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Simulation of the Process of Obtaining Anti-Corrosion Primer Material by Mixing Technological Flows

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Annotation: *The article considers Chemical-Technological Processes (CTP), the production of anti-corrosion primer material usually proceeds in moving flows, the hydrodynamic patterns of movement of which have a significant impact on the efficiency of chemical production, therefore, when compiling mathematical models of chemical-technological processes, the description of the movement of flows of substances becomes important. Flow mixers are an important unit of chemical-technological schemes.*

Keywords: *anticorrosive primer, indicator, flow, displacement interference.*

The structure of the mathematical model of the process of moving liquids and substances is determined primarily by hydrodynamic parameters and manifests itself in the nature of the distribution of the residence time of flow particles in the system under consideration. This nature of the distribution obeys statistical laws and is determined by the type of signal passing through the system. An indicator is introduced into the flow at its inlet to the apparatus in some way, and at the outlet of the flow from the apparatus, the concentration of the indicator is measured as a function of time.

This output curve is called a function of the system's response to a typical perturbation in terms of flow composition. The main requirement for the indicator is the condition for the behavior of the indicator particles in the apparatus, similar to the behavior of the flow particles. In practice, indicators are often used that do not interact with the main flow and can be easily measured. The indicator at the flow inlet to the apparatus is introduced in the form of standard signals: pulse, stepped and harmonic. With a step change in the input value, respectively, f - output curve (transition function), when applying an impulse disturbance, one obtains, respectively C - output curve (weight function), when the input value changes according to the laws of harmonic oscillation, a sinusoidal change in the output value, changed in amplitude and phase is obtained.

In hydrodynamics, there are a number of equations that can be used to describe the motion of a medium (for example, the Navier-Stokes equation, the flow continuity equation, etc.). The application of the classical laws of hydrodynamics to chemical-technological processes turns out to be difficult due to the complexity of the equations of hydrodynamics of real flows. Therefore, for composing mathematical models of hydrodynamic flows, we use simpler approximate ideas about their internal structure. The structure of a moving process medium is characterized by the degree of mixing of flow particles, which determines the concentration field and temperature gradients.

In principle, it is possible to build hydrodynamic models of flows of varying complexity that best suit the applied designs of process equipment.

Usually, when compiling mathematical models of CTP, approximate models of moving flows of individual phases are used.

Typical hydrodynamic models are divided into the following types: ideal mixing, ideal displacement, diffusion models, cell models and combined models.

Perfect mixing model

$$\frac{dC}{dt} = \frac{1}{\tau} \cdot (C_o - C) \qquad \textbf{(1)}$$

Where I is the flow of matter [moll/s], v - volumetric flow rate, m ^{3} / s ; $C_0, C_{вых}, C$ is the concentration of the substance in the flow at the apparatus inlet, outlet, and at any point of the apparatus volume, respectively, moll/m ^{3} ; V - volume, m ^{3} ., contact time is $\tau = V / v$.

The ideal displacement model

$$\frac{\partial C}{\partial t} = -uS\frac{\partial C}{\partial l} \qquad \textbf{(2)}$$

Where u – linear flow velocity, m/s ; l – apparatus length , m; t - time, S.

Diffusion hydrodynamic models

one-parameter diffusion hydrodynamic model will take the following form:

$$\frac{\partial C}{\partial t} = -u\frac{\partial C}{\partial l} + D_L\frac{\partial_2 C}{\partial l^2} \qquad \textbf{(3)}$$

Where D_L is the diffusion coefficient in the longitudinal direction, m^2 / c. Initial and boundary conditions: at $t = 0$ $C(0, l) = C_0$; at $l = 0$ $dC / dt = 0$

If the flow simultaneously occurs longitudinal and radial. Mixing substances, then the mathematical description of the flow hydrodynamics can be represented *a two-parameter diffusion model*:

$$\frac{\partial C}{\partial t} = -u\frac{\partial C}{\partial l} + D_L\frac{\partial_2 C}{\partial l^2} + D_R(\frac{\partial_2 C}{\partial r^2} + \frac{1}{r}\frac{\partial C}{\partial r} \qquad \textbf{(4)}$$

where R $_D$ is the diffusion coefficient in the longitudinal direction, m^2 / c ; r – current radius, m ; R – radius of the apparatus, m.

Cellular hydrodynamic models

Since the ideal mixing mode is realized in each cell, the equation of the ideal mixing model is valid for any cell:

$$\begin{cases} \frac{dC_1}{dt} = \frac{1}{\tau_1}(C_0 - C_1 \\ \frac{dC_1}{dt} = \frac{1}{\tau_1}(C_{i-1} - C_i \\ \frac{dC_n}{dt} = \frac{1}{\tau_n}(C_{n-1} - C_n \end{cases} \qquad \textbf{(5)}$$

The residence time of a substance in each cell $\tau = V_i / v$

total time of stay $\tau = V / v$ then the volume of all cells $\tau = nV$, where n is the number cells [1-4].

When building a flow structure model, take into account the following requirements:

- the model should reflect the physical essence of the real flow and at the same time should have a fairly simple mathematical description;

- should make it possible to determine its parameters by calculation or experimental method;
- Should be convenient for use in calculations of a specific chemical-technological process.

For this work , a multi-channel mixer is used , which is a container that provides complete mixing of two jets (Fig. 1).

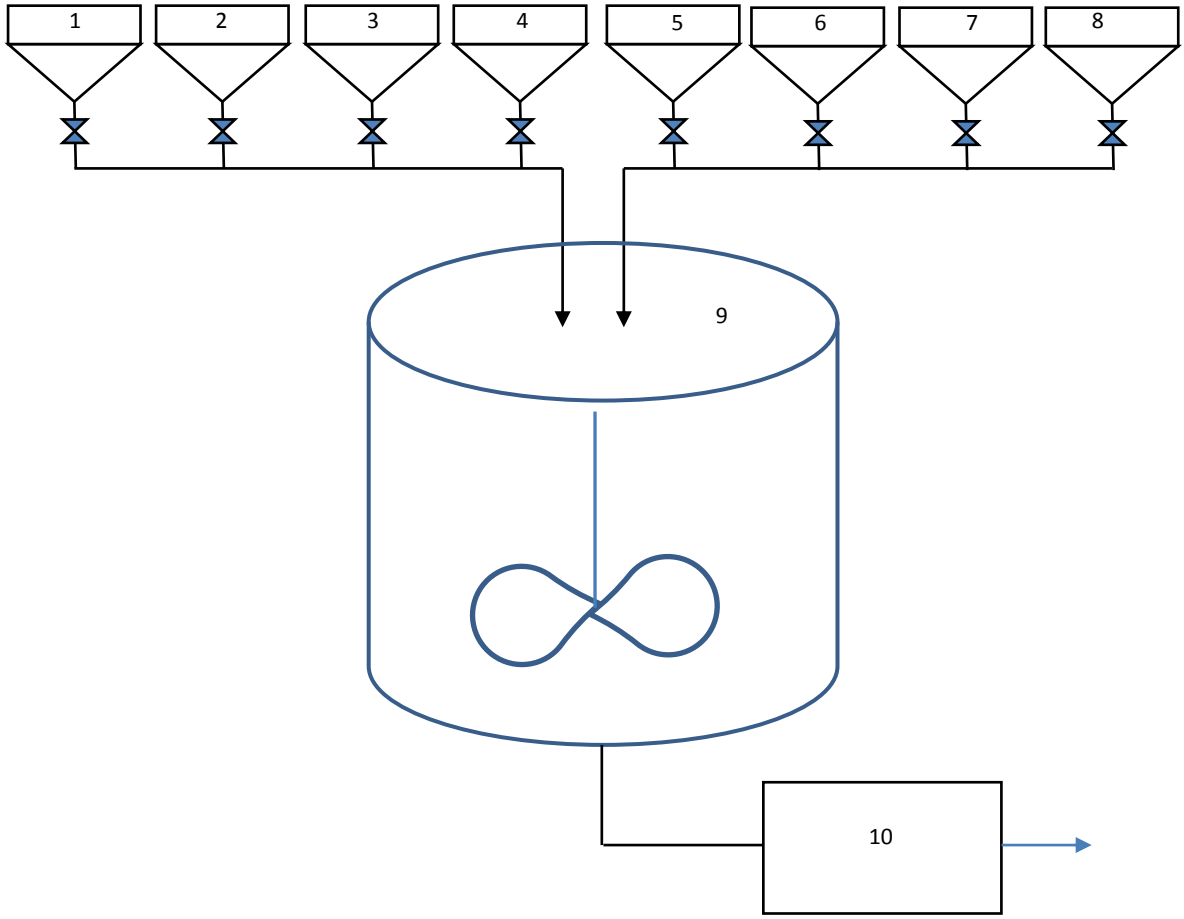


Fig. 1. Technological scheme of the simultaneous operator

1- cube of residual waste, 2-waste of phosphate suspension, 3-Titanium oxide TiO2, 4-Iron oxide (III) Fe_2O_3, 5-alif, 6- Lok PF-283 , 7-nephraz, 8-sulfanol, 9- displacer , 10 – capacity.

The turbulence of flows in the nozzles of a special device dramatically improves mixing. When compiling a mathematical description of the flow mixer (Fig. 2), we use the following assumptions:

- the flow structure in the apparatus corresponds to the ideal mixing mode;
- the mixing mode in the apparatus is steady;
- there are no sources and sinks of matter and heat inside the apparatus;
- the number of mixed streams is two;
- the heat capacities of the flows i of the component are calculated at the temperature of this flow.

Fig.2 . Mixer flows

G_i, T_i, C_i - *Consumption, temperature and vector concentrations i- the technological flow*

In compliance with assumptions general the equation material balancehas the form

$$G = G_1 + G_2 \qquad (6)$$

Where G - consumption weekend flow, kg / hour;

G_1, G_2 - expenses input flows, kg / hour. The equation material balance i the component

$$G \cdot c_i = G_1 \cdot c_{1i} + G_2 \cdot c_{2i}, i = 1, \ldots\ldots, N \qquad (7)$$

Where c_i - mass share of i substance in output stream;

c_{1i} , c_{2i} - mass shares of i substance in the first and second input flows;

N - Number of substances in stream.

From equations (7) can define mass share of i substance in output stream:

$$c_i = (G_1 \cdot c_{1i} + G_2 \cdot c_{2i})/G \qquad (8)$$

Thermal equation balance has the view

$$G \cdot c_p \cdot t = G_1 \cdot c_{p1} t_1 + G_2 \cdot c_{p1} t_2, \qquad (9)$$

Where C_p - specific heat capacity of flows $\frac{Дж}{кг \cdot K}$, t - flow temperature C.

Then temperature weekend flow determined ratio

$$t = (G_1 \cdot c_{p1} t_1 + G_2 \cdot c_{p2} t_2)/G \cdot C_p \qquad (10)$$

Temperature of specific heat capacity of i substance in j -ohm stream can be represented as a function temperature

$$G_{pij} = a_i + b_i \cdot t_j + c_i \cdot t_j^2 + d_i \cdot t_j^3 \qquad (11)$$

where a_i, b_i, c_i, d_i -empirical coefficients, found for each substances [13-14].

Heat capacity j the flow calculated by rule additivity :

$$C_{pj} = \sum_{j=1}^{N} C_{pij} \cdot c_{ij} \qquad (12)$$

For solutions equations (10) can take advantage method simpleiterations [11-12]:

$$T^{k+1} = (G_1 \cdot c_{p1}(T_1) \cdot t_1 + G_2 \cdot c_{p2}(T_2) \cdot t_2) / G \cdot c_p(T^k) \quad (13)$$

Where k - number iterations

Condition graduation accounts $\left|T^{k=1} - T^k\right| < \varepsilon$

In quality elementary approximation can accept

$$T_0 = (T_1 + T_2) / 2 \quad (14)$$

So the way asking options state of the streams entering themixer, Can define weekend options.

On entrance V mixer served two streams with massive expenses**36** and **64 kg/hour** and temperatures **150** and **20** ^{0} **C**, respectively.

Lineups flow in % wt. Table 1

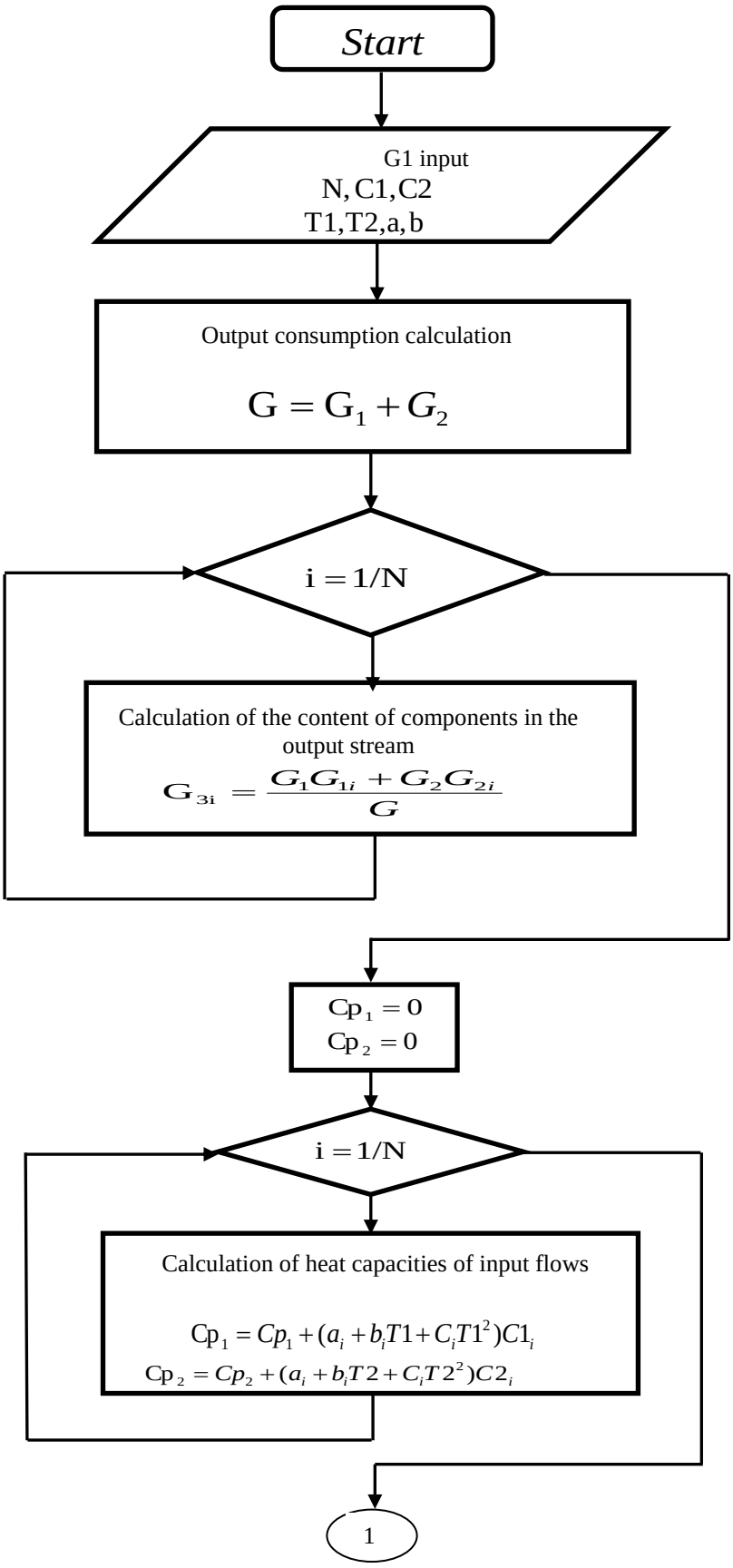
	residual waste cube	***phosphate slurry waste***	***Oxide titan TiO2***	***iron oxide (III) Fe2O3***	***Oliy-oksol***	***Lok PF-283***	***nephrase***	***sulfanol***
I flow	17	22	17	44	-	-	-	-
2nd stream	-	-	-	-	42	50	7	1

Judging by the composition of the input streams, the flow at the outlet of the mixer will be contain eight components. Therefore, the composition of both input streams and output stream should be described by arrays, dimension [5-10] and calculation the composition of the output stream to organize using a cyclic procedure (Fig. 1).

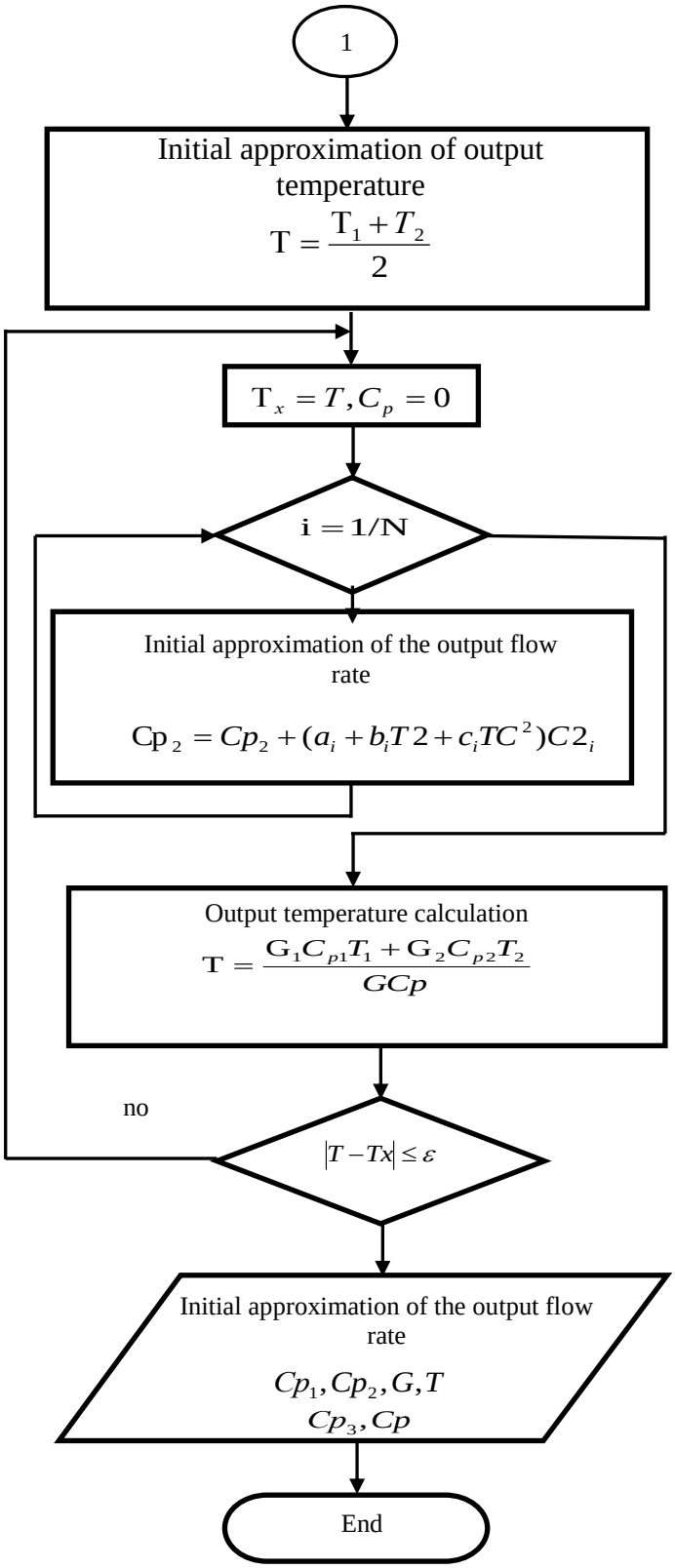
Calculation heat capacity everyone from flows also comfortable conduct with help cyclic procedure.

Since the heat capacity of the output flow is a function of the desired temperature, that her calculation is part iterative procedures and is repeated for each new temperature approximation obtained on previous iterations and then by this meaning heat capacity the following is defined approximation outlet temperature flow [15-24].

Accuracy ε , defining condition completion iterative process, evaluated by errors device, used for temperature measurements. Considering the accuracy class of instruments used for measurements temperatures, take ε = 0.5 ^{0} C



Pic. 3 Block - scheme programs calculation mixer (Start)



Pic. 4. Block diagram programs calculation mixer (end)

Conclusions

Computer simulation of CTP has fully proved its relevance and promise by now. With its help, it is possible to improve the quality of control of CTP and the efficiency of their work, and it becomes possible to optimize the economic mode of operation of installations by considering and calculating various options for increasing their productivity.

The software product is suitable for monitoring and technical support of the operation of the installation and allows you to calculate the characteristics of the current process, which cannot be determined using laboratory analyzes or current instrument readings.

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