UDC 665.62

GRAPHICAL MODELING METHOD APPLICATION IN CONSTRUCTION OF PETROCHEMICAL PLANT BLOCK-DIAGRAM

ПРИМЕНЕНИЕ МЕТОДА ГРАФИЧЕСКОГО МОДЕЛИРОВАНИЯ В ПОСТРОЕНИИ БЛОК-СХЕМЫ ЗАВОДА НЕФТЕХИМИЧЕСКОГО ПРОФИЛЯ

V.V. Fomina, Yu. A. Zharinov, A. Yu. Abyzgildin,
FSBEI HPE “Ufa State Petroleum Technological University”,
Ufa, the Russian Federation

Фомина В.В., Жаринов Ю.А., Абызгильдин А.Ю.,
ФГБОУ ВПО «Уфимский государственный нефтяной технический университет», г. Уфа, Российская Федерация
e-mail: infair@yandex.ru

Abstract. The article represents a block diagram executed by a new method. A traditional block diagram has quite a few drawbacks: place and location of blocks are not clearly defined; orientation and direction of lines are not determined by their configuration and material flow properties; communications within the plant structure form an intricate network of lines; it is difficult to trace some connections as well as to extract information contained in the diagram; the system of relationships is impossible to visually identify. Thus, the conventional methods of block diagram construction create cumbersome and uninformative graphical representations of production. The new method involves graphical modeling. Optimization of petrochemical production graphical representation is carried out on the example of a plant which is a structural unit of the largest petrochemical complex in Russia. An analysis of petrochemical production structure was carried out, its results are presented. The plant has two

productions: production of ethylene, propylene and liquid pyrolysis products containing a significant amount of aromatic hydrocarbons; plastics production. The plant production cycle is divided into petrochemical process blocks. Each production consists of several process blocks. A linear network with process blocks is constructed. Elements and their connecting bonds are arranged in a certain order. The plant block diagram is constructed by connecting all the blocks of single processes. This graphical model of a plant block diagram is more descriptive and easier to use for system analysis; it forms unified graphical representation of a petrochemical plant.

Due to the graphical modeling method system, petrochemical production block diagrams are represented in a significantly simplified form, convenient for analysis, storage, processing and using the information contained in graphic models of petrochemical processes.

Аннотация. В статье представлена блок-схема, выполненная новым способом. Традиционная блок-схема имеет множество недостатков: место блоков и их местонахождение четко не определено; ориентация и расположение линий не определяется их составом и свойствами материальных потоков; коммуникации в структуре завода образуют сложную сеть линий; затруднительно проследить некоторые связи; сложно извлечь информацию, содержащуюся в чертеже; визуально невозможно определить систему связей. Таким образом, обычные методы построения блок-схем создают громоздкие и неинформативные графические представления производства. Новый метод заключается в графическом моделировании. Оптимизация графического представления нефтехимического производства осуществляется на примере завода, который является одним из структурных подразделений крупнейшего нефтехимического комплекса в России. Проведен анализ структуры нефтехимического производства, представлены его результаты. На заводе действуют два производства: производство этилена, пропилена и жидких продуктов пиролиза, содержащих значительное количество ароматических

углеводородов; производство пластмасс. Производственный цикл завода разбивается на блоки нефтехимических процессов. Каждое производство состоит из нескольких блоков процессов. Составлена линейная схема, на которой располагаются блоки процессов. Элементы и их связующие расположены в определенном порядке. Блок-схема завода построена путем соединения всех блоков отдельных процессов. Данная графическая модель блок-схемы завода является более наглядной; легко подвергается системному анализу; образует единое графическое представление завода нефтехимического профиля. Благодаря системе метода графического моделирования блок-схемы нефтехимических производств, представляются в существенно упрощённом виде, удобном для анализа, хранения, переработки и использования информации, заключенной в графических моделях нефтехимических процессов.

Key words: method of graphical modeling, block diagram, petrochemical processes, graphic model, petrochemical production, ethylene, propylene, structural analysis, system analysis.

Ключевые слова: метод графического моделирования, блок-схема, нефтехимические процессы, графическая модель, нефтехимическое производство, этилен, пропилен, структурный анализ, системный анализ.

Modern petrochemical plants deal with processing a wide range of raw materials of various compositions. These plants have a lot of facilities, equipment and connecting pipelines of many kilometers. A large number of elements and their bonds make traditional block diagram construction rather complicated. It provides no structure in arrangement of blocks and direction of connecting lines (Figure 1).

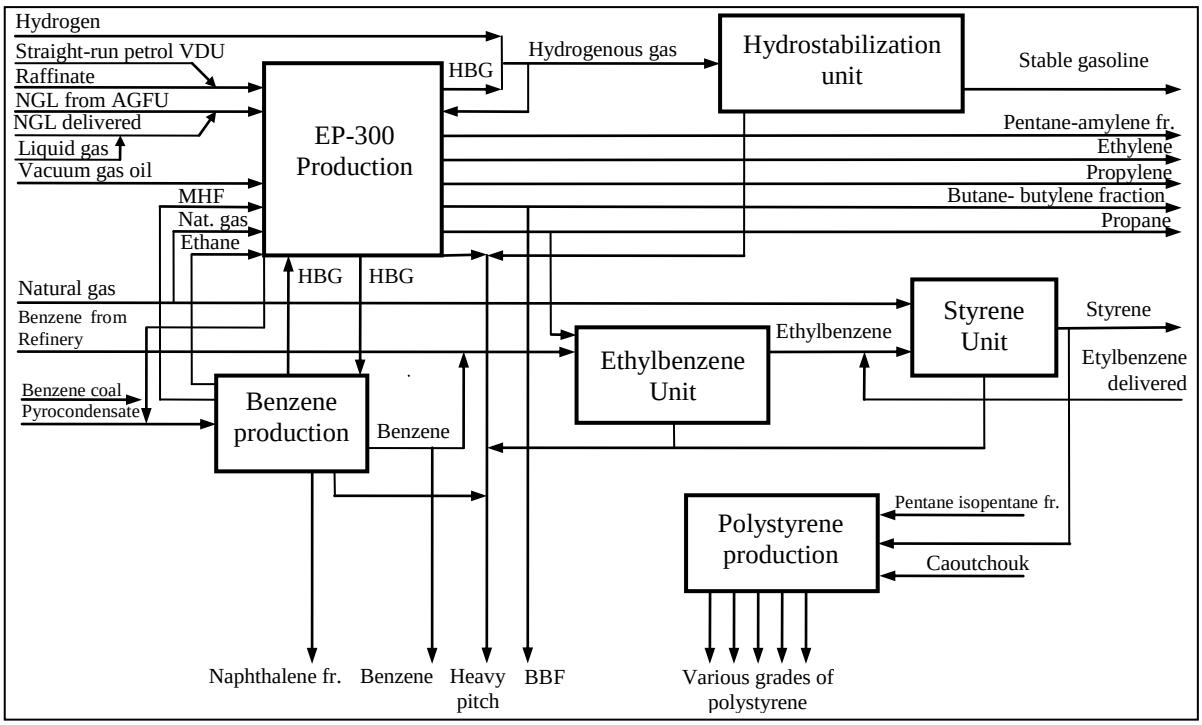

Figure 1. Plant block diagram constructed by traditional method

A traditionally constructed block diagram has many drawbacks: place and location of blocks are not defined by their purpose; orientation and direction of lines are not determined by their configuration and material flow properties; communications between units form an intricate network of lines; it is difficult to trace some connections and extract the information contained in the diagram; relationships are impossible to visually identify.

Thus, conventional methods of block diagram construction create cumbersome and uninformative graphical representations of production.

It is obvious that the block diagrams should be presented in a new way.

Optimization of graphical representation is of great theoretical and practical importance because a block diagram is the main document describing production process of any industrial enterprise, and its purpose is to show relationship between its elements. The more comprehensive is the picture of industrial production graphically displayed, the clearer and more convenient the production process will be for analysis and study.

Optimization of petrochemical production graphical representation is performed on the example of a plant which is a structural unit of the largest

petrochemical complex in Russia. An analysis of the structure was carried out and a block diagram of the plant was constructed by method of graphical modeling [1,4,5].

The plant is organized on the basis of production based on oil stock-gasoline chemical processing, NGL, ethane pyrolysis for production of ethylene, propylene and pyrolysis liquid products, containing a significant amount of aromatic hydrocarbons used as raw material for petrochemical synthesis.

A structure of the plant block diagram structure constructed by graphical modeling method is presented in Figure 2.

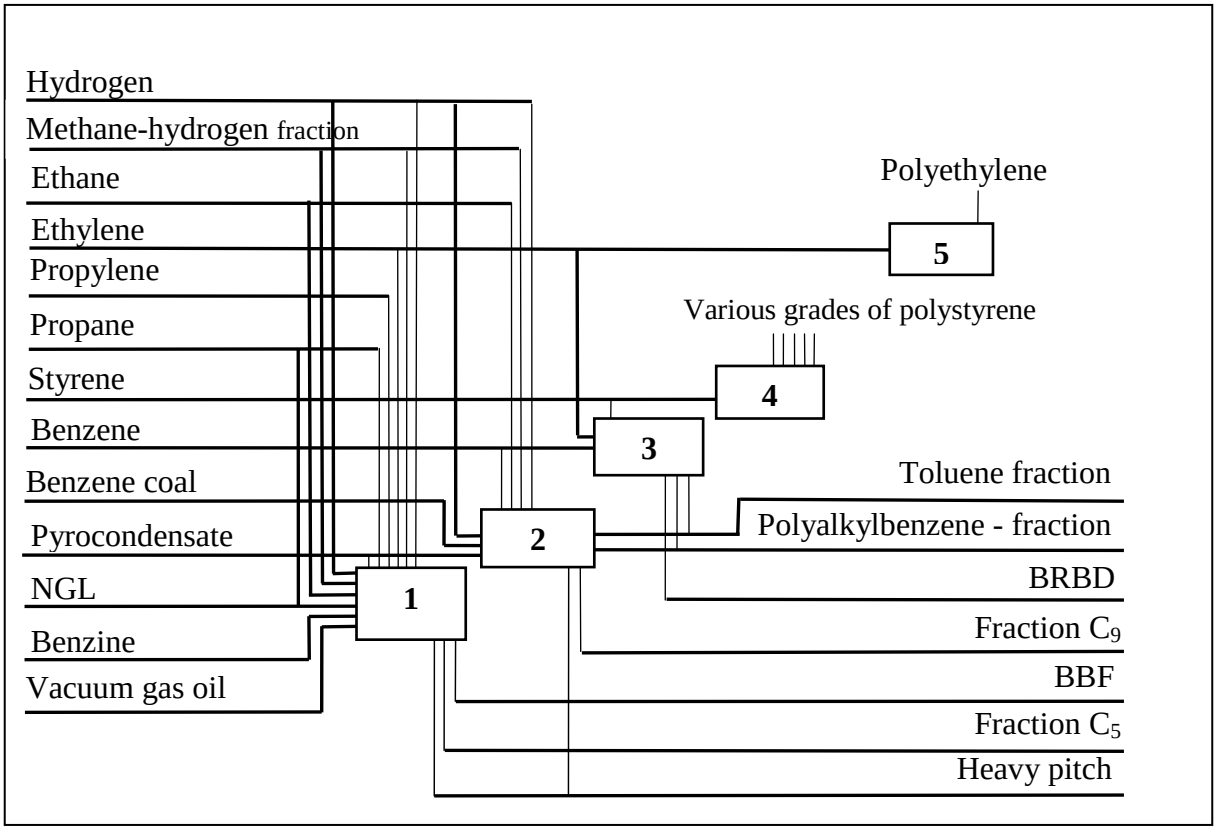

Figure 2. Plant process block association scheme: 1 – pyrogas obtaining , preparation and separation; 2 – pyrocondensate processing; 3 – ethylbenzene, styrene production; 4 – polystyrene production; 5 – high pressure polyethylene production

Feedstock lines are positioned horizontally from bottom to top in the order obtained for processing, product lines are positioned vertically from left to right on the products. The production cycle of the plant is divided into petrochemical

process blocks. First the linear network is constructed, with further arrangement of process blocks on it [2, 3, 6].

The plant has two productions: ethylene, propylene production and plastics production.

The basic blocks of ethylene, propylene production combine the following processes:

• pyrogas obtaining from hydrocarbons, pyrogas preparation and separation;

• pyrocondensate processing.

The basic blocks of plastics production combine the following processes:

• alkylation of benzene with ethylene and transalkylation of diethylbenzene followed by alkylate rectification with ethylbenzene production, dehydrogenation of ethylbenzene followed by hydrocarbon condensate rectification with styrene production;

• production of polystyrene by polymerization of styrene;

• production of high-pressure polyethylene by polymerization of ethylene.

Process block structure construction is similar to that of a plant block diagram structure.

Block diagram of a plant is constructed by connecting all the process blocks. After arrangement of the elements and their connecting bonds, the block diagram shown in Figure 2 can be presented in a form shown in Figure 3.

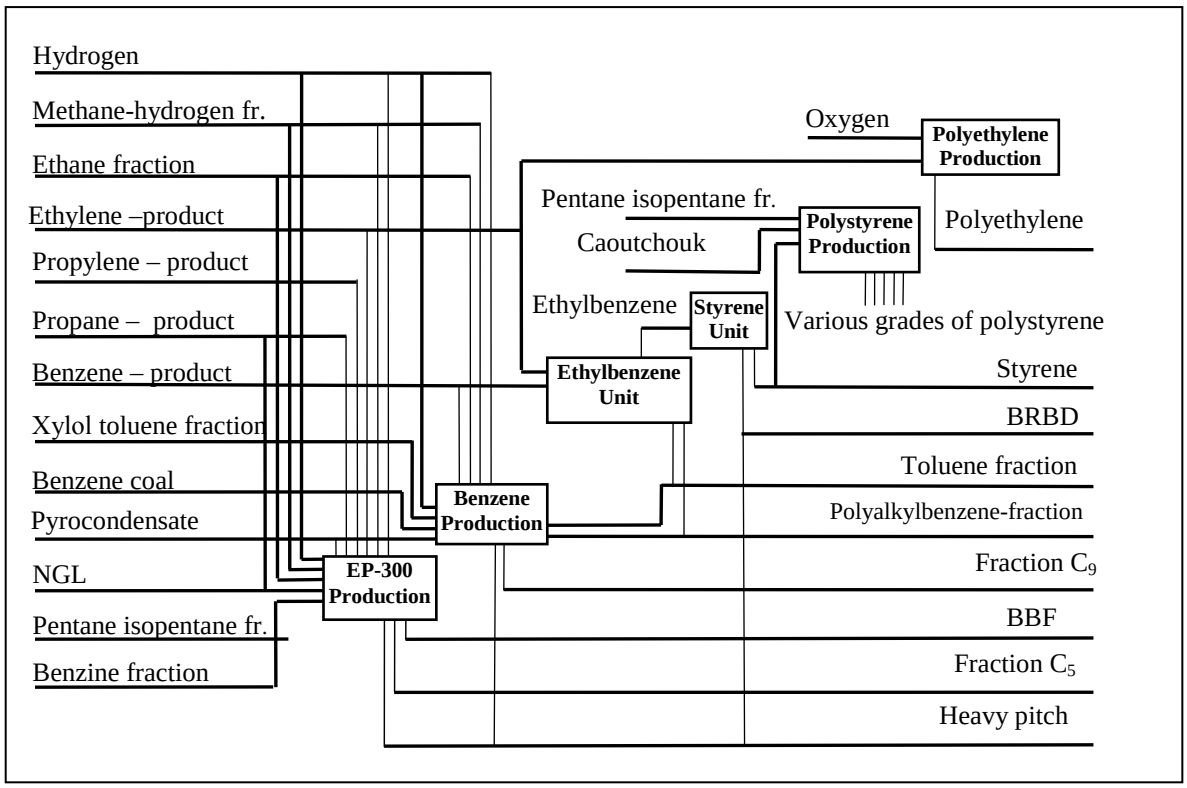

Figure 3. Plant block diagram constructed by graphical modeling method

Refined products and gas condensate from an oil refinery are used as raw materials for obtaining pyrogas from hydrocarbons, preparing and separating pyrogas. The main products are ethylene used as feedstock for polyethylene and ethylbenzene production, propylene used as the main feedstock for production of butyl alcohols, pyrocondensate used as feedstock for benzene production.

The block of benzene processing consists of benzene production. The production cycle of benzene production from gasoline pyrolysis is a link in the process chain for manufacture of plastics. The benzene produced is a raw material for ethylbenzene and styrene production.

C_9 fractions is a byproduct of benzene production that goes to hydrostabilization unit.

The block of ethylbenzene, styrene production consists of two units. The main product is styrene, 20-25% of which is used for production of various polystyrene plastics.

Manufacture of plastics finally closes the production cycle from petrol on the pyrolysis furnace – producing ethylene, propylene, pyrocondensate, benzene,

styrene to obtain the final product – polystyrene which is a marketable product itself and is used for manufacture of consumer goods.

Part of ethylene is used as feedstock for production of high pressure polyethylene.

Conclusions

Thus, as a result of the structural analysis performed a petrochemical plant block diagram with a more ordered structure was constructed on the basis of graphical modeling method.

The graphical model of the plant block diagram is more descriptive and easier to use for system analysis; it forms a unified graphical representation of the petrochemical plant profile, showing connection between its production processes.

The system of the graphical modeling method establishes a clear relationship in the image of block diagrams; represents block diagrams of petrochemical production in a significantly simplified form, convenient for analysis, storage, processing and using the information contained in the graphic models of petrochemical processes.

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About the authors

Сведения об авторах

V.V. Fomina, Candidate of Engineering Sciences , Associate Professor of the Chair «Chemical and Technological Processes», FSBEI HPE “Ufa State Petroleum Technological University”, Salavat Branch, the Russian Federation.

Фомина В.В., канд. техн. наук, доцент кафедры «Химико-технологические процессы» ФГБОУ ВПО УГНТУ филиал, г. Салават, Российская Федерация.

E-mail: asterhtp@mail.ru.

Yu.A. Zharinov, Candidate of Pedagogical Sciences, Associate Professor of the Chair “General Scientific Disciplines”, FSBEI HPE “Ufa State Petroleum Technological University”, Salavat Branch, the Russian Federation.

Жаринов Ю.А., канд. пед. наук, доцент кафедры «Общенаучные дисциплины», ФГБОУ ВПО УГНТУ, филиал, г. Салават, Российская Федерация.

E-mail: jurajarinov@yandex.ru

A.Yu. Abyzgildin, Doctor of Engineering Sciences, Professor, Head of the Chair “Engineering Graphics”, FSBEI HPE “Ufa State Petroleum Technological University”, Ufa, the Russian Federation.

Абызгильдин А.Ю., д-р техн. наук, профессор, заведующий кафедрой «Инженерная графика» ФГБОУ ВПО УГНТУ, г. Уфа, Российская Федерация.

E-mail: infair@yandex.ru.