METHODS FOR DETERMINATION OF CRUDE ASH CONTENT

Zhang Dixing,
master's student VSU named P.M. Masherov, Vitebsk, Republic of Belarus
Scientific supervisor – Buyevich T.V., Candidate of Engineering Sciences, Docent

There are many methods available for the quantification of crude ash content. Each method has its own features, advantages and disadvantages which depend on the type of sample, accuracy required, equipment availability and budget. This paper reviews the main methods for determination of crude ash content, their principles of operation, accuracy, speed of analysis, cost and destructiveness, and measurement uncertainties considered.

Objective of the study. The aim of the present study is to investigate and comparatively analyse methods for determination of crude ash content in various products to select the most effective approaches that ensure accuracy, speed and cost-effectiveness of analysis while taking into account measurement uncertainties.

Material and methods. The work is based on the results of analyses of scientific and technical information, normative documents (GOST 26226-95) and studies devoted to methods of analysing raw ash, its physical and chemical properties and application of modern technologies such as spectroscopy and machine learning.

Results and their discussion. In this paper, classification of methods for determination of crude ash content has been carried out. Based on the analysis carried out, the methods for determination of crude ash content can be classified into the following groups:

1) **Classical methods**:

– ash method – based on thermal treatment of the sample to remove organic matter;

– gravimetric method – uses strict control of the ignition conditions.

2) **Modern methods**:

– spectral methods (NIR) – analysing the spectral characteristics of the sample;

– atomic emission spectral analysis – determination of elemental composition of ash;

– machine learning methods – prediction of ash content based on input parameters.

Method precision

According to GOST 26226-95, the precision of methods is assessed through repeatability and reproducibility of results. For example, for the ash method the allowable differences between the results of parallel determinations depend on the mass fraction of ash:

– less than 3%: ±0.3%;

– 3-5%: ±10% of the average value;

– 5-20%: ±0,5%;

– 20-40%: ±2.5% of the average value;

– over 40%: ±1%.

Formula for calculating the crude ash content for the ashpel method:

$$C = \frac{m_2 - m_0}{m_1} \cdot 100, \quad (1)$$

where: C – mass fraction of raw ash (%), m_0 – mass of empty crucible (g), m_1 – mass of initial sample (g), m_2 – mass of crucible with ash after calcination (g).

The influence of factors on measurement uncertainty is considered.

The main sources of uncertainties are:

– Equipment uncertainties: for example, an error of ±0.001 g on a weighing scale can significantly affect the results of the analysis.

– Human error: operator error during sample preparation or reagent addition.

– Variations in sample composition: sample heterogeneity can lead to different results with different parts of the sample.

– Analytical conditions: jumps in temperature, humidity or pressure in the laboratory.

To account for these factors, formulae for calculating Type A and B standard uncertainty, as well as total and expanded uncertainties, were used. For example, for the gravimetric method, the total uncertainty u_c was calculated as:

$$u_c = \sqrt{u_A^2 + u_B^2}, \quad (2)$$

where u_A is the Type A standard uncertainty, u_B is the Type B standard uncertainty.

Practical application of the methods:

– The peplite method is most suitable for laboratories with limited budgets as it requires minimal equipment costs.

– The gravimetric method is recommended for large production plants where high precision of analysis is important.

– NIR (NIR) spectral methods allow rapid and accurate determination of ash content in complex samples.

– Machine learning techniques can be useful for automating the analysis process in industrial settings, but require large amounts of data to train models.

Conclusion. Based on the analysis, it can be concluded that the choice of method for determination of crude ash content depends on the type of product, required accuracy, equipment availability and budget. While classical methods remain relevant for small laboratories, modern technologies such as spectroscopy and machine learning offer new opportunities for automation and improved accuracy. Accounting for measurement uncertainties can improve the reliability of results and ensure regulatory compliance.

1. Буевич, А.Э. Разработка программ для автоматизации расчетов содержания веществ с учетом неопределенности измерений / А.Э. Буевич, Т.В. Буевич // Материалы докладов 57-й Международной научно-технической конференции преподавателей и студентов: в 2 т. / УО «ВГТУ». – Витебск, 2024. – Т. 2. – С. 364–367.

2. Буевич, А.Э. Алгоритм определения массовой доли сырой клетчатки с учетом неопределенности измерений / А.Э. Буевич, Т.В. Буевич // Наука - образованию, производству, экономике: материалы 77-й Региональной научно-практической конференции преподавателей, научных сотрудников и аспирантов, Витебск, 28 февраля 2025 г. – Витебск: ВГУ имени П.М. Машерова, 2025. – С. 15-18. – Библиогр.: с. 18 (4 назв.). – URL: https://rep.vsu.by/handle/123456789/46180.

MATHEMATICAL KINEMATIC MODEL OF THE CRANK AND SLIDE MECHANISM

Zhang Ying Xian*, Pestun D.A.**,

**master's student, **2nd year student VSU named P.M. Masherov,*

Vitebsk, Republic of Belarus

Scientific supervisor – Buyevich T.V., Candidate of Engineering Sciences, Docent

A mathematical kinematic model of a crank-slider mechanism is a system of equations describing the motion of the mechanism links depending on geometric parameters and rotation angles. Such a model allows predicting the position, velocity and acceleration of the slider, as well as optimising the design to improve performance.