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THESIS

Intellegent process control system for oil refinery

Speciality: **Computer Engeneering and Management**

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Реферат

В данной работе рассматривается интеллектуальная система управления (ИСУ) технологическими процессами в нефтеперерабатывающем производстве. В качестве примера выбран технологический процесс каталитического крекинга. В работе исследуется технологический процесс каталитического крекинга, его технологические особенности, анализ как обьекта управления.

Работа показывает реализацию интелектуальной системы управления технологическим процессом каталитического крекинга и функциональную схему управления. Интеллектуальная система управления технологическим процессом каталитического крекинга предназначена для применения на нефтеперерабатывающем предприятии. Большие размеры установки, нестабильность качества сырья сложность связей между узлами, непрерывность технологического процесса, а также большое количество параметров характеризующих процесс каталитического крекинга
обусловили необходимость разработки интелектуальной системы управления. Использование ИСУ, основанной на знаниях и опыте экспертов повысит эффективность управления установкой каталитического крекинга.

При создании интеллектуальной системы использовался аппарат теории нечетких множеств и методология исскуственного интеллекта.

Достижение поставленной цели обусловило необходимость последовательного решения следующих основных задач:

• Изучение специфики протекания технологических процессов, анализ установки как обьекта управления, а также исследование информационных аспектов управления этой установкой;

Разработка архитектуры интеллектуальной системы управления ехнологическими процессами.

Разработка базы знаний интеллектуальной системы управления ехнологическими процессами;

Реализация интеллектуальной системы управления технологическими процессами;

При разработке данной системы управления особое внимание уделялось представлению знаний о процессе каталитического крекинга и созданию базы знаний. База знаний содержит набор правил, которые сформулированы экспертами в процессе экспертного опроса с учетом технологического регламента. Для организации базы знаний используется продукционный формализм представления знаний. Для ввода знаний в базу знаний используется язык представления знаний(ЯПЗ) ESPLAN.

Abstract

The given work is considering Intelligent control system (ICS) of technological processes for oil refinery. This is chosen technological process of catalytic tracking (CC). The work is researching technological process of catalytic cracking, technological specialties of catalytic cracking process and its analysis as control object.

The work shows the realization of Intelligent control system by technological process of catalytic cracking process and functional scheme of control. Intelligent control system of a catalytic cracking is designed for application in oil plants. Large sizes of setup, nonstability of raw material quality, complexity in connection between the units, the technological process continuity in. and also a great amount of interrebated conditions characterizing the catalytic cracking process have caused the need for Intelligent control system development. The usage of ICS based on the knowledge and experience of high qualited experts would increase the efficiency in controlling the setup of catalytic cracking. When Intelligent System creating, theory of fuzzy sets and methodology of artificial intelligence have been used.

Consequently, the given work is organizing the aim research, which allow to process and realize intelligent system. Achievement of decision goal is caused the necessity of sequence solution by the following problem:

-Learning the specification flow by technological process, analysis of installation as control object, as well as researching of information control aspects by this installation;

-Architecture process of Intelligent control system by technological process;

-Knowledge base process of intelligent control system by technological process;

-Realization of intelligent control system by technological process.

When developing ICS, the special attention has been paid to representation of knowledge basis. The knowledge basis includes the rule set formulated by the

experts during the expert questioning with account of technological regulation. The production formalism of knowledge representation is used for organizing the knowledge basis. For input the knowledge in knowledge base is using knowledge representation language (KRL) ESPLAN.

Contents

Introduction

Installaton of Catalytic Cracking (CC) is leading among the installations of the second oil refinering on the oil refinering industry. Installation is characterized by continuous of technological operations and includes a lot of technological units, which are connected as straight and back material flows. High speeds of chemical reactions which are flow by increased temperatures and pressures are condition on specialities and difficulties of management by setting. The problem of increasing quantity and quality of special product oil and gas with setting catalytic cracking is actual problem, which has the meaning of pertaining to national economy.

The given work is considered Intelligent process control system with technological processes. It consists of introduction, five sections and conclusion.

The first section is critical review of the work about control system of technological processes for oil refinery. Analysis of literature shows that the creation of this control system is based on the knowledge of experts and

information about objects research.

The second section shows the structure of Intelligent control system (ICS) by technological processes.

The third section is researching technological process of catalytic cracking, Technological specialties of CC process and its analysis as control object.

The forth section is consider the construction of fuzzy production model and knowledge representation in ICS. The knowledge base consists of rule of products which is realized on evristical algorithm of taking solution by control with technological processes.

The fives section shows the realization of ICS by technological processes and control scheme (ICS).

I. The state of problem.

1.1 Review of the work by technological process control in oil refinering industry.

The installation of Catalytic Cracking is leading in the oil refinering industry, Therefore review of the work by technological process control will includes intelligent systems for technological process control of catalytic cracking. In **the** last year widespread is the creation and introduction of Automized control **system** (ACS) of different processes. Solved problems are seizing of all kinds **of** control aspects and where the main of which is optimization of installation regime and their separate units. One of more convenient approaches to formalization of information as utilization of fuzzy set theory. Known works [13] by fuzzy sets application of L.A.Zadeh to problems of automatic control for some industrial ects. Their analysis shows that the questions of using apparatus fuzzy sets theory on the stage of optimization control by industrial production and process insufficiently learned. The work [2] is one of the first fuzzy set applications for solving problem of optimization technological installation regime of catalytic cracking. However the given work is not consider about methods of identification fuzzy and dynamic models. Fuzzy model builds in supposing that its structure is ined beforehand, which acts to adequacy of the given model of technological cess. For expression of quality information using the methods of Artificial illigence and technology of Expert Systems (ES).

Expert systems are programs about complex objective areas for IBM. which able to solve problems on the expert-person level and make "human" reasoning method [4-9]. Expert systems are processed and using in the medical diagnostic, mineral deposit research and oil control object and processes, military areas and so on Artificial Intelligent of expert systems is leader in the market means. Half of sells ES are realized on PIBM. The basic presentation views of knowledge base are systems production that is rule of formats "If-Then..." Besides it may be networks, frames [10,11,1 2]. ES often is realized in the Prolog language [13].

Explanatory ability of ES has principle meanings, which allow to "explain" how it comes to certain solutions of problem. With this one just conditioned unusual popularity of ES: arguments, explanation of specialist, that provide friendly intercourse with user.

As practice shows ES is applying in confined distinct objective areas, where necessary to use evristical methods on the base of expert knowledge and their estimations. These are the problems of diagnostic, classification and prediction: problems have a lot of variables (quantities), hard to create full and whole theory so highly skilled expert systems contains only quality knowledge.

The work [14] is considered the concept of intelligent control systems. This concept contains control functions and methods based on knowledge. In the base of this concept there are a lot of special knowledge base. Prototype of intelligent system G2 includes architecture, structure KB, mechanism of sequential logic, diagnostic model. Managers are interesting which problems of decision making may be solved with ES and how should be ES in order to be effective helper in management.

The work [15] is considered review of expert control systems. Expert control systems are developed on the joint of two researching areas: support system of decision making and systems are based on the knowledge. The work has review character by given questions. As well as considering support system of decision making ES control functions (organizational coordinational, control) which of these functions need in support of ES. internal specification of ES (architecture, output mechanism, and knowledge representation languages).

The work [16] is considered the intelligent control systems of real time, Construction process of Intelligent real time controller (IRTC).

Distinctive feature of IRTC, their applications in special situations for which time for decision making are limited. The basic attention is concentrated to description of two autonomy movable robots ASV & ALV, which are illustrated opposite principles of centralized and decentralized control. There are different advantages and disadvantages of common methods and necessary to apply combination of distinctive approaches.

The work [17] is considered about expert system for support intelligent action of person in control process with network collection and information processing, **for** which the basic function is automatically execution procedure of it possible disrepair diagnostic.

The work [18] is suggested works ES of real time GAPOS, which consist of computers and executive mechanisms and destined, for operative control on city gas economy. Intelligent link system is analyze the functions of production process, the series of data time and rule of knowledge base, as well as give the forecast of possible regime deviations. Also are describing requirements which are presented to the system:

a) stability of work;

b) security;

c) accessible on cost.

Discrete-event system leads to creation new methods of analysis and synthesis. Some publications show possible utilization the apparatus of Petri's networк theory.

The work [19] is considered about synthesis method of influence control, able to correct system behavior and provide requirement dynamic features of the system. The basis of method has the idea of separation undesirable state and conditions securing, on which the system can not be found in these states, Undesirable states are defined in the result of theoretic-graphic analysis of Petri's network.

The work [20] is considered the basic problems of distributed intelligent integration system: interaction, specification and information processing, programming languages, coordination of problem solver, controlling. There are descriptions of SOCIAL program facilities for implementation distributed control model. The SOCIAL architecture includes: interface, object class library organization block of distributed int

The work [21] notes that the problem - oriented facilities of control is composite part of integral form the control command system for autonomy inttelligent transport facility. Introduction such facilities allows to realize the coordination of interaction control for robotized subsystems and establish the optimal set of really control attainable aims. There are descriptions of enclosures to problems of intelligent and autonomy control systems (PANORAMA project) as ESPIRIT 2 program project which allows to form control algorithms in the data collection system and navigation systems.

The work [22] is described the execution project research of joint application the neuron network (N planning and support of decision making, peculiar to ES. Prototype includes subystem of instruction and discernment (SID) on the basis of Intelligent System (IS) for monitoring of current network state and ES of real time, with result, control data, for controlling by network, active event, acted from SID. ES use different knowledge types and decision making and distribution of recommendation control.

The work [23] is considered the basic problems and characteristics of intelligent control. There is short description of architecture of floppy and powerful IS which based on conception of announcement table. There are advantages of anal|ysis of this architecture comparison with product and frame system. The given critical review caused the consideration processing of intelligent control system by technological process m oil refinering industry, and Intelligent control system with installation of catalytic cracking on the base of fuzzy nonproduct model and as well as the erection of problem research of thesis, which show in the next paragraph.

1.2 The erection of problem research.

The given review of state and tendentious of control system by technological process of catalytic cracking shows real unformal information about process. Installation is subjected to actions of much indignation. Non calculations of these factors are result in collection of special product and provide their quality. Consequently, the given work is organizing the aim research, which allow to process and realize intelligent system. Achievement of decision goal is caused the necessity of sequence solution by the following problem:

-Learning the specification flow by technological process, analysis of installation as control object, as well as researching of information control aspects by this installation;

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-Knowledge base process of intelligent control system by technological process;

-Realization of intelligent control system by technological process.

II. The structure of intelligent control system by technological process.

2.1 The structure of control system .

The experience of exploitation control system by technological process shows insufficient efficacy of their functioning that connected with features of process (complex characteristics, long measure of installation, unsuitability of raw material quality, complex connections between nodes, difficulty of their mathematical description, continuous of technological process), in such control system is not calculated with difficulty realized quality information about object. There are necessity conditions of intelligent control system on the basis ES technology [24-27]. By process of the given control system take into consideration the knowledge representation about process of catalytic cracking. The structure of IS for controlling
by technological process is represented in the fig.2.1 and includes the following blocks:

-Knowledge base (KB);

-Data base (DB);

-Connection block with object (CBO);

-Explanation block and distribution result (EB and DR);

-Block of logic output (BLO);

-Block of knowledge correction (BKC).

The system is functioning as: with generator, which placed in object, information about mode parameters of technological process acts in the Connection block with object system. Information from center plant laboratory about quality raw material in the intermediate product entered from keyboard of IBM.

All data reflected in the screen of technology-operator. All data stored in DB as file extension Wa. The structure of file extension Wa. is:

< object name>

<meaning>

<object name>

<meaning>

Knowledge base (KB) includes a set of rules, which are formed by experts in expert interrogation process. For organization KB using production formalism of KB More convenient method of construction KB is a product system [24,25]. Product is a rule, which consist of two parts. First part is described exact situation, second part is described a set of actions. The rule of product has the structure:

IF...THEN

Where left side is initial data and right side is action.

For example:

IF	Pressure in reactor=less than norm
AND	Expenditure for raw material=less than norm
THEN	Open regulator of expenditure for raw material
	Disk-bolt until breakdown.

KB control system processing of catalytic cracking is considered in the following paragraph.

The block of logic output is defined task of control. Result is reflected on the screen of operator. Explanation block and distribution results are forming explanation on the basis of tracing logic output, include information about product and sequence of product and prove actions. Operator cannot be agree with IS opinion and install task of control. Knowledge base includes fuzzy production model. This model is using by search of technological mode near nominal.

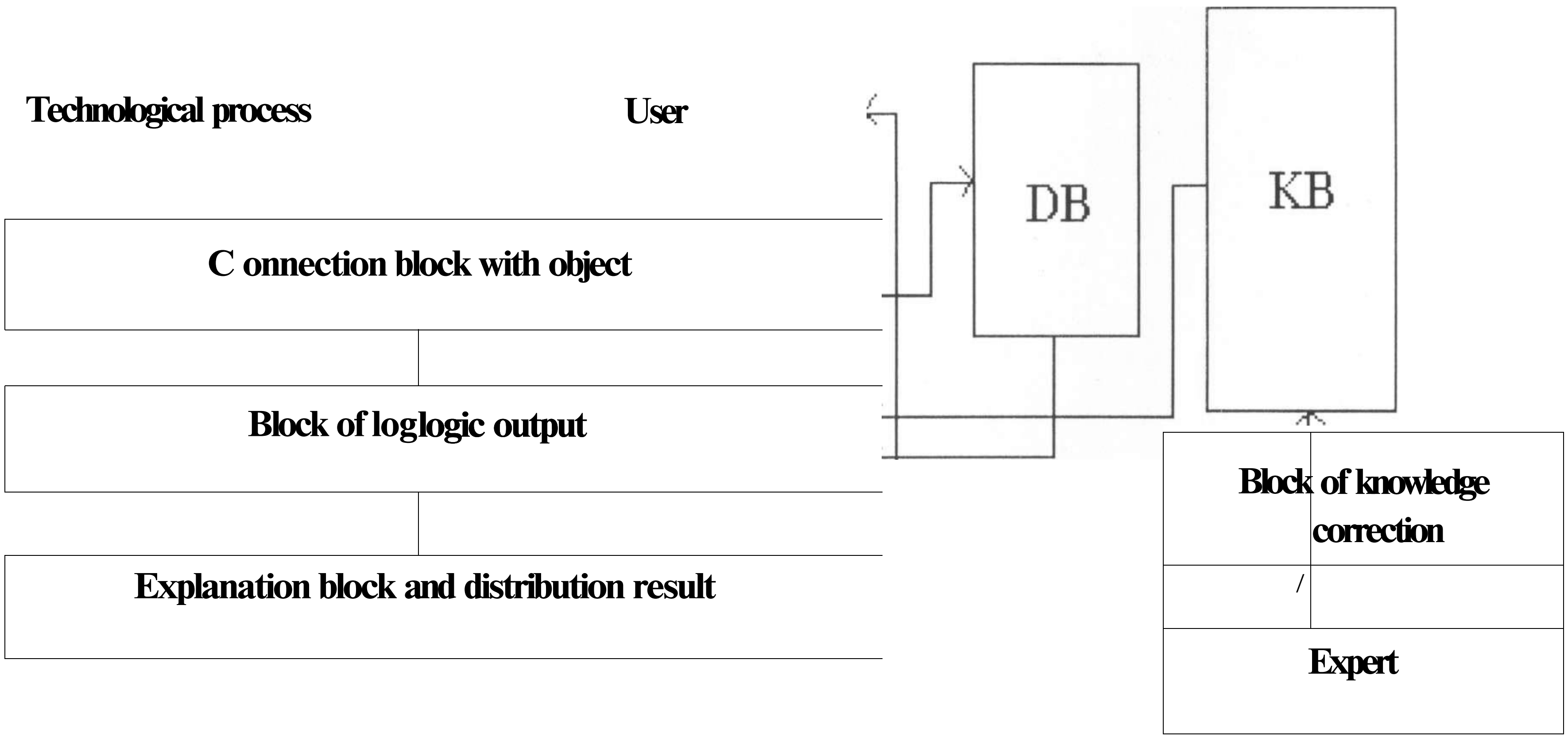


Fig. 2.1. The structure of intelligent control system by technological process

Correction block allows output on the screen, scan and correct the rule in KB. Necessity to modify the rule is arise in the result of changing ingredient of raw material, changing mode of installation and so on.

Removal modification and addition of rule may be earned out with nested text editor. As tools of construction IS for control by technological process is using ESPLAN [28] in the oil refinering industry. As noted, system block ("intelligent" face) is knowledge base. Process of such KB will consider in the paragraph N4.

III. Technological process research of catalytic cracking as control object

Installation of catalytic cracking is destined for processing of vacuum drive (350°-500°C). The short schema of Catalytic cracking installation shown in the fig.3.1 Initial raw material from the goods park reservoir by T=50°C is run through pipe line space of heat exchanger, where it heats to 200° - 240°C. Row material is divided into two flows on the output of heat exchanger and enters into stove T-20°. where it heats until 380°-420°C then it enters in rise stand of first transport line of reactor. Simultaneously, line gets part of reacted catalyst and overheat steam from heating steam, which are using for spray of raw material, decrease pressure steam of raw material and be agent for transport of catalyst. First transport line is partly (49-50%) cracking of raw material. Steam of raw material is heated water steam and catalyst from first transport line enter in the reactor under "boiling" layer of desorption, where by T=455°-475°C take place separation steams of catalyst. Product steam of cracking and water steam pass in top of apparatus through "boiling" layer of two gas distributing grid. Catalyst goes to ward movable steam in the second transport line .Its transport is realize with easy phlegm. Catalyst enters in "boiling" layers of desorption of reactor, where providing the regime counter current flow of catalyst and water steam. Worked off and steamed catalyst enters by standing of reactor in the transport line of regenerator, where joint in current air and goes into regenerator as "seldom" phase for burning the coke. The process of regeneration has high temperature that transfer in to microspherical ceolit content catalyst with higher activity and mound density. Temperature to 650°C is provided intensification process of regeneration by burning coke increasing. Regenerated catalyst enters in transport

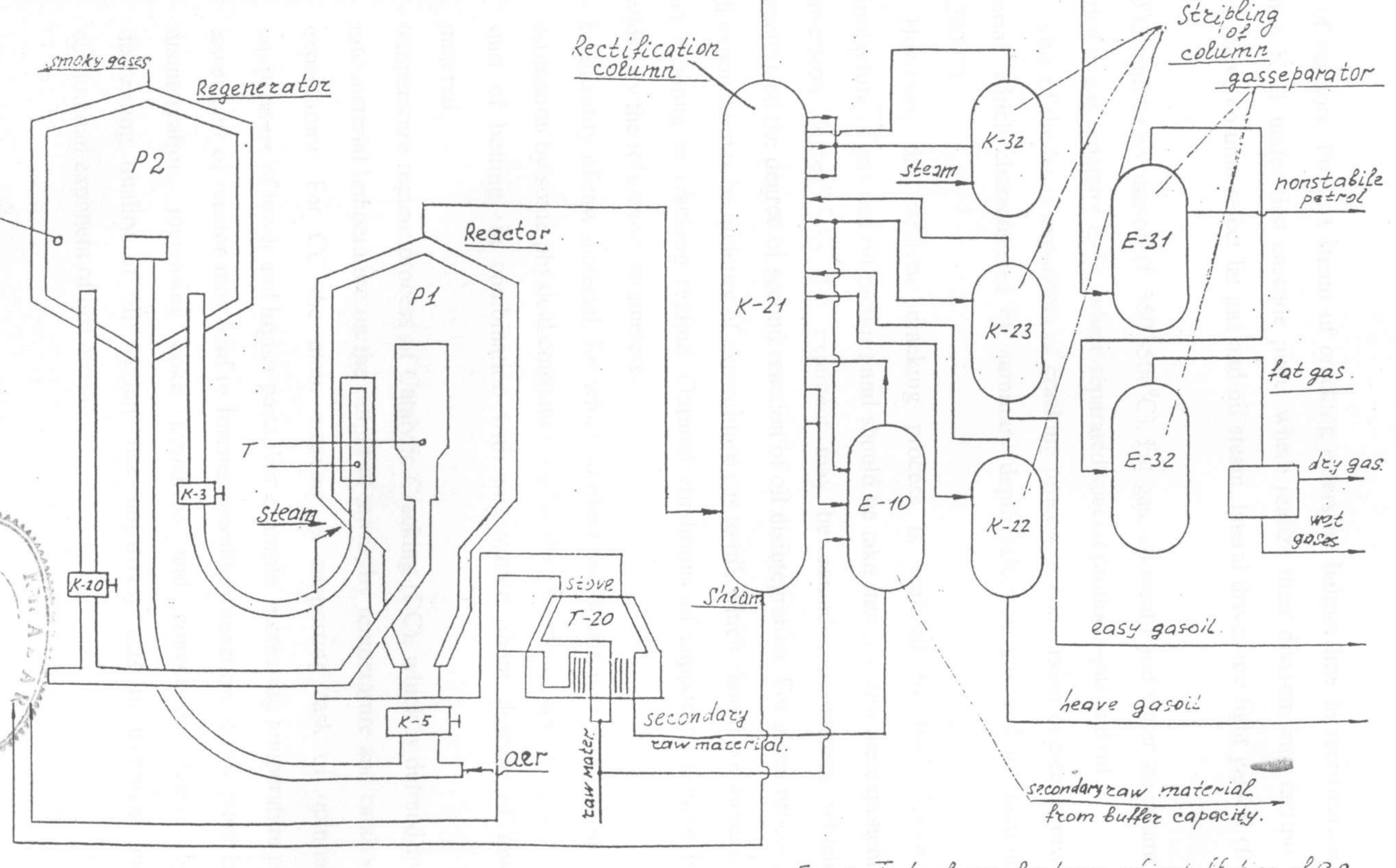


Fig.3.1. Technological scheme of installation of CC.

line of reactors. Product steam of cracking enters by helmet line in rectification column K-21 under *first* cascade plate, where realize their division into faction. From above column select fat gas and oil steam, lateral drives are light gas-oil (f. 195°
-350°C) and heavy gas-oil (f. 350°-500°Q. Fat gas, oil steam and water steam are divided in gas separator E-31, where separated special products-gas and oil.

One of the basis exponents of cracking process is conversion degree of raw material, which characterized by summary depth selection gas and oil faction (f< 200°C).

However, the catalytic cracking process is realized by two regimes (manufacture of gas and oil faction) and should be take into account the exponent "conversion degree". As this exponent may be consider parameters which characterized the degree of second reaction of oil disintegration. For given process such exponent may be quantity of expenditure gas to oil, which should not increase exact meaning in cracking regime. Optimal conditions of supporting regime is provided by the following parameters:

- by quantity of raw material, for which in plant conditions is realized oblique estimation by some physical constant (% of boiling to 350°C, specific gravity, start of boiling) in combination with information about descent of raw material;
- temperature regime process of Catalytic Cracking (CC), which is defined by raw material temperature on the output of stove, by temperature and catalyst expenditure .For CC the main meaning is supporting task of optimal temperature of lower and higher parts. For example, increasing temperature of lower part of reactor may lead to forcing secondary reaction of raw material disintegration, increasing coke formation and conversion degree by decreasing quality of oil faction, that negatively acts to technical and economical exponent of installation;

- Weight speed, which is defined ratio of weight was sent in reactor of raw material for 1 hour to weight of catalyst situated in reaction zone. Weight speed

of giving raw material depends on catalyst degree and raw material expenditure in reactor. With increasing the catalyst degree in reactor the weight speed is decreasing and vice versa. Increasing weight speed is decrease coke formation, degree of raw material conversion and average temperature in reactor.

- Multiple circulation of catalyst is defined by formula:

$$\mathbf{N} = \frac{Qc.c}{Q\ r.m}$$

Where Q_{cc}-is quantity of circulation of catalyst (kg/h)

Q_{rm}-is quantity of raw material giving in transport line of reactor.

Extraordinary flexibility ratio of circulation catalyst to raw material and possibility of modification the quantity of catalyst in reactor gives possibility to modify the depth of cracking in wide limit. Increasing the multiple circulation of catalyst is raise oil quality and increasing the depth of cracking.

- Carbunzation of catalyst is one of the factors, which influenced on quality and non stationary of process. High activity of catalyst is a function of coke remainder with minimal content on catalyst, which entered in to reactor. The coke content on regenerated catalyst is defined by analysis of latest in laboratory.
- Pressure in reactor. Necessary to note that the constant pressure has important meaning in reactor. Modification of pressure in reactor is reflected on the stable circulation of catalyst and heat steam of raw material through standing in regenerator and their inflaming.

Therefore for warning the break of oil steam in regenerator necessary to watch pressure in reactor and do not allow the sharp oscillations. In reactor the pressure is supported in limit 0.03-0.1 MP.

Installation includes the complex of technical units. The functioning of these units as one technological system, is accompanied by execution a set of different operations which should be connected with production activity of installation. Installation is characterized by different functions and it is differed a lot of parameters, which are controlled and regulated.

In practice the realization of control regime is difficult with manufacturing situation by which the modification of parameter requires its output over frame, which installed by order.

Necessary to research CC process as control object. In this case consider the quality exponent where selected "hot points":

-carbunzation of catalyst after regenerator;

-boiling percentage to 350 C;

-conversion degree of raw material;

As input regulator parameters are:

-catalyst expenditure in the first transport line of P1 reactor;

-expenditure of fuel in P2 regenerator;

-expenditure of catalyst in the second transport line of P1 reactor;

There are parameters, which characterized the state of control object:

-temperature in reactor P1 (lower part);

-temperature in regenerator P2;

-expenditure of raw material for installation;

-expenditure of circulation catalyst;

-temperature in reactor PI (upper part);

Catalytic cracking -is a complex and many-factors processes. Units of information have a lot of closed and interconnected material and energetically flows. Processes, which flow in these units, are intercaused. An exponent modification of units is modifying other that is the state of technological process is characterized by complex exponents' totality. All of these are present high requirements to installation control of CC and cause true correlation factors necessity, which defined the direction of CC process on intelligent KB. However, a set of opposite connection is characterized an object as much and interconnection. It is result in non-realized utilization modern

ANC regime and participation of people is important in decision making process. The decision quality of operator depends on knowledge and experience degree. Possibility of formalization and utilization this knowledge's presents as reserve of efficacy control process. The work shows the realization of Intelligent control system by technological process of catalytic cracking process and functional scheme of control. Intelligent control system of a catalytic cracking is designed for application in oil plants. Large sizes of setup, nonstability of raw material quality, complexity in connection between the units, the technological process continuity in, and also a great amount of mterrebated conditions characterizing the catalytic cracking process have caused the need for Intelligent control system development. The usage of ICS based on the knowledge and experience of high qualited experts would increase the efficiency in controlling the setup of catalytic cracking. When Intelligent System creating, theory of fuzzy sets and methodology of artificial intelligence have been used.

When developing ICS, the special attention has been paid to representation of knowledge basis. The knowledge basis includes the rule set formulated by the experts during the expert questioning with account of technological regulation. The production formalism of knowledge representation is used for organizing the knowledge basis. Realization of intelligent system for catalytic cracking control process on will consider in the paragraph V.

IV. Knowledge base processing of intelligent control

4.1. The construction of fuzzy production model.

The process of acquisition knowledge consists of transfer knowledge and experience by control installation of CC from different source information such as operators, special literature, and reference into KB of Expert system [29]. Where more part of knowledge is based on operator's experience. In the present acquisition methods of ES for construction the KB is not processed. ES is note that the quality such system "depends on fullness and perfection their KB" [30]. It is known that in the process of mutual intercourse between specialist by decision problem is using special form of questions, messages, and special term, which are habitual in the given professional area. The organization methods of expert interrogation have a bigger rule in the reproduction knowledge. There are two methods of discovering knowledge [31]. First method is independent reproduction as free exposition to experts of their knowledge. Second method is represent answers of experts on questions. One of the main questions of processing and realization intelligent control system by CC process is problem of creating and using KB [32-34]. Catalytic cracking -is a complex and many-factors processes. Units of information have a lot of closed and interconnected material and energetically flows. Processes, which flow in these units, are intercaused. An exponent modification of units is modifying other that is the state of technological process is characterized by complex exponents' totality. All of these are present high requirements to installation control of CC and cause true correlation factors necessity, which defined the direction of CC process on intelligent KB. However, a set of opposite connection is characterized an object as much and interconnection. It is result in non-realized utilization modern

ANC regime and participation of people is important in decision making process. The decision quality of operator depends on knowledge and experience degree. Possibility of formalization and utilization this knowledge's presents as reserve of efficacy control process. KB includes description of technological object process, info about current situation on the installation and control decision.

For construction of fuzzy production model of diagnosis CC process all regime parameters of process were divided by degree and defined their linguistic meaning (table 4.1). For manipulation with these linguistic meaning necessary their interpretation. ESPLAN is using fuzzy set theory apparatus [35]. where each linguistic meaning of parameter put implement function. For its internal presentation is used parametrical LR-format, where implement function has trapezium views and defined by four parameters.

Table 4.1.

Name of parameters	Reasoning area	Term-set
The degree of layer catalyst in reactor.	Less than 38% Between 38-56% Greater 56%	Less than norm Norm Greater than norm
Clogging with coke of catalyst.	0 Between 0-0.21 Greater 0.21	Decrease Norm Increase
Expenditure for catalyst.	Until 340 t/h Between 340-360 t/h More 360 t/h	Decrease Is not change Increase
Expenditure for raw material in reactor.	Until 160 **m3/h** Between 160-400 mVh More 400 **m3/h**	Decrease Is not change Increase
Temperature of raw material in the output of stove.	Less 320°C Between 320°-360°C Greater 360°C	Less than norm Norm Greater than norm
The boiling percentage of raw material.	Until 1% Between 1-6% More 6%	Decrease Is not change Increase
Pressure in reactor.	Less 0.9 kGs/sm^2 Between 0.9-1.35 kGs/sm^2 Greater 1.35 kGs/sm^2	Less than norm Norm Greater than norm
Pressure in regenerator.	Less 1.0 kGs/sm Between 1.0-1.45 kGs/sm^2 Greater 1.45 kGs/sm^2	Less than norm Norm Greater than norm
Temperature in reactor.	Until 480°C Between 480°-520°C More 520°C	Decrease Is not change Increase
Temperature in regenerator.	Until 400°C Between 400°-700°C More 700°C	Decrease Is not change Increase

a -left deviation;

ml -left peak;

mr -right peak;

b -right deviation.

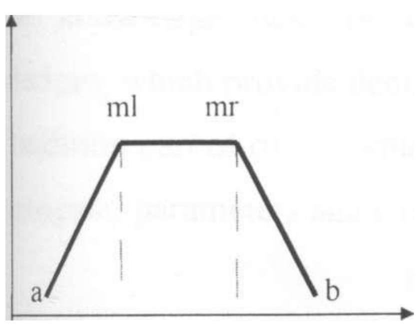
That is

$$\mu(U) = (a, ml, mr, b).$$

Analytically is noted as the following:

$$
l(u) = \begin{cases}
1 - \dfrac{ml-u}{a}, & \text{if } ml-a < u < ml \\
1, & \text{if } ml < u < mr \\
1 - \dfrac{u-mr}{b}, & \text{if } mr < u < mr-b \\
0, & \text{in other case.}
\end{cases}
$$

The graphical form is:



a ml mr b

The next step is definition of rule structure in knowledge base (KB).
The basic of KB is total rule of product:

IF XI and X2 and ... and XN

THEN Yl and Y2 and ... and YN

Condition part of rule-product is represent conjuction of logic bunch as:

< **OBJECT NAME** > **{ }** < **LINGUISTIC MEANING** >

For example.

IF CLOGGING WITH COKE OF CATALIZATOR increase AND EXPENDITURE FOR CATALIZATOR =is not change AND

Consequence of rule includes information about state of current situation in technological installation.

For example,

... THEN DIAGNOSIS = TEMPERATURE IS INCREASE IN REGENERATOR.

Totality of all rules shows the fuzzy model of process. These rules are construct m linguistic table 4.2. The first part of table shows parameters, which characterized situation in installation. The second part of table shows solution by diagnostic situation.

4.2. Fuzzy product model control process of catalytic cracking.

The knowledge base of control process of catalytic cracking includes knowledges, which provide decision making by control process.

Condition part of rule-product includes information about linguistic meaning of technological parameters and current situation of technological process.

For example,

IF DIAGNOSIS = TEMPERATURE IS INCREASE IN REGENERATOR AND CLOGGING WITH COKE OF CATALIZATOR = NORM AND...

Consequence of rule includes task to control.

For example,

...THEN OPEN VALVE OF GIVING STEAM IN 5%

Totalities of these rules are the fuzzy model of control process. These rules are constructed on the basis of table 4.2.The first part shows non-staff situation, the second-task to control.

4.3. Knowledge representation.

For input the knowledge in KB is using knowledge representation language (KRL) ESPLAN. Each object is described to its first appearance in any product-rule. Description of objects make by construction:

OB (short name);

OB (short name, full name);

OB (short name, full name, small meaning,

big meaning units of measurements);

For example:

OB ("Degree in reactor");

OB ("Degree in reactor" , "Degree of catalytic layer in reactor");

OB ("Degree in reactor" , "Degree of catalytic layer in reactor", 30,70%);

Conversions to object inside other constructions KBL make by short name and by dialog user gets full name. If full name is absent it will be equal to short name Small and big meaning are working for objects which have numerical interpretation for automatically construction of implement function, nested linguistic meanings. For description linguistic meaning have to use construction which described in (KRL) ESPLAN

Full representation about (KRL) ESPLAN: Structurally, ESPLAN consists of two parts: the shell of expert system and knowledge bases for manufacture planning tasks.

The shell of ESPLAN ensures:

- creation of expert systems for various applications;
- building module - oriented structures and segmentation of knowledge bases;
- representation of fuzzy values;
- compositional inference with possibility measures;
- arithmetic operations with fuzzy numbers;
- realization of simple question-ask dialogue by using special functions;
- set a confidence degree for any rule (in per cent);
- call of external programs;
- data interchange using file system.

All above-mentioned abilities are supported by ESPLAN knowledge representation language based on production rules.

The inference engine of ESPLAN allows:

- forward-chaining width-first inference with truth degree calculation on the continuous scale [0,100];
- set of a truth threshold during run-time in order to cut a rules with current truth degree less than the threshold;
- tracing inference to the screen;
- tracing inference to disk for further generation of the explanation;

The shell of ESPLAN has own WORDSTAR compatible text editor.

The shell of ESPLAN is represented to a user like the multiwindow interface.

ESPLAN operates under PC-DOS or MS-DOS operating systems.

IBMPC/XT/AT with RAM 512 Kb is required for ESPLAN running.

The shell of ESPLAN has been realized in Turbo Prolog (Borland Int.).

The ESPLAN architecture is shown in fig.4.1.

Table 4.2.

Clogging with coke of catalyst	Expenditure for catalyst	Expenditure for air	Diagnosis
In the norm	is not change	Is not change	Temp.in regen. is not change
In the norm	is not change	Increasing	Temp, regen. Is decreasing
In the norm	is not change	Decreasing	Temp.in regen. is increasing
. In the norm	Increasing	Is not change	Temp.in regen. is decreasing
In the norm	Increasing	Increasing	Temp.in regen. is not change
In the norm	Increasing	Decreasing	Temp.in regen. is decreasing
In the norm	Decreasing	Is not change	Temp.in regen. is not change
In the norm	Decreasing	Increasing	Temp.in regen. is decreasing
In the norm	Decreasing	Decreasing	Temp.in regen. is not change
Increasing	is not change	Is not change	Temp.in regen. is decreasing
Increasing	is not change	Increasing	Temp.in regen. is not change
Increasing	is not change	Decreasing	Temp.in regen. is decreasing
Increasing	Increasing	Is not change	Temp.in regen. is decreasing
Increasing	Increasing	Increasing	Temp.in regen. is increasing
Increasing	Increasing	Decreasing	Temp.in regen. is decreasing
Increasing	Decreasing	Is not change	Temp.in regen. is increasing
Increasing	Decreasing	Increasing	Temp.in regen. is increasing
Increasing	Decreasing	Decreasing	Temp.in regen. is decreasing
Decreasing	is not change	Is not change	Temp.in regen. is decreasing

Decreasing	is not change	Increasing	Temp.in regen. is decreasing
Decreasing	is not change	Decreasing	Temp.in regen. is not change
Decreasing	Increasing	Is not change	Temp.in regen. is decreasing
Decreasing	Increasing	Increasing	Temp.in regen. is decreasing
Decreasing	Increasing	Decreasing	Temp.in regen. is decreasing
Decreasing	Decreasing	Is not change	Temp.in regen. is not change
Decreasing	Decreasing	Increasing	Temp.in regen. is decreasing
Decreasing	Decreasing	Decreasing	Temp.in regen. is not change

The syntax of the ESPLAN production rule is represented on the syntax diagram fig.4.2.

ESPLAN shell system has a lot of automatic interpretable linguistic values:

Little	**More <X>**	**From<X> to <Y>**	**Strictly less <X>**
Large	**Less <X>**	**<X> -:- <Y>**	**Strictly more <X>**
Middle	**About <X>**		

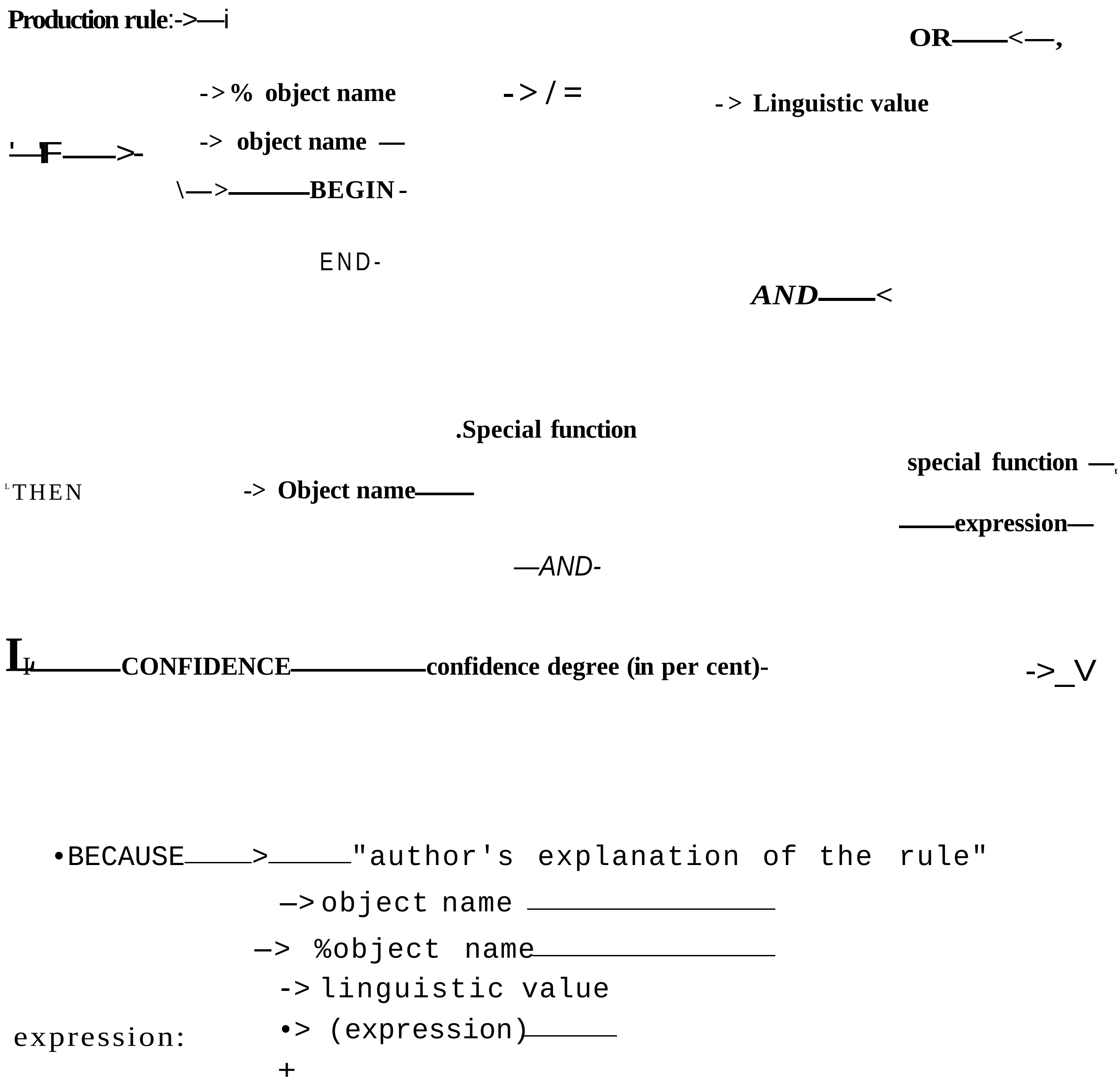
Everywhere linguistic values are allowed, membership function may **be obviously determined in simplificated modified LR-format:**

mf (<left deviation>,<left peak>,<right peak>,<right deviation>)

User may define his own linguistic values by using the following statement:

LINGV (<object name>,<linguistic value>,<left peak>,<right peak>,<right deviation>);

On the table 4.3. is shown the special function of ESPLAN knowledge representation language.



%object name -confidence degree of current value or the object.

Fig .4 2. Syntax diagram of production rulle.

Table 4.3. The special functions of ESPLAN (KRL).

Special function	Action
DISPLAY (<text>)	Display the text
DİSPLAY (<filename>)	Display the contents of the file
DISPLAY (<object name>)	Display current value of the object
DISPLAY (%<object name>)	Display confidence degree of current value of the object
DISPLAY_MF(<obj .name>)	Display membership function of current value of the object.
INQUIRY (<object name>)	Ask user to enter some value for the object
<object name 1> = AVRG(<object name 2>)	Compute average value from all values of the object 2 and asngn this value tothe object 1 (this function performs a kind of compositional inference)
(object name 1> = IRTAIN(<object name 2>)	Compute non-fuzzy value most close to current fuzzy value of the object 2 and assign this value to the object 1
STOP	Stop inference performance
KB(<KB name>)	Load in RAM the knowledge base
#KB(<KB name>)	Delete from RAM the knowledgebase
EXECUTE (<program name>)	Execute external program
WRITE_WA(<filename>)	Unload the work area to the file
READ_WA(<filename>)	Load the work area from the file
OPEN (<filename>)	Open the file for writing
WRITE (<object name>)	Write the name and current value of the object to the opened file.
CLOSE	Close the file opened by OPEN function.

V.Realization of intelligent control system of technological process.

5.1 The functioning of intelligent control system.

The previous research shows that for efficacy control of technological process **IN** the oil refinermg industry should be solved all complex tasks, which provided execution of all control functions and information process situated in system. Intelligent control system of technological process is solved the following problems:

-The system provides the operative personnel of installation by positive information:

-Control task of installation includes calculation of technological process regime and stabilization of nominal regime.

Required analysis are presented to functional assignment of intelligent system which allow to create functional scheme of intelligent control system (fig 5.1)

TP_2 -temperature in regenerator.

PP_2 -pressure in regenerator.

UP_2 -degree of catalyst layer in regenerator.

Q_c -expenditure of circulation catalyst.

TP1-temperature in reactor.

PP i -pressure in reactor.

UP1degree of catalyst layer in reactor.

TS-temperature of raw material on the output of stove.

V-expenditure of raw material in reactor.

The basis of construction has the following principles:

-Maximum utilization of control standard means;

-Extension possibility;

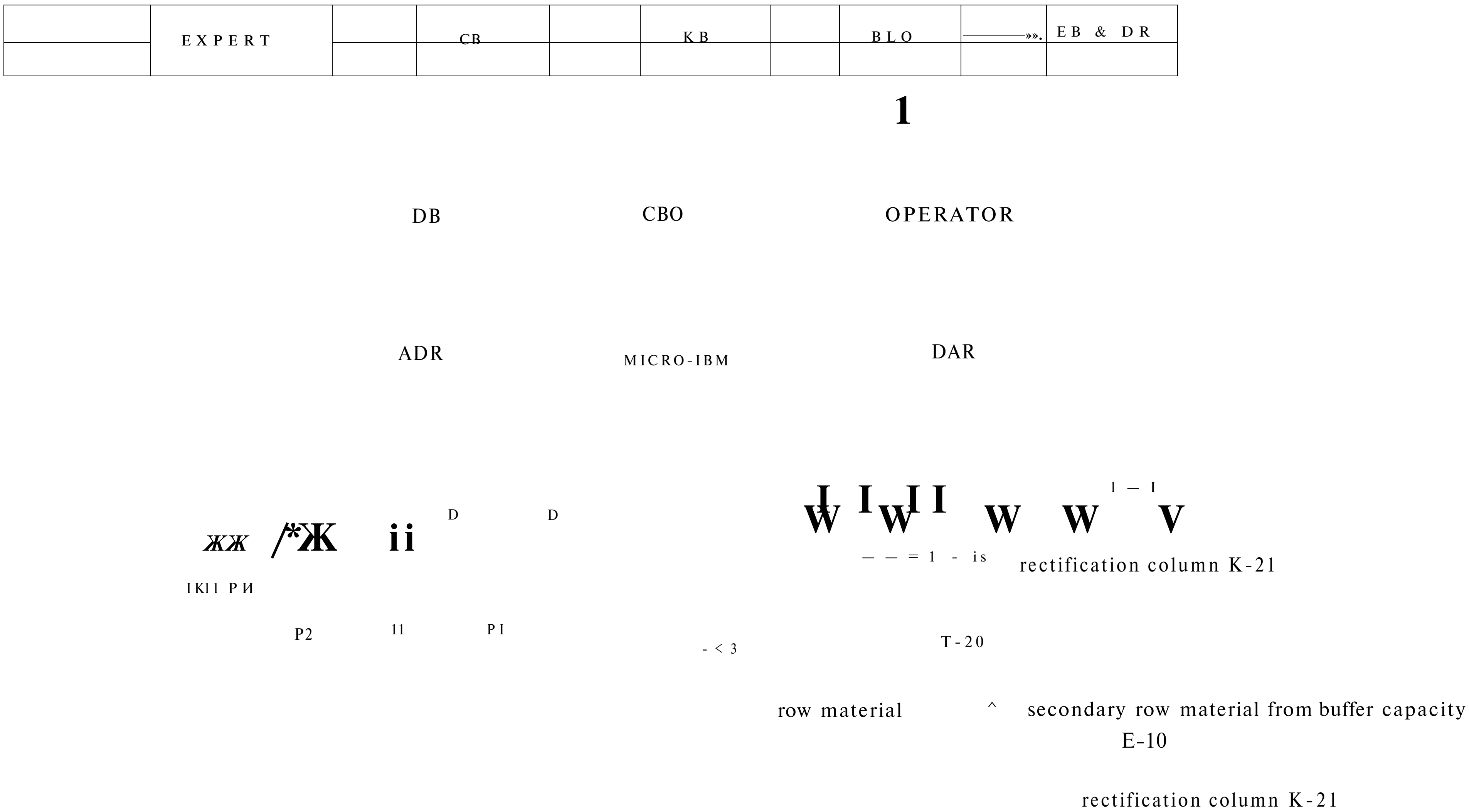


FIG. 5.1. Functional scheme of intelligent control system

-Convenient intercourse of operator with system.

System represents as decentralized two degrees, which functioning on the basis of evristical algorithm of control nominal regime selection and realized numerical control on the low and high degree. The low stage is solving collection of task and information processing. Result is forming the meaning of technological parameters, which stored on the external carrier of micro-IBM. Processed information is using by solving control problems in the external stage. Founded nominal meanings of control process parameters supported by system of circulation control.

Necessary to note that:

-Temperature in reactor is regulated by modification of raw material temperature on the output of stove;

-temperature in regenerator is regulated with catalyst calculation speed;

-weight speed is regulated by catalyst stage in reactor or by modification raw material expenditure in reactor;

-pressure is regulated by multiple circulation or weight speed or raw material expenditure in reactor.

Degrees in reactor, degree in regenerator and raw material expenditure are regulated with valves and bolts. The system is functioning as follows:

Nominal meaning of control process parameters enters in micro-IBM as installation, current reformed meaning into standard current signal 0-5 mA, and analog-numerical reformers (ANR) with interval in 30 second. Information enters into data bank from installation about current parameters through connection block with object. Control problem is solved on the higher degree. Block of logic output is solved the search problem of nominal regime. Block of distribution results shows the meanings of parameters. Founded meanings of control parameters transfer into connection block with object and block of distribution results. Block of distribution results is form explanation text of giving decision on the basis of logic conclusion tracing. Explanation block allows following by logic system that is allowed to control the processing of rule. For construction and function intelligent control system by technological process considered the following requirements:

-possibility to process of fuzzy information;

-realization possibility of production formalism KB.

-explanation to solving problems;

-realization the efficacy of logic output;

-providing the connection with object;

-higher quality of system functioning.

Take into account these features as means of IS construction is using the system cover "ESPLANH, which we considered in the previous. "ESPLANT based on the execution of mathematical operation possibility, fuzzy data and knowledge process, and explanation logic decisions.

Conclusion

The improved Intelligent control system by technological process of catalytic cracking allows effectively to solve the questions of collection and initial improvement of technological information from the main aggregates of installation, investigation, going out of the mam routine parameters from regulated, getting on the base of selected knowledge of the controlling influences and representation of this decision to the operator in the form that suits it.

The thesis is considered Intelligent process control system with technological processes. It consists of introduction, five sections and conclusion.

The first section is critical review of the work about control system of technological processes for oil refinery..

The second section shows the structure of Intelligent control system (ICS) by technological processes.

The third section is researching technological process of catalytic cracking. Technological specialties of CC process and its analysis as control object.

The forth section is consider the construction of fuzzy production model and knowledge representation m ICS.

Due to the improved intelligent control system the probability of subjective mistake, which includes the operator-technolog decrease.

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APPENDIX

```
OB ("Pressure in reactor","Pressure in reactor", 0.3. 1.0,"Mpa");
OB ("Temperature in reactor'VTemperature in reactor", 400, 600,"grad. C");
OB ("Temperature in regenerator","Temperature in regenerator", 500, 800,"grad.
• C");
0B (Temperature in raw material on the output stove'VTemperature in raw
I materia] on the output stove", 300,500,"grad. C");
0B ("Weight speed","Weight speed", 0.01, 0.25,"11Г);
0B ("Multiple circulation","Multiple circulation", 4. 12,"  ");
0B ("Degree in reactor","Degree in reactor", 30, 70."%");
0B ("Degree in regenerator'7'Degree in regenerator", 30, 65,"%");
0B ("Boiling percentage of raw material ""Boiling percentage of raw material".
10.50."%");
0B ("Carburization of catalyst'Y'Carburization of catalyst", 0.01, 0.25,"%");
0B ("Giving of water steam to desorper","Giving of water steam to desorper", 2.
Ю.Т/Ъ");
0B ("Pressure in regenerator","Pressure in regenerator", 0.02, 0.045,''Mpa");
LINGV ("Pressure in reactor","greater than norm", 0.02, 0.7, 0.9, 0.1)
LINGV ("Pressure in reactor","norm", 0.1, 0.6, 0.7. 0.1);
LINGV ("Pressure in reactor",less than norm", 0.0, 0.3, 0.6, 0.02);
LINGV ("Pressure in regenerator","greater than norm", 0.002, 0.04. 0.043. 0.02);
LINGV ("Pressure in regenerator","norm", 0.002, 0.03, 0.04, 0.002);
LINGV ("Temperature in regenerator","greater than norm", 10, 640. 800. 0.0);
LINGV ("Temperature in regenerator","norm", 200. 600, 640, 100);
LINGV ("Temperature in regenerator",less than norm", 0.0, 500, 600, 10);
LINGV ("Temperature of raw material on the output of stove","greater than
norm", 10, 420, 500, 0.0);
```

LINGV ("Temperature of raw material on the output of stove"," norm", 20. 380, 420. 0.0);

LINGV ("Temperature of raw material on the output of stove'Y'less than norm", 0.0, 300. 380, 10);

LINGV ("Weight speed'V'greater than norm", 0.1, 1.0, 2.5. 0.0);

LINGV ("Weight speed","norm", 0.2, 0.5, 1.0, 0.8);

LINGV ("Weight speed",less than norm". 0.0. 0.1, 0.5, 0.1);

LINGV ("Multiple circulation","greater than norm", 1.0. 10, 12, 0.0);

LINGV ("Multiple circulation","norm", 2.0, 7.5. 10, 1.0);

LINGV ("Multiple circulation",less than norm", 0.0, 4.0, 7.5, 0.5);

LINGV ("Degree in reactor","greater than norm", 7, 60, 70. 0.0);

LINGV ("Degree in reactor","norm", 2.0, 40, 60, 2.0);

LINGV ("Degree in reactor","less than norm", 0.0, 30, 40. 70);

LINGV ("Degree in regenerator","greater than norm", 10, 60, 65, 0.0);

LINGV ("Degree in regenerator","norm", 5.0, 40, 60, 0.0);

LINGV ("Degree in regenerator","less than norm", 0.0, 30. 40, 0.0);

LINGV ("Boiling percentage of raw material","greater than norm", 3.0, 35, 50. 0.0);

LINGV ("Boiling percentage of raw material"," norm", 5.0, 25, 35, 5.0);

LINGV ("Boiling percentage of raw material","less than norm", 0.0, 10. 25. 3.0);

LINGV ("Carburization of catalyst"."greater than norm". 0.02. 0.2. 0.25. 0.0);

LINGV ("Carburization of catalyst"," norm", 0.0, 0.01, 0.2. 0.02);

LINGV ("Carburization of catalyst","less than norm", 0.0. 0.01, 0.01, 0.0);

LINGV ("Expenditure of raw matenal","greater than norm". 80, 400, 500, 0.0);

LINGV ("Expenditure of raw material," norm", 20, 160 400, 50);

LINGV ("Expenditure of raw material ,"less than norm", 0.0, 0.0, 160. 100);

LINGV ("Giving of water steam to desorper","greater than norm", 1.0, 8.0, 10. 0.0);

```
LINGV ("Giving of water steam to desorper"  "norm", 1.0. 6.0, 8.0. 1.0):
LINGV ("Giving of water steam to desorper" ," norm", 2.0, 4.0, 6.0. 1.0);
IF BEGIN
THEN DISPLAY ("Logical output")
AND INQUIRY ("Pressure in reactor")
AND INQUIRY ("Pressure in regenerator")
AND INQUIRY ("Temperature in reactor")
AND INQUIRY ("Temperature in regenerator")
AND INQUIRY ("Temperature of raw material on the output of stove")
AND INQUIRY ("Weight speed")
AND INQUIRY ("Multiple circulation")
AND INQUIRY ("Degree in reactor")
AND INQUIRY ("Degree in regenerator")
AND INQUIRY ("Boiling percentage of raw material")
AND INQUIRY ("Carburization of catalyst")
AND INQUIRY ("Expenditure of raw material")
AND INQUIRY ("Giving of water steam to desorper")
AND DISPLAY ("Managing influences");
IF "Pressure in reactor"="greater than norm"
AND "Expenditure of raw material"="greater than norm"
THEN DISPLAY ("Close regulator of expenditure of raw material-crant" m7%
IF    "Pressure in reactor"="greater than norm"
AND "Temperature in reactor"="greater than norm"
AND "Temperature of raw material on the output of stove"="norm"
AND "Temperature in regenerator"="norm"
AND "Multiple circulation"="greater than norm"
THEN DISPLAY ("Close the valve of circulation inl0%");
IF    "Pressure in reactor"="greater than norm"
AND "Temperature in reactor"="greater than norm"
AND "Temperature of raw material on the output of stove'-"greater than norm'
```

AND "Weight speed"="less than norm'*

AND "Expenditure of raw material"="less than norm"

THEN DISPLAY ("Open regulator of expenditure of raw material-crant in 10%");

IF "Pressure in reactor"="greater than norm"

AND "Temperature in reactor -"greater than norm"

AND "Temperature of raw material on the output of stove"="greater than norm"

AND "Weight speed"="norm"

THEN DISPLAY ("Decrease temperature in stove in 20 grad. C");

IF "Pressure in reactor"="greater than norm"

AND "Temperature in regenerator"="greater than norm"

AND "Carburization of catalyst"^"greater than norm"

AND "Degree in regenerator"="norm"

AND "Multiple circulation"="greater than norm"

THEN DISPLAY ("Close the valve of circulation m6%");

IF "Pressure in reactor"="greater than norm"

AND "Temperature in regenerator"="greater than norm"

AND "Carburization of catalyst"="greater than norm"

AND "Degree in regenerator"="less than norm"

AND "Multiple circulation"="norm"

THEN DISPLAY ("Add catalyst from reservation ");

I IF "Pressure m reactor ^"greater than norm"

AND "Temperature in regenerator"="greater than norm"

i AND "Carburization of catalyst"="norm"

AND "Boiling percentage of raw material"="norm"

AND "Expenditure of raw material"="norm"

AND "Giving of water steam to desorper"="less than norm"

1 THEN DISPLAY ("Open the valve of giving of water steam in 12%");

l IF "Pressure in reactor ^"greater than norm""

l AND "Temperature in regenerator"="norm"

AND "Temperature in reactor ="norm"

AND "Expenditure of raw material'-'norm"

AND "Giving of water steam to desorper"="greater than norm"

THEN DISPLAY ("Close the valve of giving of water steam in 15%");

IF "Pressure m reactor"="less than norm"

AND "Temperature in regenerator"="norm"

AND "Temperature in reactor"="norm"

AND "Expenditure of raw material"="less than norm"

THEN DISPLAY ("Open regulator of expenditure of raw material-crant m 5%");

IF "Pressure in reactor"="less than norm"

AND "Temperature in regenerator'-"norm"

AND "Temperature in reactor"="less than norm"

AND "Expenditure of raw material"^"norm"

AND "Temperature of raw material on the output of stove'-"norm"

AND "Multiple circulation"="less than norm"

THEN DISPLAY ("Open the valve of circulation m20%");

IF "Pressure in reactor"="less than norm"

AND "Temperature in reactor"="less than norm"

AND "Expenditure of raw material'-"norm"

AND "Temperature of raw material on the output of stove"="less than norm"

THEN DISPLAY ("Close the valve of giving oil in stove in 10%");

IF "Pressure in reactor"="less than norm"

AND "Temperature in regenerator"="norm"

AND "Temperature in reactor"="less than norm"

AND "Expenditure of raw material'-"norm"

AND "Temperature of raw material on the output of stove"="norm"

AND "Multiple circulation"="less than norm"

THEN DISPLAY ("Open the valve of circulation ml 7%");

IF "Pressure in reactor"="less than norm"

AND "Temperature m regenerator"="less than norm"

AND "Degree m regenerator"="norm"

AND "Expenditure of raw material' -"norm"

AND "Giving of water steam to desorper'-"norm"

AND "Boiling percentage of raw material"="greater than norm'

THEN DISPLAY ("Open the crant of giving shlam until max")

IF "Pressure in reactor"="less than norm"

IF "Pressure in reactor"="less than norm'"

AND "Temperature in regenerator"="less than norm"

AND "Degree m regenerator"="less than norm"

AND "Expenditure of raw material"="norm"

AND "Giving of water steam to desorper''="norm"

AND "Boiling percentage of raw material"="norm"

THEN DISPLAY ("Add catalyst from reservation");

IF "Pressure in reactor"="less than norm"

AND "Temperature in regenerator'-"less than norm"

AND "Degree m regenerator"="norm"

AND "Expenditure of raw material"="norm"

AND "Giving of water steam to desorper"="greater than norm"

AND "Boiling percentage of raw material'-"norm"

THEN DISPLAY ("Close the valve of giving of water steam in

IF "Pressure in reactor ="less than norm"

AND "Temperature in reactor"="norm"

AND "Temperature in regenerator"="norm"

AND "Weight speed"="norm"

THEN DISPLAY ("Open the crant of giving shlam until max")

IF "Temperature in reactor"="greater than norm"

AND "Multiple circulation"="greater than norm"

THEN DISPLAY ("Close the valve of circulation m8%");

IF "Temperature in reactor"="greater than norm"

AND "Expenditure of raw material"^' norm"

AND "Temperature of raw material on the output of stove'-"greater than norm"

THEN DISPLAY ("Close the valve of oil in stove in6%");

IF "Temperature m reactor"="greater than norm"

AND "Expenditure of raw material' -"norm"

AND "Temperature of raw material on the output of stove"="greater than norm"

AND "Weight speed"="less than norm"

THEN DISPLAY ("Open regulater of expenditure of raw material-crant in 9%"); .

IF "Temperature in reactor"="greater than norm"

AND "Temperature in regenerator"="greater than norm"

AND "Carburization of catalyst'-" norm"

AND "Expenditure of raw materiar="norm"

AND "Giving of water steam to desorper' -"norm"

AND "Boiling percentage of raw material"="less than norm"

THEN DISPLAY ("Close crant of guving shlam in25%")

IF "Temperature in reactor"="greater than norm"

AND "Temperature in regenerator ^"greater than norm"

AND "Carburization of catalyst'-"norm"

AND "Expenditure of raw material"="greater than norm"

AND "Giving of water steam to desorper"="norm"

AND "Boiling percentage of raw material"="norm"

THEN DISPLAY ("Close regulater of expenditure of raw material-crant m 15%");

IF "Temperature in reactor"="greater than norm"

AND "Temperature in regenerator"="greater than norm"

AND "Carburization of catalyst"="greater than norm"

AND "Expenditure of raw material"="norm"

AND "Giving of water steam to desorper' -"norm"

AND "Boiling percentage of raw material'-"norm"

THEN DISPLAY ("Close regulater of expenditure of raw material- crant in 10%");

IF "Temperature in reactor"="greater than norm"

AND "Temperature in regenerator"="greater than norm"

AND "Carburization of catalyst"="norm"

AND "Expenditure of raw material"=="norm"

AND "Giving of water steam to desorper"="less than norm"

AND "Boiling percentage of raw material* ="norm"

THEN DISPLAY ("Open the valve of giving of water steam in 8%");

IF "Temperature in reactor"="less than norm"

AND "Temperature in regenerator"="norm"

AND "Temperature of raw material on the output of stove"="norm"

AND "Weight speed"="less than norm"

AND "Multiple of circulation'-"norm"

THEN DISPLAY ("Open regulator of expenditure of raw material-crant m 5%");

IF "Temperature in reactor"="less than norm"

AND "Temperature in regenerator"="norm"

AND "Temperature of raw material on the output of stove"="norm"

AND "Weight speed'-"norm"

AND "Multiple of circulation"="less than norm"

THEN DISPLAY ("Open the valve of circulation in20%");

IF "Temperature in reactor"="less than norm"

AND "Temperature of raw material on the output of stove"="less than norm"

AND "Expenditure of raw material"="norm"

THEN DISPLAY ("Close the valve of giving oil in stove in7%");

IF "Temperature in reactor"="less than norm"

AND "Temperature of raw material on the output of stove"="less than norm"

AND "Expenditure of raw material"="norm"

AND "Weight speed"="greater than norm"

THEN DISPLAY ("Close the regulator of expenditure of raw material- crant in 11°/<T)

IF "Temperature in reactor"="less than norm"

AND "Temperature in regenerator"="less than norm"

AND "Degree in regenerator"="norm"

AND "Expenditure of raw material' -"norm"

AND "Giving of water steam to desorper"="norm"

AND "Boiling percentage of raw material"="greater than norm"

THEN DISPLAY ("Open the crant of giving shlam until max");

IF "Temperature in reactor"="less than norm"

AND "Temperature in regenerator"="less than norm"

AND "Degree in regenerator"="less than norm"

AND "Expenditure of raw material'-"norm"

AND "Giving of water steam to desorper"="norm"

AND "Boiling percentage of raw material"="norm"

THEN DISPLAY ("Add catalyst from reservation");

IF "Temperature in reactor"="less than norm"

AND "Temperature in regenerator"="less than norm"

AND "Degree in regenerator"="norm"

AND "Expenditure of raw matenal"="less than norm"

AND "Giving of water steam to desorper"="norm"

AND "Boiling percentage of raw material'-"norm/*

THEN DISPLAY ("Open the regulater of expenditure of raw material-crant tnlO%");

IF "Temperature in reactor"="less than norm"

AND "Temperature in regenerator"="less than norm"

AND "Degree in regenerator"="norm"

AND "Expenditure of raw material"="norm"

AND "Giving of water steam to desorper"="greater than norm"

AND "Boiling percentage of raw material"="normT

THEN DISPLAY "(Close the regulater of expenditure of raw material-crant m8%");

IF "Carburization of catalyst'-"greater than norm"

AND "Degree in regenerator'-"norm"

AND "Multiple of circulation"="norm"

AND "Temperature in regenerator'-"norm"

AND "Weight speed"="norm"

AND "Boiling percentage of raw material"="less than norm"

THEN DISPLAY "(Close the valve of giving shlam in stove in25%");

IF "Carburization of catalyst"="greater than norm"

AND "Degree in regenerator"="less than norm"

AND "Multiple of circulation'-"norm"

AND "Temperature in regenerator"="norm"

AND "Weight speed'-"norm"

AND "Boiling percentage of raw material'~"norm"

THEN DISPLAY ("Add catalyst from reservation");

IF "Carburization of catalyst"="greater than norm"

AND "Degree in regenerator"="greater than norm"

AND "Multiple of circulation"="norm"

AND "Temperature in regenerator'-"norm"

AND "Weight speed"="norm"

AND "Boiling percentage of raw7 matenal"^"norm"

THEN DISPLAY ("Close the valve of circulation in3%");

IF "Carburization of catalyst"="greater than norm"

AND "Degree in regenerator"="norm"

AND "Multiple of circulation'-"norm"

AND "Temperature in regenerator"="norm"

AND "Weight speed"="less than norm"

AND "Boiling percentage of raw matenal"="norm"

THEN DISPLAY ("Increase the circulation from P-l into P-2 inl 1 %");

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IF "Carburization of catalyst' '="greater than norm"
AND "Degree in regenerator"="norm"
AND "Giving of water steam to desorper"=="norm"
AND "Temperature in regenerator"="less than norm"
AND "Expenditure of raw material"="nornT
AND "Boiling percentage of raw material"="greater than norm"
THEN DISPLAY ("Open crant of giving shlam until max in7% ");
IF "Carburization of catalyst"="greater than norm"
AND "Degree in regenerator"^"norm"
AND "Giving of water steam to desoфer"="norm"
AND "Temperature in regenerator"="less than norm"
AND "Expenditure of raw material'-"less than norm"
AND "Boiling percentage of raw matenal"="norm"
THEN DISPLAY ("Open the regulator of expenditure of raw material-crant 19%");
IF "Carburization of catalyst"^"greater than norm"
AND "Degree in regenerator"="less than norm"
AND "Temperature in regenerator"="less than norm"
THEN DISPLAY ("Add catalyst from reservation");
IF "Carburization of catalyst"="greater than norm"
AND "Degree in regenerator"="norm"
AND "Giving of water steam to desoфer"="greater than norm"
AND "Temperature in regenerator'-"less than norm"
AND "Expenditure of raw material"="norm"
AND "Boiling percentage of raw material"="norm"
THEN DISPLAY ("Close the valve of giving of water steam in 6%");
IF "Temperature in regenerator"="greater than norm"
AND "Carburization of catalyst"="norm"
AND "Expenditure of raw material' -"norm"
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AND "Giving of water steam to desorper"="norm"

AND "Boiling percentage of raw material' -"norm"

THEN DISPLAY ("Close the crant of giving shlam in 12% ");

IF "Temperature in regenerator"="greater than norm"

AND "Carburization of catalyst"="norm"

AND "Expenditure of raw material"="norm"

AND "Giving of water steam to desorper"="less than norm"

AND "Boiling percentage of raw material"^' norm"

THEN DISPLAY ("Open the valve of giving of water steam in 9%");

IF "Temperature in regenerator"="greater than norm"

AND "Carburization of catalyst "="norm"

AND "Expenditure of raw materiaT-"greater than norm"

AND "Giving of water steam to desorper"="norm"

AND "Boiling percentage of raw material"="norm"

THEN DISPLAY ("Close the regulater of expenditure of raw material-crant in 11%");

IF "Temperature in regenerator'-"greater than norm"

AND "Carburization of catalyst"="greater than norm"

AND "Degree in regenerator"="less than norm"

AND "Multiple of circulation"="norm"

AND "Weight speed"="norm"

AND "Boiling percentage of raw material'^'norm"

THEN DISPLAY ("Add catalyst from reservation");

IF "Temperature in regenerator"="greater than norm"

AND "Carburization of catalyst'-"greater than norm"

AND "Degree in regenerator"="norm"

AND "Multiple of circulation'-"greater than norm"

AND "Weight speed"="norm"

AND "Boiling percentage of raw material'-"norm"

THEN DISPLAY ("Close the valve of circulation in5%");

IF "Temperature in regenerator"="less than norm"

AND "Degree in regenerator"="norm"

AND "Expenditure of raw material"="norm"

AND "Giving of water steam to desorper"="norm"

AND "Boiling percentage of raw material"="norm"

THEN DISPLAY ("Open the the crant of giving in shlam in9% ");

IF "Temperature in regenerator"="less than norm"

AND "Degree in regenerator"="less than norm"

AND "Expenditure of raw material'-"norm"

AND "Giving of water steam to desorper"="norm"

AND "Boiling percentage of raw material'^'norm"

THEN DISPLAY ("Add catalyst from reservation");

IF "Temperature in regenerator"="less than norm"

AND "Degree in regenerator"="norm"

AND "Expenditure of raw material'-"less than norm"

AND "Giving of water steam to desorper"="norm"

AND "Boiling percentage of raw matenal"="norm"

THEN DISPLAY ("Open the regulator of expenditure of raw material-crant in 15%");

IF "Temperature in regenerator"="less than norm"

AND "Degree in regenerator"="norm"

AND "Expenditure of raw material"="norm"

AND "Giving of water steam to desorper"="greater than norm"

AND "Boiling percentage of raw material"="norm"

THEN DISPLAY ("Close the valve of giving of water steam in 6%");

IF "Weight speed"="greater than norm"

AND ""-"greater than norm"

AND "Degree in reactor"="norm"

AND "Expenditure of raw material"="greater than norm"

THEN DISPLAY ("Close the regulater of expenditure of raw material-crant in

8%");

IF "Weight speed"="greater than norm"

AND "Degree in reactor"="less than norm"

AND "Expenditure of raw material'-" norni"

THEN DISPLAY ("Increase the circulation from P-2 into P-l ml 1 %");

IF "Weight speed'-"less than norm"

AND "Degree in reactor'-"norm"

AND "Expenditure of raw material'-"less than norm"

THEN DISPLAY ("Open the regulater of expenditure of raw material- in10%");

IF "Weight speed'-"less than norm"

AND "Degree in reactor"="norm"

AND "Expenditure of raw material'-"greater than norm"

THEN DISPLAY ("Increase the circulation from P-l into P-2 ml 5%");