Accuracy	High	High	Depends on the quality of the data
Destructiveness	Destructive	Non-destructive	Non-destructive
Cost	Low	High	High

The major sources of uncertainty in moisture determination include:

– **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.

– **Conditions of analysis**: changes in temperature, air humidity or pressure.

Conclusion. Based on the analysis, it can be concluded that the choice of method for determining the mass fraction of moisture 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 CRANK-CRANK MECHANISM

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The aim of the study is to develop a mathematical kinematic model of crank and connecting rod mechanism.

The research is devoted to the creation of a mathematical kinematic model of the crank-crank mechanism, which allows for a detailed analysis of its operation and optimisation of parameters for specific tasks.

Material and мethods. The work is based on the results of analyses of scientific and technical information. Trigonometric transformations and numerical methods are used in the work.

Results and their discussion. The geometrical model of the crank mechanism is constructed based on the following parameters:

– crank length ; r

– connecting rod length ; l

– crank angle θ (measured in relation to the horizontal axis);

– slider position (coordinate x);

The coordinates of the slider x_p are calculated using the formula:

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

This formula takes into account the geometric constraints of the mechanism and ensures correct calculation of the link position.

The mathematical model allows the calculation of velocities and accelerations.

The velocity of v_p is defined as the time derivative of the coordinate x_p :

$$v_p = \frac{d}{dt}\left(r \cdot \cos(\theta) + \sqrt{l^2 - (r \cdot \sin(\theta))^2}\right). \quad (2)$$

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

$$a_p = \frac{d^2}{dt^2}\left(r \cdot \cos(\theta) + \sqrt{l^2 - (r \cdot \sin(\theta))^2}\right). \quad (3)$$

Trigonometric transformations and numerical methods are used to simplify calculations. Realisation of the model in a programming language.

The \`assur\` module implements procedures that allow you to calculate the positions, velocities and accelerations of crank links. For example:

– the \`pp1\` procedure calculates the coordinates of the second point based on the starting point, the segment length and the slope angle;

– The \`p1\` procedure calculates the velocity and acceleration of a point moving on a circle.

An example of using the procedure p1:

procedure p1(x1, y1, l21, f21, w21, e21: real; var x2, y2, vx2, vy2, ax2, ay2: real);

Where

– x1, y1: coordinates of the starting point;
– l21: the length of the segment;
– f21: tilt angle;
– w21: angular velocity
– e21: angular acceleration;
– x2, y2: coordinates of the second point;
– vx2, vy2: velocity of the second point;
– ax2, ay2: acceleration of the second point.

The developed model allows:

– accurately calculate the positions, velocities and accelerations of all crank links;
– analyse the effect of mechanism parameters (e.g. connecting rod length) on mechanism performance;
– optimise the design of the mechanism to minimise vibration and improve efficiency.

Limitations of the model:

– ideal stiffness of the links is assumed;
– friction forces and other external influences are not taken into account.

Conclusion. The developed mathematical kinematic model of the crank-crank mechanism is a powerful tool for analysis and optimisation of its operation. The model can be used to design new mechanisms and improve existing designs. Further research can be directed to take into account dynamic effects such as friction and deformation, as well as to extend the model to analyse more complex mechanisms.

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INTEGRATED SAPR OF THE SURFACE SWEEP OF A TRUNCATED TETRAHEDRAL PYRAMID

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Surface reaming of a truncated tetrahedral pyramid is a key step in the design and manufacture of complex geometries. However, manual calculation and construction of reamings is time-consuming, error-prone and inefficient for mass production. To solve this problem, an integrated computer-aided design (CAD) system has been developed, which is implemented in AutoCAD's LISP language. The system automates the calculation of the reamer, its division into parts and integration with existing CAD systems such as Profile Master PM2000.

The aim of the research is to develop an integrated CAD of surface sweep of truncated tetrahedral pyramid in LISP language in AutoCAD with the possibility of exporting the results in DXF format for further use in CAD "Profile Master" PM2000.

Material and methods. Gauss method for calculating the area of polygons, numerical integration for calculating the areas of curved surfaces, experimental studies to check the accuracy and correctness of the algorithms on real data, statistical analysis to compare the results obtained by the system with manual calculations and data from AutoCAD were used.

Results and their discussion. The study of CAD functionalities (CATIA, SolidWorks, FreeCAD) has shown that they are not always adapted for specific tasks of enterprises, for example, for truncated pyramids. In addition, their use requires expensive licences and complicated personnel training.

The following development tools were used to refine the functionality:

– AutoCAD: The primary environment for visualising and exporting sweeps.

– LISP: A programming language for creating custom AutoCAD scripts that automate calculations and interface.

– Lazarus (Free Pascal): Used to develop the main programme CAM_by.exe, which generates DXF files and LISP scripts.

– PM2000 "Profile Master": System for part nesting that accepts DXF data.

Stages in the implementation of CAD sweep.

1. Interface Design:

– Creation of a window for entering parameters (length and width of the base, section, height, allowances).

– Visualisation of a 3D model of a pyramid with parameters plotted.

2. Development of LISP scripts:

– The "Piram.lsp" file automatically builds a sweep in AutoCAD using the entered data.

– The files "Piram_L.dxf" and "Piram_R.dxf" export the results for PM2000.

The results of the Razvertka CAD development are the creation of the interface, interchange files, and integration with PM2000.