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MACHINE LEARNING MODELS IN PREDICTING FAILURES OF HYDROTURBINE COMPONENTS

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Abstract: This paper explores the application of machine learning models for predicting failures in hydroturbine components within energy systems digital transformation. Various models including Random Forest, XGBoost, SVM, LSTM, and CNN are analyzed for their effectiveness in processing operational

data from sensors monitoring parameters such as vibration, temperature, and pressure. The research demonstrates that intelligent models can identify hidden patterns in degradation processes and enhance system reliability in real time.
Keywords: machine learning, hydroturbine components, failure prediction, LSTM, CNN, intelligent maintenance, energy systems.

Introduction. The digital transformation of energy systems requires advanced tools for equipment monitoring and maintenance. Predicting failures of hydroturbine components is critical for ensuring operational reliability and efficiency. Machine learning models offer promising solutions by providing accurate analytics of equipment technical conditions based on processing large volumes of operational data collected from various sensors monitoring parameters such as vibration, temperature, pressure, load, and more.

Methodology and Research

Machine learning models enable the identification of hidden patterns in degradation processes, forecast remaining useful life, and enhance system reliability in real time. In modern scientific research, special attention is given to deep recurrent neural networks (LSTM) and convolutional neural networks (CNN), which demonstrate high effectiveness in analyzing time series and signals. Classical ensemble methods such as Random Forest and XGBoost remain relevant for processing structured operational data due to their reliability and interpretability.

Hybrid approaches that combine machine learning with physical modeling of the system improve prediction accuracy while maintaining the physical validity of the results. A promising direction includes automated AutoML systems and adaptive self-updating models that take into account changes in operating conditions.

Table 1 presents a comparative overview of commonly used machine learning models for predicting

failures of hydroturbine components.

Table 1: Comparative characteristics of common machine learning models used for predicting failures of hydroturbine components

Model	Task	Advantages	Limitations
Random Forest	Classification, Regression	Stability, noise resistance, interpretability	Can be overfitted with excessive depth
XGBoost	Classification, Regression	High accuracy, accounts for data imbalance	Complex hyperparameter tuning
SVM	Classification	Effective with small datasets	Poor scalability, sensitive to kernel choice
LSTM	Time Series Forecasting	Detection of long-term dependencies	High computational cost
CNN	Signal Analysis	Handles spectrograms and time patterns well	Requires transformation of signals into image format

Conclusions. The use of machine learning models in the field of predicting failures of hydroturbine components opens new horizons for the development of intelligent maintenance and the enhancement of energy system efficiency. Further research should focus on optimizing model parameters and exploring hybrid approaches that combine different machine learning techniques with domain-specific knowledge.

COMPOSITE COATINGS FOR CORROSION PROTECTION OF AISI 304 STAINLESS STEEL

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Abstract. Austenitic steels, especially AISI 304, are widely used because of their strength and corrosion resistance, but are subject to dangerous types of corrosion. Inhibitors and coatings are used for protection, but inhibitors are poorly understood under extreme conditions and coatings require refinement. A promising solution is composite coatings combining a matrix (polymers, metals, oxides) and a dispersed phase (carbides, nitrides, borides, oxides, carbon nanomaterials). They provide strength and chemical inertness. This paper gives a brief overview of the research relevance in the development and application of composite coatings for corrosion protection.
Keywords: stainless steel, corrosion protection, protective coatings.

Among all types of stainless steels, austenitic steels are the most widely used. They are characterised by durability, good weldability and also possess higher corrosion resistance than other types of steels. However, austenitic steel