SAFETY MONITORING OF PRODUCTION PROCESSES

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Abstract. Safety monitoring of production processes is a fundamental component of modern industrial management systems. With the increasing complexity of technological equipment, automation, and human–machine interaction, the risk of industrial accidents, occupational injuries, and environmental damage has significantly increased. Effective safety monitoring ensures early detection of hazardous conditions, continuous risk assessment, and timely implementation of preventive measures. This article examines the theoretical foundations, methods, tools, and organizational aspects of safety monitoring in production processes. Particular attention is paid to hazard identification, risk assessment techniques, monitoring indicators, digital technologies, and the role of management systems in ensuring sustainable industrial safety. The study highlights that integrated safety monitoring systems significantly reduce accident rates, improve working conditions, and enhance overall production efficiency.

Keywords: industrial safety, safety monitoring, risk assessment, industrial processes, occupational health, risk control.

Anotatsiya: Ishlab chiqarish jarayonlarining xavfsizligini monitoring qilish zamonaviy sanoat boshqaruv tizimlarining asosiy tarkibiy qismidir. Texnologik uskunalar, avtomatlashtirish va inson-mashina o‘zaro ta'sirining murakkablashishi bilan ishlab chiqarishdagi baxtsiz hodisalar, ishlab chiqarishdagi jarohatlar va atrof-muhitga zarar yetkazish xavfi sezilarli darajada oshdi. Samarali xavfsizlik monitoringi xavfli sharoitlarni erta aniqlash, doimiy xavfni baholash va profilaktika choralarini o‘z vaqtida amalga oshirishni ta'minlaydi. Ushbu maqolada ishlab chiqarish jarayonlarida xavfsizlik monitoringining nazariy asoslari, usullari, vositalari va tashkiliy jihatlari ko‘rib chiqiladi. Xavfni aniqlash, xavfni baholash usullari, monitoring ko‘rsatkichlari, raqamli texnologiyalar va barqaror sanoat xavfsizligini ta’minlashda boshqaruv tizimlarining roliga alohida e’tibor qaratilgan. Tadqiqotda integratsiyalashgan xavfsizlik monitoringi tizimlari baxtsiz hodisalar darajasini sezilarli darajada kamaytirishi, ish sharoitlarini yaxshilashi va umumiy ishlab chiqarish samaradorligini oshirishi ta’kidlangan.

Kalit so‘zlar: ishlab chiqarish xavfsizligi, xavfsizlik monitoringi, xavfni baholash, sanoat jarayonlari, mehnat salomatligi, xavfni nazorat qilish.

Аннотация. Мониторинг безопасности производственных процессов является фундаментальной составляющей современных систем управления производством. С ростом сложности технологического оборудования,

автоматизации и взаимодействия человека и машины значительно возрос риск производственных аварий, травм на производстве и нанесения ущерба окружающей среде. Эффективный мониторинг безопасности обеспечивает раннее выявление опасных условий, непрерывную оценку рисков и своевременное внедрение профилактических мер. В данной статье рассматриваются теоретические основы, методы, инструменты и организационные аспекты мониторинга безопасности в производственных процессах. Особое внимание уделяется идентификации опасностей, методам оценки рисков, показателям мониторинга, цифровым технологиям и роли систем управления в обеспечении устойчивой промышленной безопасности. Исследование показывает, что интегрированные системы мониторинга безопасности значительно снижают количество несчастных случаев, улучшают условия труда и повышают общую эффективность производства.

Ключевые слова: производственная безопасность, мониторинг безопасности, оценка рисков, производственные процессы, охрана труда, контроль опасностей.

Introduction.

Industrial production processes play a crucial role in economic development and technological progress. However, they are also associated with numerous hazards that can negatively affect workers' health, equipment reliability, and environmental safety. According to international labor statistics, a significant proportion of occupational accidents occur due to insufficient monitoring of hazardous production factors and delayed response to unsafe conditions. Safety monitoring of production processes is a systematic activity aimed at identifying, analyzing, and controlling hazards throughout the entire production cycle [1;2]. It includes technical, organizational, and human-centered measures designed to ensure safe working conditions and prevent accidents. In modern industry, safety monitoring is no longer limited to periodic inspections; it increasingly relies on continuous data collection, automated control systems, and predictive risk analysis. The relevance of this topic is driven by the growing use of high-speed machinery, complex technological systems, hazardous substances, and energy-intensive processes. In such conditions, traditional safety approaches are insufficient, and proactive monitoring becomes essential [4]. This article aims to analyze the main principles, methods, and technologies of safety monitoring in production processes and to demonstrate their importance for sustainable industrial development.

Safety monitoring of production processes can be defined as a continuous, systematic observation and assessment of working conditions, technological parameters, and human factors in order to detect deviations from safe operating conditions and prevent hazardous events. It integrates technical diagnostics, risk

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management, and occupational safety practices into a unified system [5]. Unlike reactive safety management, which focuses on responding to accidents after they occur, safety monitoring is preventive in nature. Its primary goal is to identify potential threats before they lead to incidents, injuries, or production losses.

The main objectives of safety monitoring in production processes include:

- Identification of hazardous and harmful production factors;
- Continuous assessment of occupational and industrial risks;
- Early detection of abnormal operating conditions;
- Prevention of accidents, incidents, and occupational diseases;
- Improvement of working conditions and labor protection;
- Ensuring compliance with safety regulations and standards;
- Supporting management decision-making in safety-related issues.

Achieving these objectives requires an integrated approach that combines technical monitoring, organizational measures, and human resource management.

Production processes involve various types of hazards that can be classified as follows:

- **Mechanical hazards:** moving parts of machinery, rotating shafts, cutting tools, conveyors, and press equipment.
- **Electrical hazards:** electric shock, short circuits, arc flashes, and static electricity.
- **Thermal hazards:** high temperatures, hot surfaces, molten materials, steam, and fire risks.
- **Chemical hazards:** toxic gases, vapors, dust, corrosive substances, and flammable materials.
- **Physical hazards:** noise, vibration, radiation, poor lighting, and extreme microclimatic conditions.
- **Ergonomic hazards:** improper workplace design, excessive physical нагрузка, repetitive movements, and awkward postures.

Methods. These methods allow safety specialists to identify both obvious and hidden hazards that may not be immediately apparent during routine operations [6]. Risk assessment is a key component of safety monitoring and involves evaluating the likelihood and severity of potential hazardous events. Industrial risk is commonly defined as the combination of the probability of an accident and the magnitude of its consequences.

Common methods used for hazard identification include:

- Workplace inspections and audits;
- Analysis of technological processes and equipment design;
- Job safety analysis (JSA);
- Failure mode and effects analysis (FMEA);

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- Hazard and operability studies (HAZOP);
- Analysis of accident and near-miss statistics.

Discussions. Safety monitoring is most effective when integrated into an occupational health and safety management system, such as ISO 45001. Management systems define responsibilities, procedures, communication channels, and performance indicators related to safety. Top management commitment is critical for successful monitoring, as it ensures adequate resource allocation and continuous improvement.

Human factors play a decisive role in production safety. Even the most advanced monitoring systems cannot be effective without competent and safety-conscious personnel. Regular training, safety briefings, and awareness programs are essential components of safety monitoring. A strong safety culture encourages employees to report hazards, near-miss incidents, and unsafe conditions, contributing to the overall effectiveness of monitoring systems.

Conclusion. Safety monitoring of production processes is an essential element of modern industrial safety management. It provides a proactive approach to identifying hazards, assessing risks, and preventing accidents before they occur. By integrating technical monitoring tools, risk assessment methods, management systems, and human-centered practices, organizations can significantly improve occupational safety and production reliability. In the context of rapid industrial and technological development, safety monitoring must continuously evolve, incorporating digital technologies and predictive analytics. Ultimately, effective safety monitoring not only protects workers' health and lives but also contributes to sustainable production, economic efficiency, and long-term organizational success.

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