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Prevention of Fire and Risk of Explosions in "Porofor" Production

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***Abstract* – We think that not enough attention is devoted to the aspect of safety along with the development of dangerous technologies, equipment and machinery, as well as discovery of new manufacturing methods. This issue concerns essentially enterprises and areas, which contain explosive materials and toxics. Therefore, special attention should be devoted to these kinds of enterprises to define the level of risk of technogenic breakdowns and disasters, involving fire and explosion. When producing Porofor, we offer precise methods and means to decrease dangerous risks related to working with explosive and flammable substances, for example, we propose the protection package to prevent the explosion hazards during the technological process of manufacturing the forming agents.**

***Keywords* – Fire, Porofor, preventive activities (events), production, risk of explosion.**

I. Introduction

Since Duke Jēkab's time, chemistry has always taken a very important place in Latvia. After the Second World War, Latvia became the citadel of chemical production. A lot of chemical plants and enterprises were established in Latvian cities; it is worth mentioning Olaine – a town of chemical production, where medicine, chemical reagents, plastics and glue were produced. It must be said that nowadays the branches of chemical engineering still evolve: the same high-technology products are invented, tested, and produced, such as space product testing, automobile production, biomedicine manufacturing, production of electronic and military equipment etc. One of the newly produced perspective products in Olaine is "Porofor 57", which is used for different purposes, including initiator for polymerizations and agent of foam formation for producing porous materials. For this kind of production it is necessary to provide highly equipped plants, excellent security systems and perfectly educated employees. The object of research is Olaine Chemical Plant BIOLARS Ltd. (SIA Olaines Ķīmiskā rūpnīca BIOLARS), precisely, methods to reduce technological risks in production of "Porofor 57", as well as protection and prevention of its explosion.

II. Porofor Production and Related Fire Risks

Enterprise BIOLARS is well known to consumers mostly for paint and varnish production. However, the most considerable branch unfortunately is less known – production and its results. And for this creative and intellectual work meeting the demands of today's technological equipment, it is familiar to the global chemical industry. Olaine Chemical Plant BIOLARS Ltd. was founded in 1967 as a research and industrial enterprise. Nowadays the plant mainly specialises in chemical products, varnish and paint industrial semi-products, produces varnish and paint as well as household chemicals.

For these reasons there are generated three main industrial structures: chemical industry, enamel as well as varnish and candle production. The enterprise has a store for raw materials and ready-made production, for keeping easily flammable liquids. There is a customs store as well as its own auto roads and railways. Many laboratories such as scientific investigation laboratory, which is working out new kinds of chemical materials for today's market needs, are found at the plant. Research is conducted both in the branch of organic synthesis and into varnish and paint materials. The end-products are many-sided tested before coming to consumers.

Analytical laboratory constantly controls the raw materials and the end-products. The management system ISO9001 of quality is introduced in the enterprise and successfully works there, but despite that the plant was on fire on 11 March 2013 at 00.35 on the 3rd floor. The fire spread to the roof and the second floor. One of the possible reasons of the fire was the breakdown of technological application and chemical reaction that led to spontaneous ignition. Fast spreading of fire caused explosion, which took place on the 3rd floor. There were four explosions, due to which the building became deformed. At that time the building was not equipped with stationary fire-extinguishing systems. Although there were extinguishing fire-cocks on the floors, they were not used, which caused fast spreading of the fire and further evacuation of people [12]. The representatives both of local police and enterprise administration organised an operation section there to find out the chemical substance quantity and its danger [3], [4].

To put out the fire was very difficult because of great smoke in the place of fire. This caused difficulties for investigating and getting information about the accident fast. Some other disadvantages could be mentioned such as bad radio connection at the place of the accident, low temperature and very complicated building design. There was no information about chemical substances existing at the place on fire; there were no possibilities to get in touch with the administration. The representatives arrived at the place at 3:59, on 11 March 2013.

Besides, explosions, which were taking place on the third floor, made difficulties to put out the fire. Due to the explosions, a 200-litre barrel with hydrochloric acid was damaged, and the leakage of hydrochloric acid took place.

The total area on fire was 2000 m^2: 1500 m^2 on the third floor and 500 m^2 on the second floor burnt down. As a result of explosion, the building became deformed.

One of the workers – a 41-year-old woman suffered from the accident. She got burn due to intensive fire spreading. During the fire extinguishing, 4 rescue firemen got injured, too. The above-mentioned accident led to attentive investigation of the fire and explosion reasons. It was necessary to analyse processes applied to organic synthesis of agent condensation, oxidation by chlorine reaction of etherification and polymerization.

All these processes are definitely very dangerous; especially production of sodium hypochlorite, Porofor-57, its crystallization, regeneration of methanol, carbamate formal dechite candles K-411 and plastificator production as well as carbamide and acrylic candle production. Therefore, special attention was paid to Porofor-57 production, as on each stage of its production there is danger of explosion.

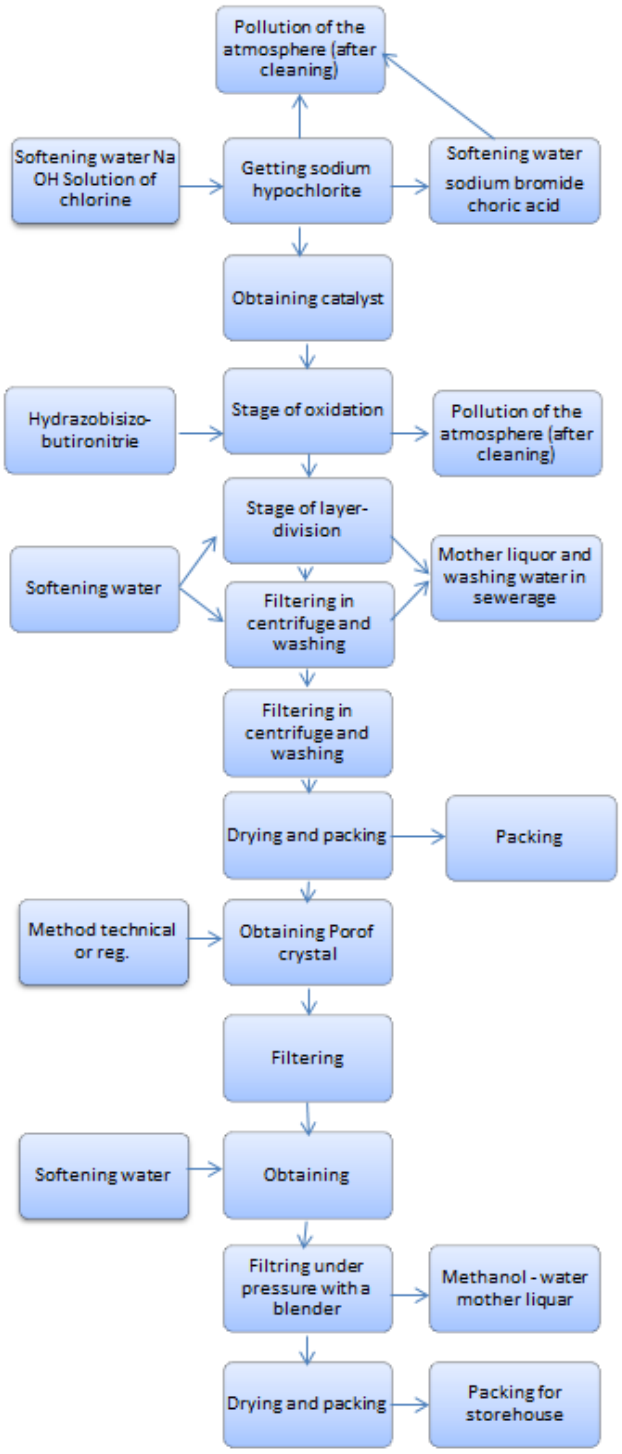

Fig.1. Diagram of Porofor production.

Description and features of Porofor AIBN.

ts – temperature of keeping;

tc – max. transportation temperature;

tem – alarm temperature;

tsait – the start of fast division temperature.

Data are taken from the catalogue of AkzoNobel firm. Division and combustion of Porofor AIBN can follow after the following reactions: thermal division combustion in the large (enough quantity) presence of O2 burning in the pretty low quantity of O2.

Besides, a radical recombination could take place, e.g., self-destruction after the following reaction: tetrametilsukcionitril (TMSN) stable substance at $t = 169$ °C, but its dust in combination with air can form an explosive mixture. Working environment is considered explosively dangerous if there can be found gas, vapour, fog or these kinds of dust, which are easily or intensive flammable. The fire can spread the whole explosive mixture.

Porofor-57 is very easily inflammable. It can start burning just from a spark or a match, other heating sources. The flame is energetic and bright. The start burning temperature is 400 °C, but spontaneous combustion t is 670 °C. Despite the fact that Porofor is not an explosive substance, it is inflammable in specific conditions, such as its division that causes explosion. If the temperature is normal, Porofor does not react to rubbing or blow. These actions do not cause fire or explosion. However, Porofor dust in suspension is very dangerous. Porofor dust in suspension with air in concentration 20–40 g/m^3 and higher can form an explosive mixture, with a very low explosive concentration limit. Thus, Porofor can inflame or explode at rather low temperatures. In specific conditions, it can cause explosion in technological equipment and lead to serious breakdowns in rooms with high concentration of Porofor dust in the air.

III. Fire and Explosion Risk Decreasing

Taking into consideration all the above-mentioned, some methods for decreasing fire and explosion risks were proposed. These methods include engineering and technological as well as organizational events. Each working place was tested from the point of view of risks of fire and explosion both within the time of keeping and technological maintenance as well as operation. An analysis of applied substances and industrial products and their possibility to interact was performed. The objects are reconstructed so, that in case of breakdown or fire, they for a precise period of time would keep solidity, limiting fire and smoke beginning and their spreading over the building to enable people to leave the objects or to be evacuated and rescued, and not interfere with the fire and rescued brigades to work effectively. A stationary fire-prevention system of fire-tools is set up in the cellar, which is thought to work both automatically and be operated manually [5], [6].

But dangerous explosive conditions cannot be excluded completely, if there is an inflaming resource. To limit this resource, there is a secondary preventive explosion device. Inflaming resources contain different inflaming potential, corresponding to only ideal dust air mixture. Solution is made taking into consideration existing conditions. Some mentioned sources of standards EV1127-1 can be excluded for some reasonable arguments. Estimating the keeping and processing of Porofor industry firstly, it is necessary to avoid explosive atmosphere arising from dust and air. When packing Porofor in the sacks, there always is explosive dust, which can be inflamed by high initiative energy. Although in existing keeping systems there is dust, it is not mixing with air as an oxidation agent. The isolation dust appears only in the place of packing work. It takes place only in the technological equipment of the plant (mixer). Dust itself does not cause explosion.

Accumulation of dust, its burning is considered to be a dangerous explosive source. The term "normal working conditions" means that all equipment is applied following appropriate aims and parameters. One of the ways to prevent explosion is a concentration limit. Danger of explosion of gas and dust in the air exists only in precise limits of concentration. Working in definite conditions it is possible to stay away of explosive limits and then there is no risk at all.

In connection with the fact that the technological process is very inflammable and explosive, it is offered to install diesel generator and electrical equipment as well as fire extinguishing systems in the reconstructed plant. Stationary fire extinguishing water consumption is 20 l. To increase pressure of water in the stationary fire-extinguishing system, two electrical pumps are offered. (Now there is only one, and there is no diesel generator).

There are also offered two mutually tied posts to control water flow relay for inner fire extinguishing water-pipe.

All necessary signals about stationary fire-extinguishing systems and inside fire-extinguishing water-pipe systems as well as their unit conditions are transferred to the control panel in the security room in case of fire alarm. In the reconstructed building, there is a possibility to connect fire-machines to fire-preventive systems of inside nets [7], [8].

The ventilation system was reconstructed as well. Rooms, which are supplied with easily departed constructions of glass packages for windows, serve to decrease air pressure in the following conditions:

1) the area of windows and roof constructions should not be less than 0.05 m^2 and the volume of building or room – 1 m^3;
2) the usage windows of glass packages makes them easily departed;
3) rooms are protected with certificated metal fireproof doors RE 145 with a tambour ventilation as fire prevention means.

The quantity of prevention activities depends on the zone of possible explosive area [9].

Environment that can easily explode near the equipment must be averted as soon as possible. It can be achieved by the usage of closed equipment hermetically sealed. Equipment must work without leakage in normal conditions. To achieve this, regular service, control and supervision over equipment should be organised. In case of impossibility to prevent flammable substance leakage, the explosion can be averted

with the help of ventilation instalment and dust cleaning. To get rid of dust sedimentary, all equipment, technical rooms should be regularly cleaned. Special attention should be devoted to high surfaces, which are difficult to reach, but there could be found a lot of dust sedimentary. If it is impossible to prevent formation of explosive environment, everything should be done to avert fire, the risk of fire can be decreased with the help of different security means, to choose more effective events one must know kinds of flammable sources and how they are inflaming. Operating activities and their volume depend on probability of finding both explosive environment and inflammable source at the same place [10].

IV. Conclusion

The task of research has been to identify the risk factors of "Porofor" production, to state and give the reasons of production risks, as well as suggest preventive events to avert formation of explosive environment and inflaming. The research estimates technological process at the working place and offers ways to prevent or decrease risks of explosion. The research results are demonstrated in the following conclusions.

1. "Porofor-57" production is very dangerous. Consequences of explosion can lead to flame formation of poisonous substances, air pressure effect, and lack of oxygen in the air that is dangerous for health and life of enterprise employees.

2. Unfortunately, very often enterprises pay attention to fire preventive events only after disasters, such as explosion or other accidents. In the beginning, the enterprise did not have fire-extinguishing systems or alarm signalization systems in the production rooms, which could prevent or help fight fire risks. Besides, the technological equipment becomes out of date and does not meet technical and operation demands that also can cause accidents. The main recommendation for preventing or decreasing explosive risks is to avert the possibilities of explosive environment formation. It can be achieved by renovating technological equipment, which meets the today's demands and is safe for environment and employees.

Thus, an enterprise, which has rooms with dangerous explosive and flammable substances, must be equipped with both fire-extinguishing systems and fire detection systems as well as alarm signalization system. They will help identify the dangerous situation fast and start necessary preventive and rescue events. It is necessary to separate explosive environment with a fireproof door and ensure with easily departed building constructions, which prevent from spreading the fire or might avert explosion. All these events would lead to safe production of "Porofor-57" and prevent or minimise technological risks.

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