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CONTROL OF THE TECHNOLOGICAL PROCESS OF OBTAINING POLYPROPYLENE BY ALKALINIZING, WASHING AND DRYING THE PROPANE-PROPYLENE FRACTION (PPF)

Y. SARDAROV[1*], I. ZAFARLI[2], N.SH. HUSEYNOVA[3,4], §

Abstract. The work is devoted to the control of the technological process of obtaining polypropylene by alkalizing, washing and drying the propane propylene fraction (PPF). As a scientific innovation in the presented work, the following should be noted: 1) For the first time, a dynamic expert system has been created for the technological process of obtaining polypropylene by the above-mentioned method; 2) A dynamic database has been developed that provides storage and use of fractographic data used in the management of the technological process of obtaining polypropylene; 3) Appropriate instrumentation have been selected and their activities in the system have been provided for the full automatic implementation of the processes of production, primary processing and maintenance of the regime parameters of the technological process; 4) Algorithms for the initial processing of setting values of parameters for the management of the technological process have been developed; a complex of relevant programs for questioning and processing of transmitters has been created. To ensure the security of the database developed by me in SQL Server, it is first necessary to create users and assign them appropriate access privileges, including management, data editing, device addition, and other related operation.

Keywords: data pre-processing, decision support, expert system, logical inference mechanism, database.

AMS Subject Classification: 9010, 68T35.

1. Introduction

Oil Refinery (OR) is a continuous production area with a complex structure, various technologies, a large flow of materials. In the process of making operational management decisions at oil refining and petrochemical enterprises, it is important to provide the decision-maker (DM) with current information. Managerial DM is a cyclical process.

[1]Azerbaijan State University of Oil and Industry, Baku, Azerbaijan
e-mail: yagub53@mail.ru
[2] Oilgasscientificresearchproject Institute of State Oil Company of Azerbaijan Republic, Baku, Azerbaijan
[3] Baku State University, Institute of Applied Mathematics, Baku, Azerbaijan
[4] Azerbaijan Technical University, Baku, Azerbaijan
* Corresponding author: Yagub Bali Sardarov, yagub53@mail.ru
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This process includes the stages of preparation, acceptance and implementation of solutions that are consistently and uninterruptedly controlled. The collection and primary processing of data with the required frequency is one of the main issues in the field of uninterrupted production. In order to manage each process, it is necessary to periodically use the indicators of the main parameters characterizing it. The production of polypropylene by alkalizing, washing and drying PPF is one of the complex technological processes of petrochemical enterprises. Here, management decisions are often caused by various problems. In the process of making managerial decisions in real practical situations, the DM is faced with a number of technological and methodological problems. To solve some of these problems, a dynamic expert system for controlling technological processes for the production of polypropylene was developed at the oil refinery. At the same time, a logical extraction mechanism was developed. In expert systems, the logical inference mechanism applies knowledge to the solution of a real problem, ensures the selection of the best knowledge from the knowledge base (KB) during process management. In fact, it acts as a KB interlocutor. It is possible to perform extractions from the KB in both straight and reverse ways. Production models were used to describe the knowledge. The expert system must also contain the facts for specific cases. This also includes dynamic data characterizing situations. And for the use of fractographic data, a database (DB) has been created. The DB periodically contains the values of the main technological parameters characterizing the object, which helps the DM in making managerial decisions. The created DB consists of four tables. Each of these tables refers to one of 4 processes. Tables are created in SQL Server Management Studio 2012. DB diagrams provided by the SQL Server DB management system were used to establish and describe the relationship between the tables created in SQL server.

As in all production areas, the oil refining industry is always on the agenda with the use of new information technologies in managerial DM [4, 8]. The analysis shows that the use of artificial intelligence is of great importance in the management of the technological process of alkalizing, washing and drying PPF in order to obtain propane propylene. The work provides assistance to the DM by creating a dynamic expert system in the field under consideration, as well as a dynamic DB. This is also an urgent issue in the management of the technological process in question.

For this purpose, the work considers the solution of the following issues:

- creation of database for operational management of PPF alkalization, washing and drying section for obtaining polypropylene in catalytic cracking unit.
- creation of a dynamic expert system for DM in the process of obtaining PPF.

The regime parameters characterizing the technological process are determined.

The selection of relevant information-measuring devices is justified in order to carry out the processes of production, primary processing and maintenance of regime parameters fully automatically. After that, these devices were installed and started operating in the system. The process modelling was carried out in the MATLAB environment [10].

The collection and processing of primary data for the control of the main production at the oil refinery, as well as the management of the technological process of obtaining propane-propylene, is the main primary issue in operational management. Therefore, in order to promptly collect the current prices of technological parameters characterizing the processes, to ensure control over them, algorithms for the initial processing of setting the prices of parameters for the management of the technological process have been developed, and a complex of relevant programs for the query and processing of transmitters has been created on the basis of these algorithms. For the implementation of these algorithms on a computer, a software complex was created in the Delphi environment. Delphi

XE7 application software package belonging to Embarcadero Delphi family belonging to Borland software company was used for implementation of the software complex. In order to ensure security in the created software complex, depending on the powers of the person who wants to implement the program, they were given different logins and each of these logins was assigned a password. The logins are divided into four parts. "ADMIN", "OPERATOR", "MANAGER"and "USER".

2. Problem statement and preliminary results

Each employee is required to enter a password after selecting a login credential. Database access rights and permitted operations are defined by the system administrator and, in soma cases by the Admin.

The algorithms included in the complex of programs implementing the algorithms for querying and controlling transmitters are as follows:

(1) Algorithm for querying transmitters.
(2) Transmitter control algorithm.
(3) Integrated transmitter query and control algorithm.
(4) Production cost calculating algorithm.
(5) Algorithm for calculating production weight coefficients over time T.

The processes in the technological facility where the process is carried out include:
- hydrotreatment of diesel distillate.
- catalytic cracking and rectification.
- absorption and gas fraction.
- heat utilization and Heat Supply.
- purification of smoke gases from Catalyst dust.

The dynamic database in which we work periodically contains the values of the main technological parameters characterizing the object, which helps the DM in making managerial decisions. Here, the periodicity of filling the mode sheet is once every 2 hours.

The database created for the operational management of the section of alkalization, washing and drying of PPF in order to obtain polypropylene in the catalytic cracking unit where the process is carried out consists of four tables. The attributes established for each of the 4 mentioned processes are defined. At the stage of implementation and realization of dynamic DB, tables were created using SQL Server Management Studio 2012 database management system, which is a product of Microsoft and is intended for the creation of information systems with "client-server" architecture, as well as belonging to the relational model database management system group and belonging to the SQL (Structured Query Language) Server family [7]. Because this type of database management system meets the requirements of scattered information processing systems, supports data copying, parallel processing, creation and processing of large-scale databases, differs in simplicity of management and use, and provides mutual integration of databases with the internet and Intranet environment. The tables are named as follows:
- absorption-desorption column;
- stabilization column;
- propane column;
- the values of the defined limit of the parameters.

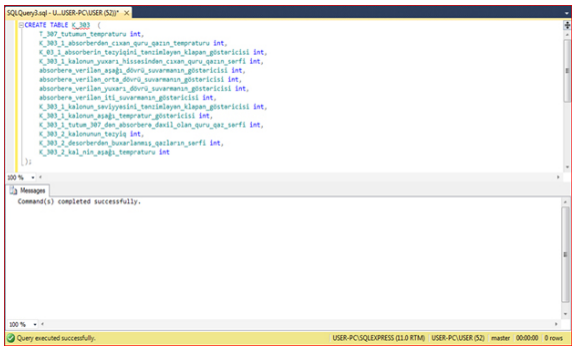

Figure 1. Creation of absorption- desorption column table.

Entering data related to that column is described in Figure 2, and searching in the table is described in Figure 3.

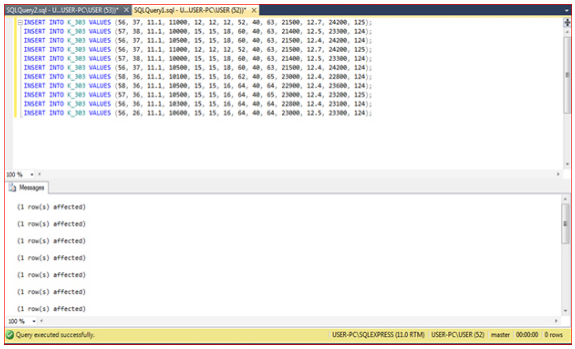

Figure 2. Entry of data.

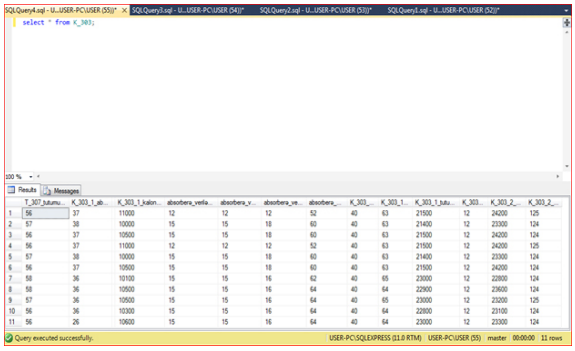

Figure 3. Data in the table.

The "NEZ_PP" dynamic expert system [13] has been created for use in the management of the technological process by taking polypropylene, processing PPF, washing and drying (Figure 4).

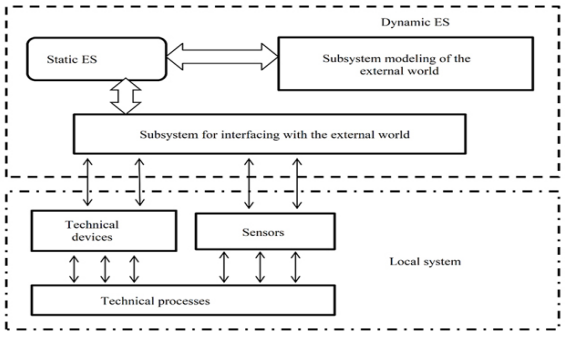

Figure 4. 'NEZ_PP" dynamic expert system.

3. Mathematical models and solution algorithms for the automation of PPF processing

The inference subsystem (solver) of the dynamic expert system for managing the technological processes of polypropylene production at the Refinery consists of a Knowledge Base [13], a database and a inference mechanism (Figure 5).

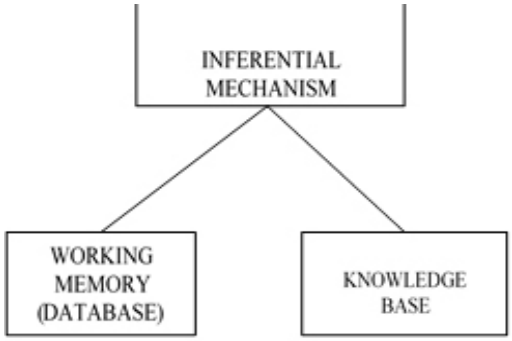

Figure 5. General structure of the inferential mechanism.

The knowledge base consists of production in the form of "if-then". We have divided them into two groups: emergency productions and technological productions. Here are some of these productions:

1. Productions for emergency situations:

1.1. If oil products are not changed during insulation impregnation, then the insulation materials ignite on their own.

1.2. If a fire occurs at the plant, then the direct supply of raw materials to the plant must be stopped.

2. Productions of a technological nature:

2.1. If a preventive examination of equipment is carried out irregularly, this can lead to failure of both equipment and some components and devices.

2.2. If the pumps are not cooled during operation, this can lead to pump failure.

Both direct and reverse implementations of quotation from the knowledge base are possible. A rule base for fuzzy knowledge was also created. At this time, you must do the following:

1. There must be at least one rule for each linguistic term of the output variable.

2. For any term of the input variable, there must be at least one rule in which this term is used as a prerequisite.

An imitation model has been created for data analysis. The computer imitation model (simulation methods) is increasingly used in matters of researching and designing production systems. Unlike real production systems, the parameters of which for experimental research are allowed to be changed only in exceptional cases and with very strict restrictions, simulation models of machines are used to conduct a wide variety of complex experimental studies organized in the order of laboratory bench tests and the like [1, 3, 5, 6, 12].

4. Mathematical models and solution algorithms for the automation of PPF processing

Designing new technological lines and production processes of an oil refinery (oil refinery) is one of the most important tasks of machine simulation. To ensure the continuous

growth of production productivity, it is necessary to constantly improve its technology, organization, planning and management.

In machine modeling of production systems, the output of products is simulated on a certain accepted Time Scale, which creates quasiexperimental conditions for the study of processes. The values of the variables characterizing the state of the system are recorded and processed step by step over time. Thus, during simulation, it is necessary to ensure as accurately as possible the similarity of processes observed only in practice and processes reproduced in machine experiments with models. To this end, modeling methods and tools are being developed that determine the possibilities of the simulation approach as a method of solving practical problems in the production sector. The reliability of the results obtained during modeling depends on the accuracy of modeling real behavior, which in turn is determined by the accuracy of the simulation model and the simulated system. The latter applies both to the volume or complexity of the model, as well as to the problems of simulating various structural representations of systems, as well as to stochastic aspects of simulation.

The database (working memory), as we mentioned above, is designed to store primary and intermediate information about the task currently being solved [9-11].

The database stores the actual data for analysis and decision-making on the operational management of the refinery.

This is the mechanism we have proposed for analysing and making decisions about situations that may arise at the facility.

The automation of decision-making (DM) can be formulated as follows. Let's assume that a number of circumstances may arise at the facility:

$$S = \{S_z\}, z = 1, 2, \ldots, m.$$

Each state of Sz is characterized by a number of characteristics:

$$P_{S_z} = \{P_i \ S_z\}, i = 1, 2, \ldots, n.$$

The presence of the $P_i \ S_z$ state leads to a fuzzy set of $D_{P_i \ S_z}$ states with the $\mu_{D_{P_i \ S_z}}$ membership function.

The structure of the $\mu_{D_{P_i \ S_z}}$ membership function is based on the study of an expert opinion on the compliance of a certain set of situations with the situation under consideration. At the same time, the expert evaluates the degree of compliance in the form of linguistic expressions.

Then the set of fuzzy states corresponding to the Sz state with the $P_i \ S_z$ feature set is defined as:

$$D_{S_z} = \bigwedge_{i=1}^{n} D_{P_i \ S_z},$$

or the transition to the membership function (herein, $\bigwedge_{i=1}^{n}$ −conjunct) :

$$\mu_{D_{S_z}}(d) = min_i \mu_{D_{P_i \ S_z}}(d).$$

The best action in this case will be the action in which the value of the membership function $\mu_{D_{S_z}}(d)$ will be the maximum, that is

$$d* = sup(\bigwedge_{i=1}^{n} D_{P_i S_z}),$$

or

$$d* = argmax\ \mu_{D_{S_z}}(d) = argmax[min_i \mu_{D_{P_i S_z}}(d).$$

A dynamic expert system has components of a static expert system, as well as subsystems for modelling the external environment and interaction with the external environment.

5. Conclusions

In conclusion, we can mention the following:

(1) A complex of programs implementing the algorithms for querying and controlling transmitters for primary data has been implemented.
(2) The created system was implemented using Delphi programming technology, SQL Server Management Studio 2012 database management system and SQL programming language operators were used to organize operations and search on data according to user requests, as well as to store these data in the database.
(3) A dynamic expert system has been developed to assist the decision-maker in the field of managing the technological process in question in order to obtain propane-propylene.
(4) To perform the operation of fuzzy inference, a rule base has been created containing fuzzy expressions in the form of a basic "If-then" and the functions of belonging to the corresponding linguistic terms. A mechanism has also been developed for analyzing situations that may arise at the facility and making decisions in conditions of uncertainty.

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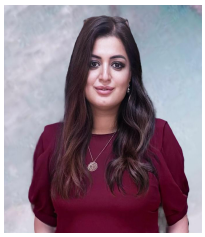
Yagub Sardarov is a Candidate of Technical Sciences at the Department of Computer Engineering, Azerbaijan State Oil and Industry University. His research focuses on systems analysis, artificial intelligence, and fuzzy logic. He has published peer-reviewed articles in these areas.



Ilaha Zafarli is a research fellow at the Oil and Gas Scientific Research Project Institute. She is currently a Ph.D. candidate at Azerbaijan Oil and Industry University. Her research interests include systems analysis, management, and information distribution.

Nargiz Huseynova received Ph.D. degree from Baku State University in 2015. She is currently a senior researcher at the Institute of Applied Mathematics of Baku State University. Her research interests include quantum mechanics and optimization.