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SYSTEMATIC ANALYSIS OF FORMALIN PRODUCTION ON THE EXAMPLE OF WELL-KNOWN FOREIGN COMPANIES AND JSC "NAVOIAZOT"

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ABSTRACT

Currently, formalin is gaining more and more practical importance as a very valuable intermediate product on the way of obtaining various organic compounds and polymeric materials with a wide variety of properties. The world consumption of formalin is growing all the time. Today, there is a significant deficit of formalin, both in the domestic market and in the markets of foreign countries. In this regard, there is a need to create new production facilities, as well as reconstruction (expansion) and modernization of existing production facilities. The article presents an analysis of several technological schemes for the production of formalin.

KEYWORDS: *Formalin, Methanol, Alcohol Evaporator, Reactor, Absorber Pumps, Steam Generator, Circulating Coolant Pump, Collector Of The Coolant, Water Pump.*

INTRODUCTION

Formalin is one of the large-tonnage products of the chemical industry. Formaldehyde, which is part of formalin, has a high reactivity, availability and low cost, therefore formalin has become one of the most important intermediates in the chemical industry. Its importance for modern industrial organic synthesis can hardly be overestimated. Formalin is used for the production of synthetic resins, plastics, plasticizers, organic dyes, various adhesives, varnishes, pharmaceuticals and other products. Formalin is also used in agriculture for seed dressing, in the leather industry for tanning leather, in medicine and animal husbandry as an antiseptic, etc. The world production of formalin is estimated at 14-45 million tons per year.

LITERATURE REVIEW: One of the first industrial production facilities for formalin on metal oxide catalysts was built by the Italian firm Monteedisson, which has extensive experience in chemical engineering (Fig. 1).

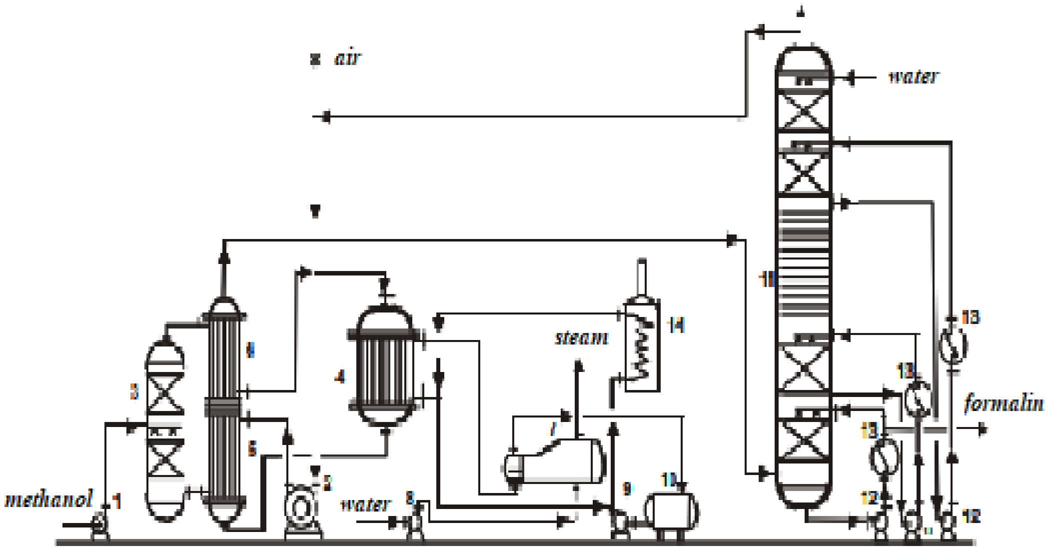


Figure 1 - Technological scheme of the Italian company "Monteedisson"

1 - methanol pump; 2 - blower for air / offgas mixture; 3 - alcohol evaporator; 4 - reactor; 5 - heater for the mixture of air with exhaust gas; 6 - working mixture superheater; 7 - coolant cooler - steam generator; 8 - water pump; 9 - circulating coolant pump; 10 - collector of the coolant; 11 - absorber; 12 - absorber pumps; 13 - absorber coolers; 14 - coolant heater at start-up.

At this installation, the production of a working air-off-gas methanol-containing mixture is carried out by adiabatic evaporation of methanol due to the heat accumulated by the heated mixture of air and off-gas. “The process of evaporation of alcohol is carried out in a packed column apparatus. Methanol is fed into the middle of the apparatus through spray devices, the upper part of the nozzle serves as a spray catcher. The mixture of air with offgas entering the lower part of the apparatus and the resulting working mixture are heated in a two-section heat exchanger by hot reaction products leaving the reactor. The composition of the resulting mixture of air with abgaz in terms of oxygen concentration and the composition of the working mixture in terms of methanol content are automatically maintained at all operating installations of this and other companies. Initially, the heat exchanger, which acts as a waste heat boiler for removing the heat of the reaction products and heating the air-exhaust gas mixture and overheating the working mixture, was installed horizontally, and in subsequent schemes - vertically. The catalyst in the reactor tubes is cooled by a circulating refrigerant - a high-temperature organic coolant (HERE). The refrigerant is forcibly circulated in the system "reactor shell - waste heat boiler (where the heat exchanger is cooled by evaporating water) - circulation pump - reactor". The preset catalyst temperature is automatically maintained by the amount of circulating heat carrier. At start-up of the installation, the catalyst is heated to the initial reaction temperature by a circulating coolant in a special furnace with flue gases or heating elements. Reaction products cooled in a two-section heat exchanger

go down the absorption column, where formaldehyde and methanol are extracted from them with water flowing in countercurrent to the top of the absorber. Water for irrigation is supplied on the basis of obtaining a given concentration of formalin. Exhaust gas leaves the upper part of the absorber, about 75% of which is returned back to the process for mixing with air and vapors of methyl alcohol. The disadvantage of the technology for producing formalin using metal oxide catalysts from Monteedisson is the high specific power consumption, since to obtain an equal amount of formalin in comparison with the use of a silver catalyst, a 6-fold volume of the reaction mass is passed through the system. Accordingly, the power of the installed blowers and the electricity consumption are also six times higher. A significant amount of it is consumed by the pump for circulating the liquid coolant in the "reactor - waste heat boiler" system. According to experts, the power consumption can be reduced if the methanol content in the working mixture is increased or, instead of the liquid cooler of the reactor, evaporative heat removal with the elimination of the circulation pump is used.

Analysis of the installation of the firm "Perstorp Formox"

Almost simultaneously with the Monteedisson firm, the process of formalin production by a similar method was carried out by the Swedish company Perstorp Formox, which has been producing formalin since 1905. Differences of the technological scheme "Perstorp Formox" from "Monteedisson" are as follows [2, P.33]. First, the production of a methanol-air-gas mixture and its overheating are performed without an alcohol evaporator by injecting a given amount of methanol into the pipeline of the air-gas mixture supplied to the tubular heat exchanger. At the same time, water vapor obtained at the installation is directed into the shell space of the heat exchanger, and methanol evaporates and its vapors are mixed in the tube space with an air-gas mixture.

Secondly, an evaporating Dowtherm coolant, a mixture of biphenyl and biphenyl oxide, is used to cool the catalyst in the reactor. The coolant vapors are condensed in a heat exchanger - heat recovery boiler and return by gravity to the catalytic reactor, that is, the thermosyphon principle is implemented. Water vapor obtained during the condensation of heat carrier vapors is issued as a commercial one. Thirdly, the cooling of the reaction products is carried out in a heat exchanger with water to obtain water vapor, which is used to heat the heat exchanger, in which the working mixture is obtained and overheated (Fig. 2).

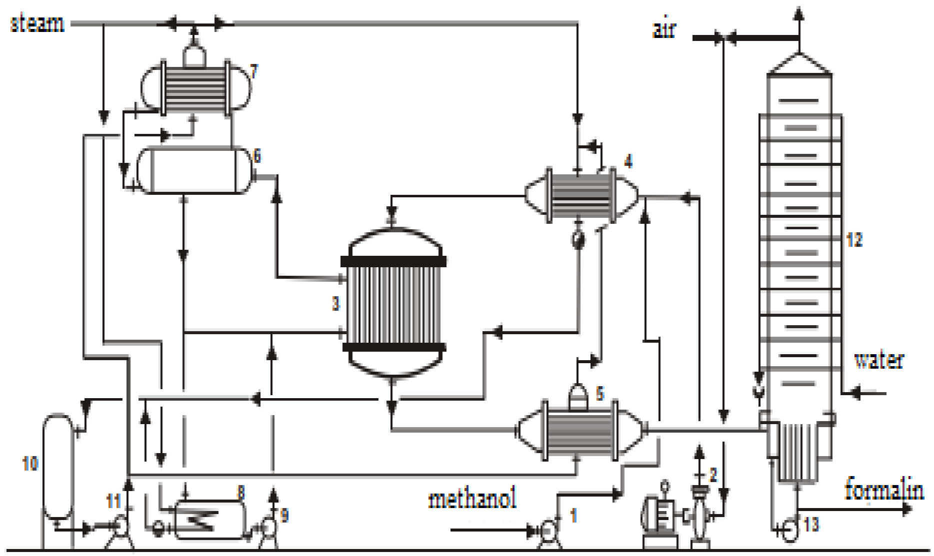


Figure 2 - Technological scheme of the Swedish company "Perstorp"

1 - methanol pump; 2 - blower for air / offgas mixture; 3 - reactor; 4 - apparatus for obtaining a working mixture; 5 - cooler of reaction products; 6, 7 - refrigerant vapor condensers; 8 - coolant collection; 9 - pump for circulation of the coolant at start-up of the installation; 10 - condensate collector; 11 - condensate pump; 12 - absorber; 13 - formalin pump

The regulation of the temperature regime of the catalyst operation with the evaporating coolant can be performed by two methods - direct and indirect. With the direct method, the amount of heat taken is directly related to the vapor pressure of the coolant. With a decrease in their pressure, more heat is taken away, which helps to lower the catalyst temperature. The indirect one consists in changing the pressure of the water vapor obtained in the heat-transfer boiler. Maintaining the set temperature in both methods is performed automatically.

The absorption system consists of one column with a bottom formalin cooling heat exchanger and heat removal on each plate. For this reason, the technological scheme of the Swedish company "Perstorp Formox" is more perfect and economical than in the case of "Monteedisson".

Firm "Haldor-Topsoe"

The technology for obtaining formalin from the Danish-Japanese company Haldor-Topsoe is close to Perstorp, which is easy to see when looking at Figure 3 in detail .

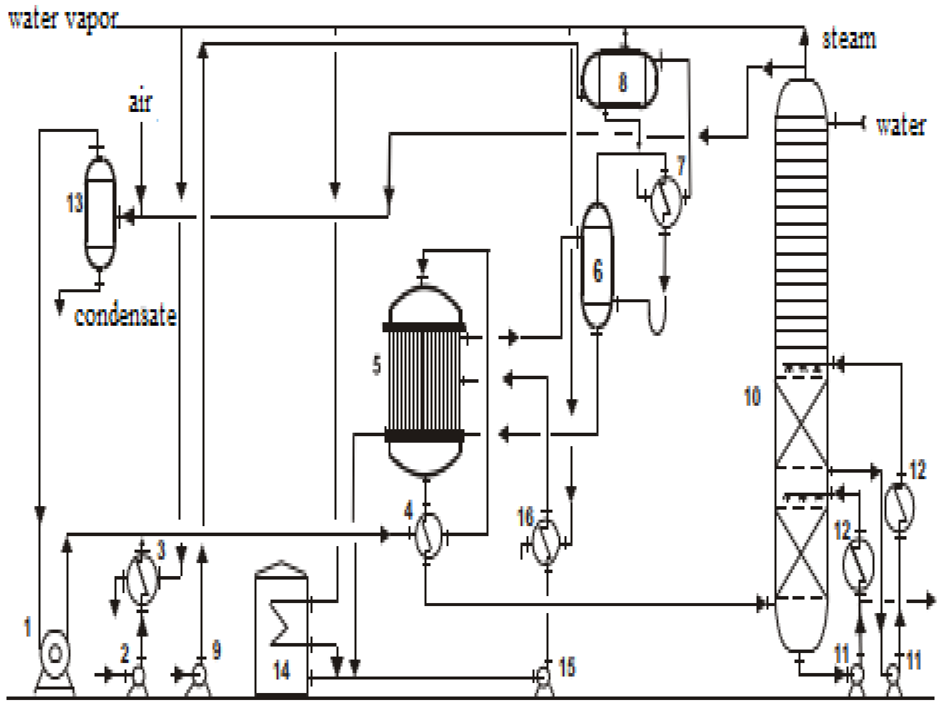


Figure 3 - Technological scheme of the Danish-Japanese company "Halder- Topsoe "

1 - blower for a mixture of air with offgas; 2 - methanol pump; 3 - methanol evaporator; 4 - working mixture superheater; 5 - reactor; 6, 7, 8 - coolant vapor condensers; 9 - water pump; 10 - absorber; 11 - formalin pumps; 12 - absorber refrigerators; 13 - condensate separator; 14 - coolant reservoir; 15 - pump for circulation of the coolant when starting up the installation; 1 6 - heat carrier heater.

In the proposed technological scheme, the evaporation of methanol is carried out in a special apparatus with the subsequent mixing of its vapors with a mixture of air and offgas. Condensation of methanol vapors does not occur in this case, since, when compressed in a supercharger, they are heated above the boiling point of methanol. Overheating of the working mixture is carried out in a heat exchanger by hot reaction products leaving the reactor.

For the absorption of formaldehyde, one three-section absorption tower is used. The two lower sections are packed with the outlet, cooling and forced return to the top of their section of the liquid phase, and the third one performs sanitary functions and is intended for additional binding of formaldehyde from the abgas.

ANALYSIS OF THE PLANT OF THE FIRM "LUMMUS"

According to the scheme of the American company Lummus (Fig. 4), two industrial plants for the production of 37% formalin were built: in 1967 in Calver City by GAF (General Aniline Fabrik) and in 1970 by a Japanese company "Semitzu" in Osaka [2].

The capacity of each was approximately 25 thousand tons per year.

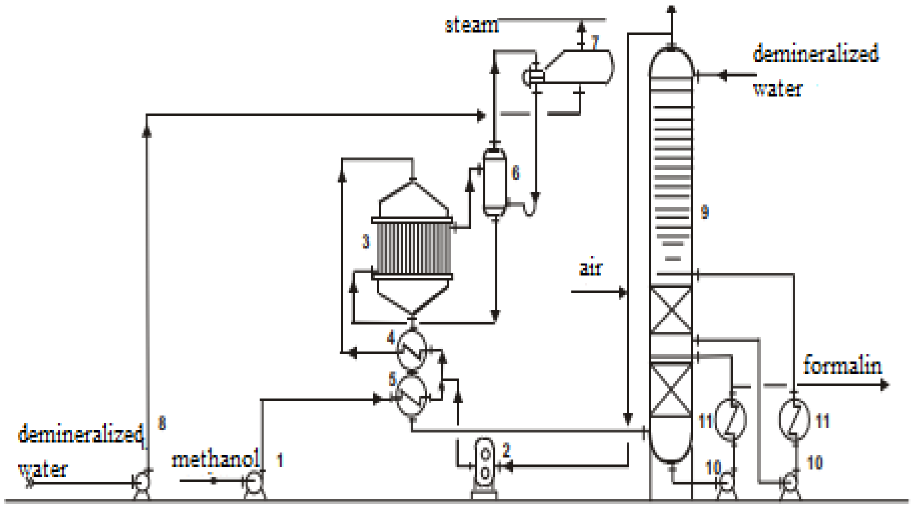


Figure 4 - Technological scheme of the company "Lummus"

1 - methanol pump; 2 - blower for air / offgas mixture; 3 - reactor; 4 - working mixture superheater; 5 - methanol evaporator; 6, 7 - coolant vapor condensers; 8 - pump of demineralized water: 9 - absorber; 10 - formalin pumps; 11 - formalin refrigerators

In this scheme, methanol is vaporized by hot reaction products, which first enter the heat exchanger, overheating the working mixture. Cooling of the catalytic reactor is carried out with an evaporating coolant to obtain commercial water vapor. The formaldehyde absorber is three-section, as in the previous schemes - two sections are packed and one is disc-shaped. This design ensures good absorption of formaldehyde from the offgas. In addition, during the implementation of the process, an additional stage of neutralization of acidic formalin is provided in the installation using ion-exchange resins, which significantly complicates the process. To prevent corrosion, the reactor is made of low alloy carbon steel.

It should be noted that due to the noted shortcomings, the technological processes of Lummus are less known than other licensors.

ANALYSIS OF THE INSTALLATION OF THE COMPANY "KLEKNER-HUMBOLT"

Process flow diagram developed by Klöckner

Humboldt ", the hardware design is somewhat different from previous (Fig. 5).

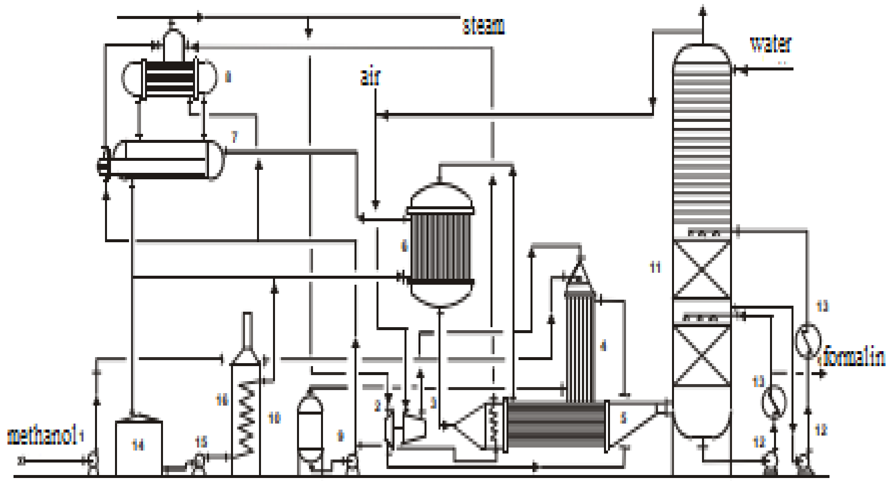


Figure 5 - Technological diagram of the German company "Klöckner-Humboldt "

1 - methanol pump; 2 - blower for air / offgas mixture; 3 - steam turbine; 4 - methanol evaporator; 5 - working mixture superheater; 6 - reactor; 7, 8 - coolant vapor condensers; 9 - condensate pump; 10 - condensate collector; 11 absorber; 12 - formalin pumps; 13 - absorber coolers; 14 - coolant reservoir; 15 - pump for circulation of the coolant when starting up the installation; 16 - heating agent heating furnace

Here, the injected mixture of air with exhaust gas enters the conical cover and then into the tube space of a vertical heat exchanger heated by hot steam condensate from a steam turbine. Methanol is fed into the same top cover through a shower-type spray nozzle and evaporates. This heat exchanger is installed on another horizontal heat exchanger, in which the working mixture is overheated by the hot reaction products passing through it and then enters the contact apparatus. Heat is removed by an evaporating heat carrier. The absorber, as in the previous schemes, is three-section: the first two sections are packed, the upper one is disc-shaped.

The reaction products are pre-cooled with evaporating water in a coil mounted in the front chamber of the heat exchanger. The blower is driven by a steam turbine running on steam from the installation. In the proposed technological scheme, the power consumption is the lowest in comparison with all other schemes, but there is no commercial water vapor.

Research Methodology: System analysis of the formalin production process flow diagram at Navoiazot JSC in Uzbekistan.

The description of the technological scheme is given in accordance with [3].

The method for the production of formalin from methanol consists in obtaining formaldehyde on a catalyst "silver on a carrier" at a temperature of 550 °C ÷ 700 °C , followed by its absorption in water and rectification. The formalin production process for one technological line consists of the following stages:

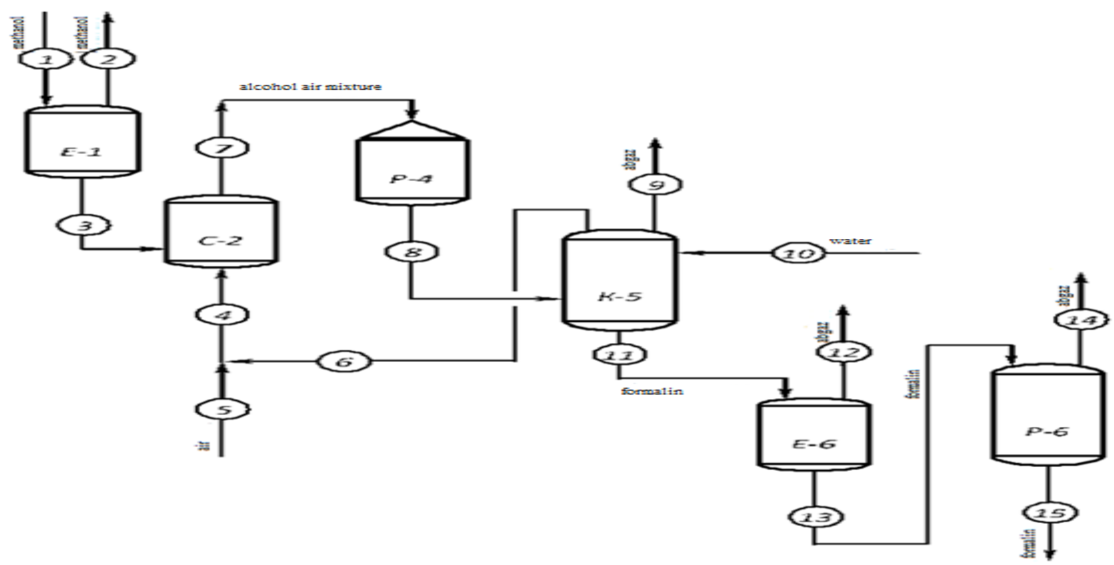
- obtaining a methanol-air mixture;
- synthesis of formaldehyde;

- absorption of formaldehyde to obtain "raw formalin";
- rectification of "raw formalin". The knots common to all threads are:
- collection and processing of substandard and drained products,
- purification of gas emissions,
- Combustion of absorption gases in a flare, heat supply, collection and pumping of condensate.

The auxiliary nodes are:

- preparation of the catalyst,
- storage and shipment of formalin,
- thermal disposal of waste.

A graphic representation of the stage of obtaining a methanol-air mixture and the stage of contacting is given on FYURA PF 000.000 ST.



Analysis and results: Getting a methanol-air mixture

Methanol from the warehouse is fed through check valves to the “methanol manifolds”, where return methanol from the rectification units is added to the “fresh” methanol. Methanol (for one process line) from

"Methanolic comb" pre warmed in embedded heat exchangers absorption column pos. K16 up to 65 ° C and enters the alcohol evaporator for the formation of a methanol-air mixture. To reduce the side reactions of the formaldehyde production process, methanol in the mixer pos. X11 is miscible with demineralized or oversized water.

CONCLUSION/RECOMMENDATIONS: The work was to determine the possibility of expanding the production of formalin using the example of a formaldehyde synthesis unit.

However, an increase in productivity entails an increase in the heat load on heat exchangers and, as a consequence, an increase in the consumption of heat carriers (refrigerants). Also, to ensure the required degree of conversion of methanol into formaldehyde, it is necessary to increase the amount of catalyst loaded into the contact apparatus.

Along with this, in the project, the issues of analytical and technological control of the process, ensuring safe production conditions and environmental protection were considered.

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