DEVELOPING A MODEL OF THE COMBINE TYPE MACHINE

A.A. Deriglazov
Scientific Supervisor: Assistant N.S. Krinitsin
Language advisor: Senior teacher N.G. Novikova
Tomsk Polytechnic University, Russia, Tomsk, Lenin str., 30 634050
E-mail: daa424@yandex.ru

Annotation

Currently, nuclear industry has entered a new phase of its development, establishing itself in the world as a reliable and cheap source of electricity.

Fuel consumption in a nuclear industry is increasing every year, which requires an increase in the amount of fuel production and, consequently, increase of production capacity and performance of the nuclear fuel cycle,including sublimation plant (SP) of "Siberian Chemical Combine (SCC)."

Introduction

Today at the SP of "SCC" uranium hexafluoride is produced by direct fluorination of uranium oxides. Block diagram of the uranium hexafluoride production (UHP) is shown in Figure 1.

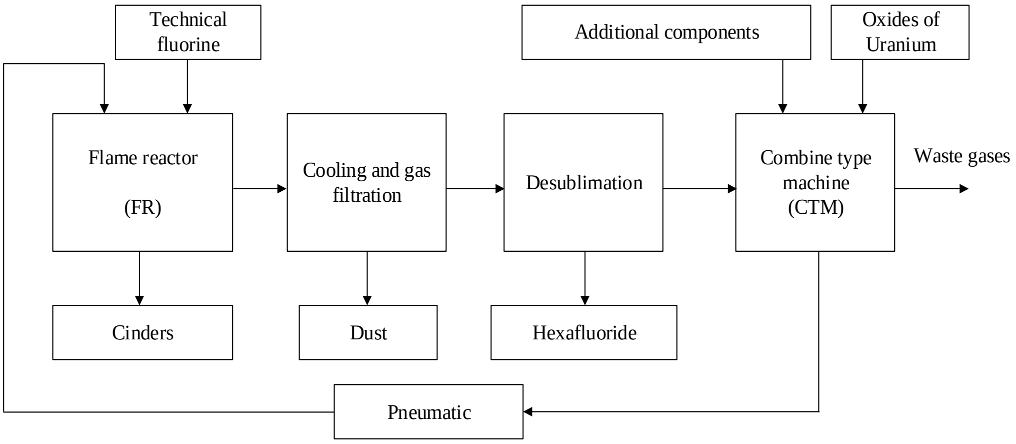

Figure 1 - Block diagram of the production of hexafluoride of uranium (UHP)

Fluorination node which is based on the flame reactor is designed to produce uranium hexafluoride by high uranium fluorination of components coming from the capture node (U3O8, UO2F2 and UF4). Gaseous hexafluoride of uranium which obtained in the flame reactor is transported to the desublimation node where uranium hexafluoride is deposited on the cooling pipes [1].

Next, the process gas enters the CTM, where the capture of valuable components “tail of gas” (F 2 fluorine, hydrogen fluoride, HF, uranium hexafluoride UF6) on uranium oxide occurs.

Closure of production by solid-phase component provides a pulsed pneumatic, which organizes the overload of necessary elements from CTM to FR’s batchers.

Development, methodology

Today consistency of solid-phase components loadings is currently provided in the manual mode. For making automatic control system which can organize automatic calculation of amount of uranium oxide loading in the CTM requires the development of a mathematical model of the horizontal part of the

CTM. This model will produce parametric synthesis algorithm matching loadings in PR machines and ACT.

The analysis of the recorded variables characterizing the amount of components at the input and output of the horizontal part of CTM revealed rotational speed of the transporting screw which is responsible for CTM loadings and value of mass of solid-phase components in chamber feeders (Fig. 2).

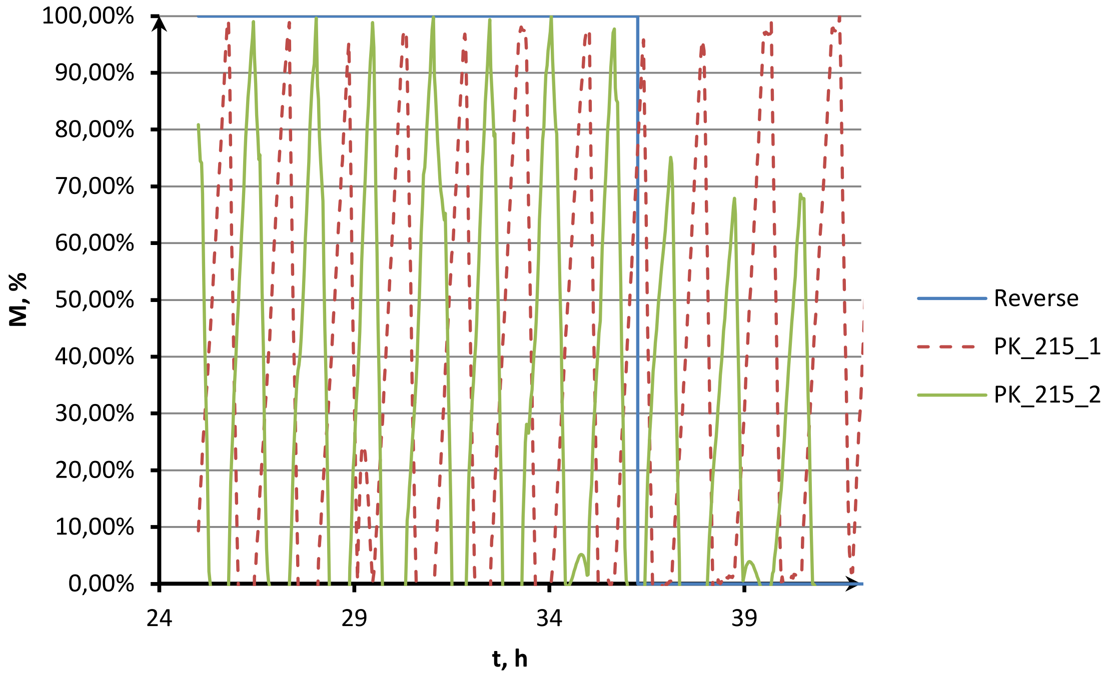

Figure 2 – Amount of solid-phase components in chamber feeders CTM

Figure 2 shows that the work of the horizontal part of the device is acceptable for both directions rotation of the mixer. This is proven by continuous filling of chamber feeders and by the independence of the mixer rotation direction.

This feature allows us to make a conclusion that rotation of the mixer tends to align with the distribution profile of solid-phase components inside the machine. Based on structural features of the device (Figure 3), it has been assumed that an ideal mixing occurs at the interval Δl in figure 3, which corresponds to 150 mm. This is due to different orientation of the mixer blades on the interval.

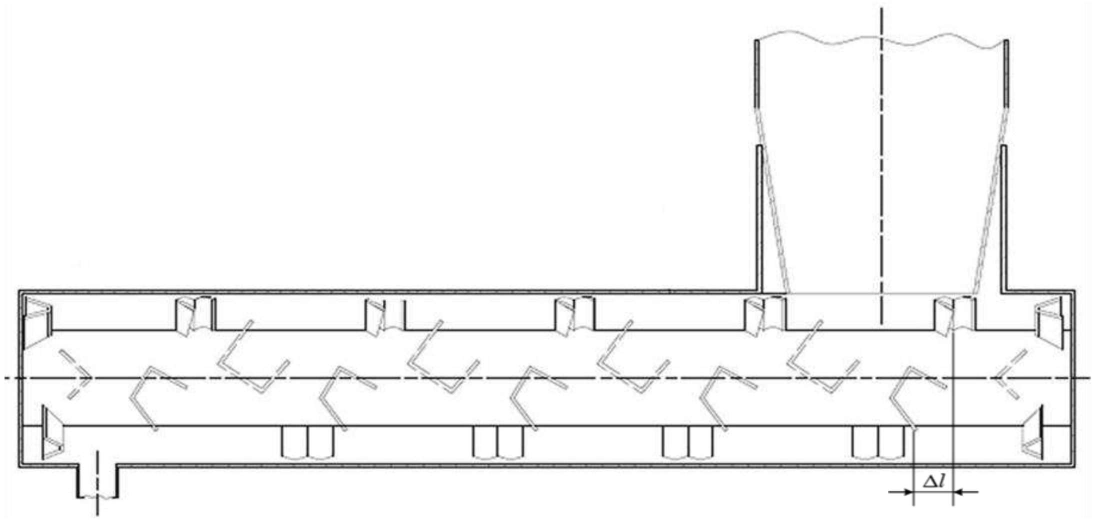

Figure 3 - The horizontal part of the CTM

Accepted assumption allows us to make a system of two equations based on the model of perfect mixing describing stirring at the interval Δl figure 3 [2].

$$\begin{cases} \dfrac{dM_1^k}{dt} = \left(M_2^k - M_1^k\right) \big/ 2 \cdot T_{mix.} \\ \dfrac{dM_2^k}{dt} = \left(M_1^k - M_2^k\right) \big/ 2 \cdot T_{mix.} \end{cases}, \qquad (1)$$

k = UO_2, UO_3, UO_2F_2, UF_4;

M_1^k, M_2^k - weight k-th component in the i-th cell, kg;

T_{mix} – inertia of mixer.

The time constant was obtained experimentally and it is described by mathematic equation:

$$T_{mix} = \frac{60}{3 * N_{mix}} \qquad (2)$$

Equation (2) was obtained by adjusting the coefficient of the multiplier 60/Nmix of time corresponding to one turn of the mixer that achieves ideal mixing of two adjacent cells.

The resulting system of equations describing the distribution of the solid-phase components in horizontal part of CTM is represented by the expression:

$$\begin{cases} \dfrac{dM_1^k}{dt} = \left(M_2^k - M_1^k\right) \big/ 2 \cdot T_{mix.} \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ \dfrac{dM_i^k}{dt} = \left(M_{i-1}^k + M_{i+1}^k - 2 \cdot M_i^k\right) \big/ 2 \cdot T_{mix.} \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ \dfrac{dM_{39}^k}{dt} = \left(M_{38}^k - M_{39}^k\right) \big/ 2 \cdot T_{mix.} \end{cases},$$

k = UO_2, UO_3, UO_2F_2, UF_4;

To create a mathematical description of the horizontal part, 38 cells with the width of 75 mm, and one cell, the width of which is equal to 70 mm have been described. The principle of separating horizontal part of the CTM is described in Figure 4.

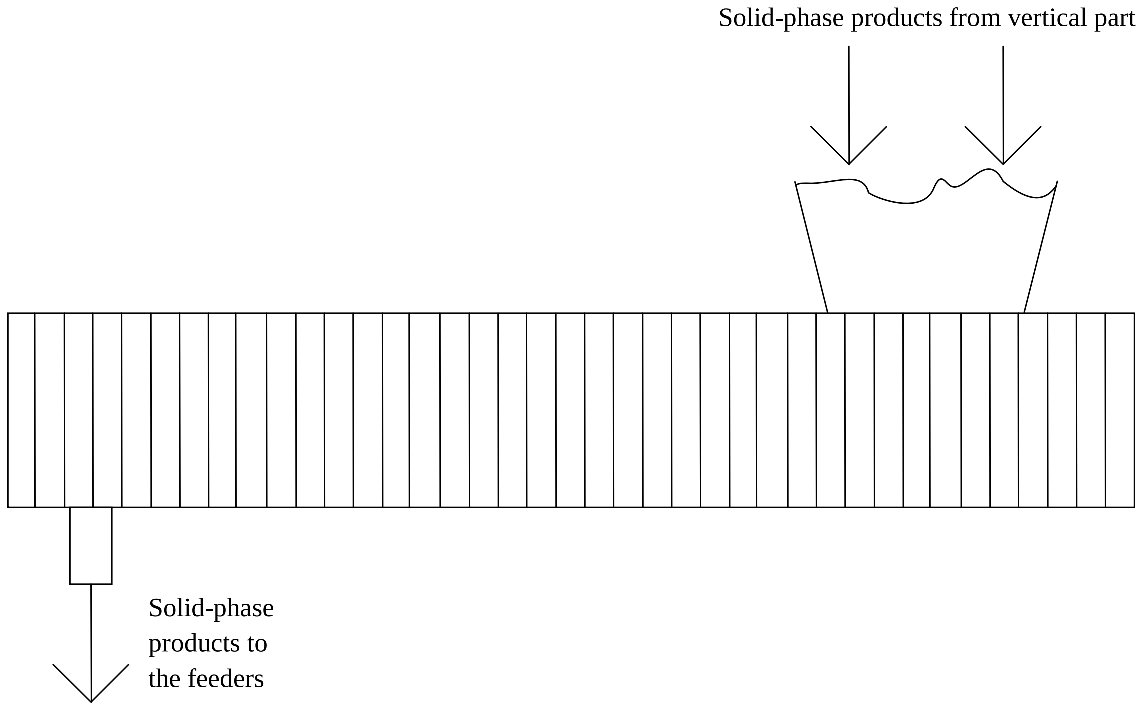

Figure 4 - The principle of horizontal partitioning of CTM into elementary cells

Results

All of researches were carried out in the package Matlab. After making a computer model in Mathlab and our researches, we compared the model graphs and derived from actual production trends. In this case, we took into account only the areas with devastation of chamber feeders (Figure 5). After that we calculated standard deviation [3]. It was near 6,5 %.

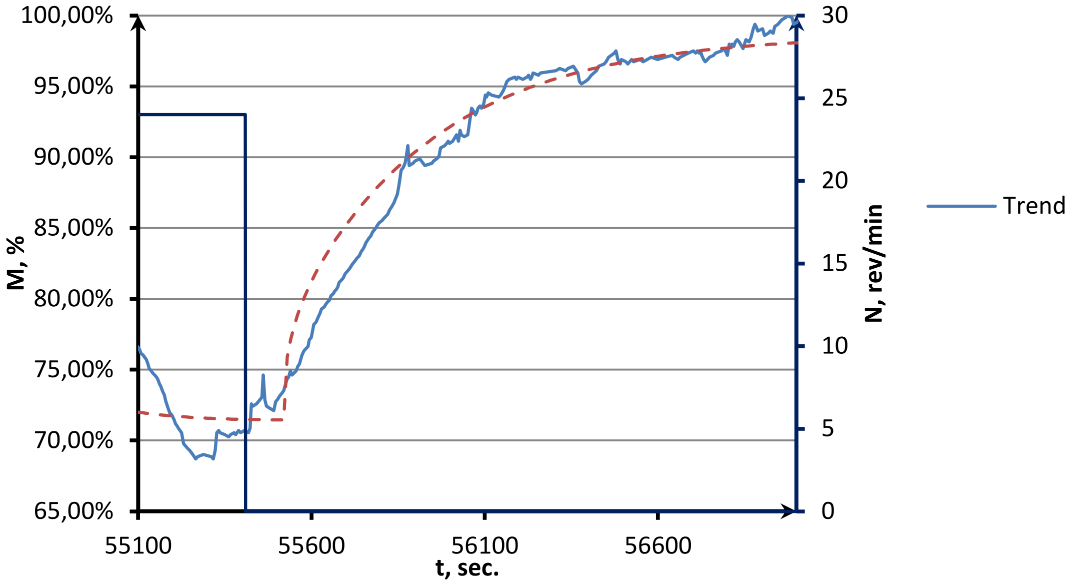

Figure 5 Change in reading devices load feeders chamber when emptying the horizontal part of the CTM

With the help of the mathematical model developed ACP calculated intermediate distribution [4] along the length of the device at nominal operation of the existing oxide production line of uranium hexafluoride.

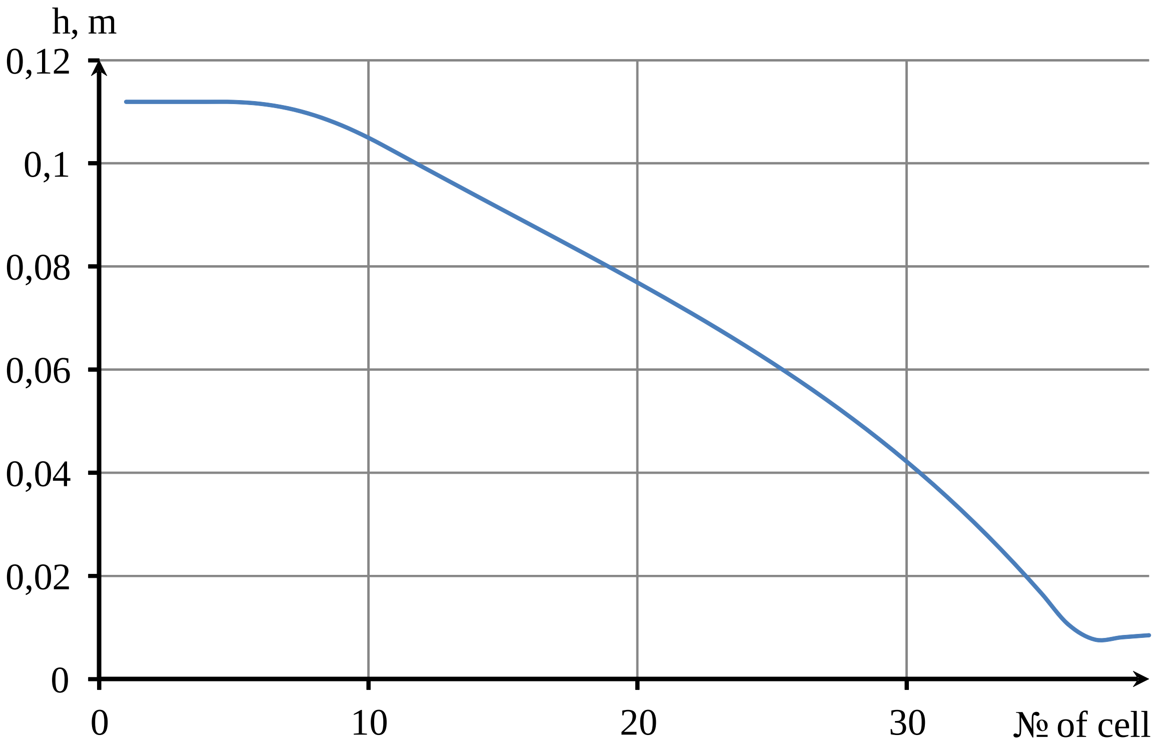

Figure 6 - *Distribution of components in mixer's cells*

From the figure 6 we can see distribution of components in mixer at the nominal operating level of production.

Conclusion

The result of this work is a dynamic mathematical model of the horizontal part of the CTM, the adequacy of which was proved by comparing the calculated data with the trends. The developed model will be used in the synthesis of solid-phase matching algorithm of loading components in machines of PHU.

References

1. Baydali, S. A. Automation and management of technological processes. Dissertation work for the degree of candidate of technical sciences
2. Slinko, M. G., Beeskow, V. S., Skomorokhov, V. B., etc. Methods for modeling of catalytic processes on analog and digital computers. Novosibirsk. Science, 1972.
3. Lisev, V. P. Probability theory and mathematical statistics. Moscow, 2006.
4. Glushko, M. M. Russian – English dictionary math minimum, 1988.