INVESTIGATION OF THE PLASMA UTILIZATION PROCESS OF SPENT NUCLEAR FUEL PROCESSING WASTES

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Uranium-238 and plutonium-239 synthesized in a nuclear reactor are about 97 % of the nuclear fuel spent at nuclear power plants. In its turn, the plutonium isotopes and the share of fission products of the uranium-235 isotope does not exceed 3 % [1]. Weakly concentrated water nitrate solutions (raffinates) are the spent nuclear fuel reprocessing waste (SNF RW) left after the extraction cycle without uranium, plutonium and minor actinides. These solutions have the following characteristic elemental composition: 0.11 % Nd, 0.10 % Mo, 0.07 % Fe, 0.06 % Y, 0.058 % Zr, 0.04 % Na, 0.039 % Ce, 0.036 % Cs, 0.031 % Co, 0.026 % Sr, 18.00 % HNO_3, 81.43 % H_2O.

SNF RW is concentrated by evaporation, pumped into acid-resistant steel tanks and sent for long-term storage, which does not provide for the possibility of further use of valuable metals according to the current multi-stage and energy-intensive technology. SNF RW is proposed to perform in an air-plasma flow from dispersed water-organic nitrate solutions (WONS) containing an organic component (alcohols, ketones, etc.). An adiabatic combustion temperature $T_{ad}\approx$1200 °C [2]. The effect of the content of SNF RW on T_{ad} of water-organic nitrate solutions based on ethanol (a) and acetone (b) shown in figure 1.

The characteristic equilibrium compositions of the main products of plasma utilization of the SNF RW in the form of a WONS-1 based on acetone at a mass fraction of the air plasma coolant of 65 % (a) and 70 % (b) shown in figure 2.

A mass fraction of air of 65 % (a), plasma utilization of SNF RW in the form of WONS-1 leads to the formation of oxides of various metals in the condensed phase, including magnetic iron oxide

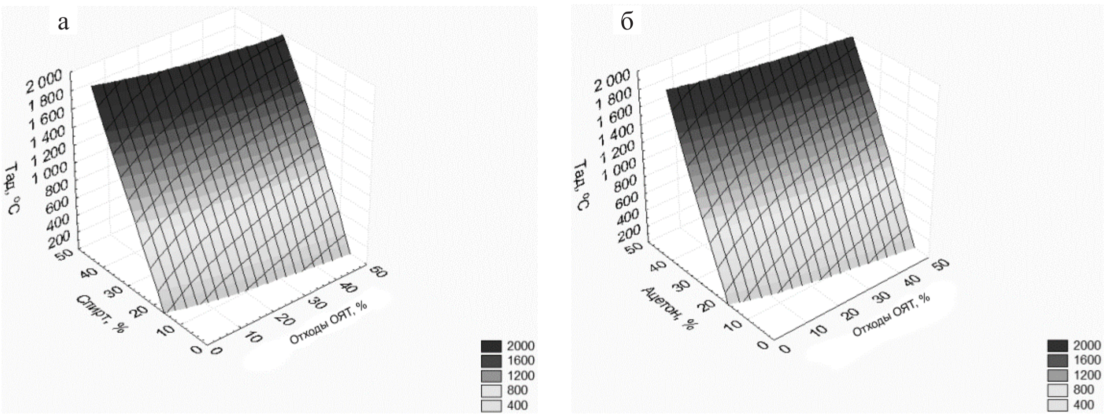

Fig. 1. *Influence of the SNF RW content on T_{ad} of water-organic nitrate solutions based on (a) ethanol and (b) acetone*

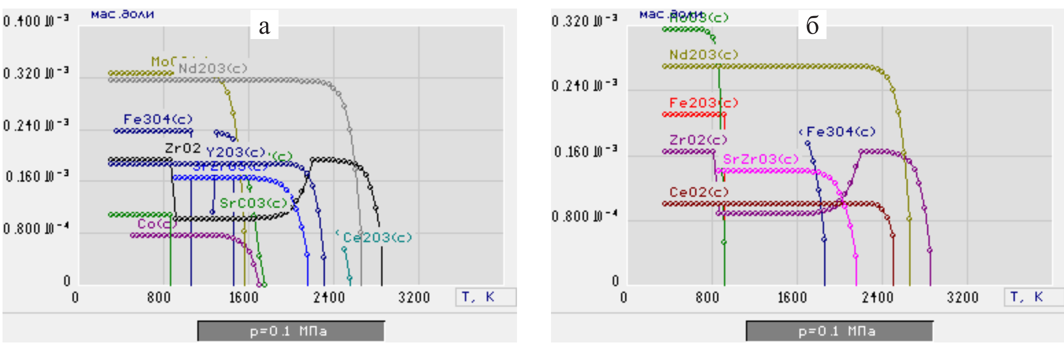

Fig. 2. *Equilibrium composition of the products of air-plasma utilization of SNF RW in the form of WONS-1 at a mass fraction of air of 65 % (a) and 70 % (b)*

(Fe_3O_4) that follows from the analysis. The formation of non-magnetic iron oxide Fe_2O_3(c) in the condensed phase performs by an increase in the mass fraction of air from 65 to 70 % (b).

For the process of plasma, utilization of the spent nuclear fuel in air plasma by taking into account the obtained results the following optimal regimes can be recommended:

- operating temperature range (1500 ± 100) K;
- composition of WONS-1 (65 % SNF RW : 35 % acetone);
- mass ratio of phases (65 % air : 35 % WONS).

References

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2. *Karengin A. G., Karengin A. A., Novoselov I. Yu., Tundeshev N. V. Calculation and Optimization of Plasma Utilization Process of Inflammable Wastes after Spent Nuclear Fuel Recycling // Advanced Materials Research, 2014. – Vol. 1040. – P. 433–436.*

SOFTWARE MONITORING OF CHEMICALS CONSUMPTION AT THE RESEARCH LABORATORY

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Chemicals are substances that are used in chemical and medical laboratories for processing analyses and syntheses. Those compounds are organic and non-organic substances, analytical reagents, dissolvers, and indicators of various hazard classes. All of the reagents must be strictly accounted for and stored as required by safety rules.

In laboratories, an accounting file for any material must be kept on interdisciplinary form No. M-17 and contain a vast amount of information about each component, including: the entry's date, the number of the document, the entry's sequence number, the name of the recipient or the person to whom the reagent is dispensed, income and expanse, signature and more.

Research laboratories handle a large number of chemicals on a regular basis, and each requires a manual entry, which is a labor-intensive and time-consuming process.

The aim of this work is a development of chemical accounting software package for educational institutions' research laboratories using mobile and computer applications.

The first step of development was to create a digital log of reagents' income and expenses with the ability to make a formatted data output on the following terms: month\day, the surname of the person who made an entry, the reagent's name, and the reason for making an entry.

An entry in the digital log is made via the Android smartphone's camera. The individual code (e. g., barcode or QR-code) placed on the package, which contains a reagent, is read and the obtained data, complemented with the text message about volume or mass of the taken reagent, is transferred to the VK application, which transmits accumulated data to the PC and, as a result, an entry about the change in amount of the reagent is made [1].

Thus, the digital log consists of two parts: VK messages processor and the log itself. The code (Fig. 1) below, implemented in the Python 3.7.0 programming language, illustrates how an entry is formed for logging.

The log is formed and displayed as a table in the graphical shell, developed in Python 3.7.0 with built-in API Tkinter [2, 3]. The program provides an option to sample data by certain terms: DD/MM/YY-HH:MM-FULL NAME-REAGENT NAME(g, ml)-REASON (e.g., 03/01/2022-13:12-Ivanov Ivan Ivanovich-NaOH(sodium hydroxide)-10-Lab1), where DD stands for days, MM – months or minutes, YY – years, HH – hours, REASON – task type,