves in comparison with manual valves is the quick closing (opening) time of the valve. The closing time is 12 seconds in the standard version. Installation of high-speed shut-off valves at the boundaries of the charge cooling unit will minimize the amount of hazardous substances entering the accident site, if any.

5. Conclusion

The main factors and reasons that contribute to the emergence and further development of the emergency situation at the cooling unit of isopentane-isoprene charge are analyzed. Installation of high-speed shut-off valves will minimize the amount of hazardous substances entering the accident site which leads to significant reduction of environmental and economic damage.

6. Reference lists

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