– 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.

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MATHEMATICAL KINEMATIC MODEL OF THE CRANK AND SLIDE MECHANISM

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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.

The crank and slide mechanism is one of the basic elements in mechanical engineering, converting rotary motion into translational motion and vice versa. It is used in internal combustion engines, pumps, compressors and other devices. To accurately design and analyse the operation of a crank-slider mechanism, a mathematical kinematic model is required, which takes into account the geometry of the links, their velocities and accelerations.

Research Objective. To develop a mathematical kinematic model of the crank-slider mechanism, allowing:

– determine the position, velocity and acceleration of slider at any moment of time;

– analyse the influence of crank length, connecting rod and other parameters on the system dynamics;

– provide a basis for optimising the design of the mechanism for specific applications.

Material and methods. The work is based on the analysis of the following sources and methods:

– study of the structure of the mechanism including crank, connecting rod and slider;

– Determination of geometrical parameters: crank length r , connecting rod length l , slider coordinates ; x_p

– Using trigonometric functions to calculate the coordinates of the slider;

– application of differential calculus to determine velocities and accelerations;

– numerical methods for solving systems of equations (e.g., Cramer's method).

Results and their discussion. The geometrical model allows us to calculate the kinematic characteristics of the mechanism links.

The position of the slider x_p is calculated via the angle of rotation of the crank θ and the lengths of the links:

$$x_p = r \cdot \cos(\theta) + \sqrt{l^2 - (r \cdot \sin(\theta))^2}. \quad (1)$$

This formula takes into account the geometric constraints of the mechanism, ensuring the correct position of the slider at any . θ

The calculation of velocities and accelerations in the model is implemented as follows.

The speed of the slider v_p is defined as the derivative of : x_p

$$v_p = \frac{dx_p}{dt} = -r \cdot \omega \cdot \sin(\theta) - \frac{r^2 \cdot \omega \cdot \sin(2\theta)}{2\sqrt{l^2 - r^2 \sin^2(\theta)}}, \quad (2)$$

where $\omega = \frac{d\theta}{dt}$ is the angular velocity of the crank.

The acceleration of the slider a_p is calculated via the second derivative:

$$a_p = \frac{d^2 x_p}{dt^2} = -r \cdot \alpha \cdot \sin(\theta) - r \cdot \omega^2 \cos(\theta) - \frac{r^2 \cdot \omega^2 \cos(2\theta)}{\sqrt{l^2 - r^2 \sin^2(\theta)}}, \quad (3)$$

where $\alpha = \frac{d\omega}{dt}$ is the angular acceleration.

Conclusion. The mathematical kinematic model of the crank-slider mechanism, developed on the basis of the analysis of link geometry, provides accurate calculation of positions, velocities and accelerations. Software implementation in Pascal (`assur` module) confirms the correctness of the model. Further research may include consideration of dynamic factors (friction, inertia) and extension of the model to analyse multi-link systems.

Prospects of application of the developed model:

– Optimisation of motor and pump designs

– creation of digital twin mechanisms for industrial monitoring.

The developed mathematical model can be used as a basis for engineering solutions in the field of energy efficiency and reliability of machines.

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METHODS FOR DETERMINING THE MASS FRACTION OF CRUDE FIBRE WITH CONSIDERATION OF MEASUREMENT UNCERTAINTY

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Accurate measurement of crude fibre content is essential for product quality control, regulatory compliance and ensuring efficient feed utilization. However, the results of analyses can be subject to various sources of uncertainty that need to be considered to improve the reliability of the data. This article discusses methods for determining the mass fraction of crude fibre, their features, and approaches to estimating measurement uncertainties.

Objective of the study**.** The aim of this study is to investigate methods for determining the mass fraction of crude fibre, taking into account factors affecting the accuracy of the analysis, such as equipment errors, analysis conditions and human factors. Particular attention is paid to the calculation of measurement uncertainties to ensure the reliability of the results.

Material and methods. The work is based on the results of analysis of scientific and technical information, normative documents (GOST 13496.2-91) and researches devoted to methods of determination of crude fibre, its physical and chemical properties and application of modern technologies.

Results and their discussion. Classification of methods for determining the mass fraction of crude fibre was performed. On the basis of the analysis, the methods of determination of crude fibre content can be divided into the following groups:

1) **Classical methods**:

– gravimetric method – based on treatment of the sample with weak acids and alkalis, subsequent precipitation and drying of the insoluble residue;

– Weindaus method – involves the use of special reagents for fibre extraction.

2) **Modern methods**:

– NIR spectroscopy – analysing the spectral characteristics of the sample;

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

As a result of the analysis, common characteristics of the methods are highlighted. All methods considered are aimed at quantitative determination of crude fibre content, but differ in principle of operation, speed of analysis, cost and destructiveness.

Precision of methods according to GOST 13496.2-91 is assessed through repeatability and reproducibility of results. For example, for the gravimetric method, the allowable