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NON-CONTACT MONITORING OF WATER AND MILK QUALITY. (The latest developments in the field of non-contact monitoring of drinking water and cow's milk quality based on the principles of electromagnetic resonance spectroscopy)

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Abstract

The article discusses modern developments in the field of non-contact monitoring of drinking water and cow's milk quality based on resonance control methods and complex digital indicators of the dynamic state of the medium.

The growing need for continuous monitoring of water and milk quality under increasing environmental risks, stricter regulatory requirements, and higher food safety standards is emphasized. Particular attention is given to the limitations of traditional control methods based mainly on electrical conductivity measurements and the need for more comprehensive approaches to liquid parameter analysis.

The article presents technical solutions for real-time monitoring of water and milk quality, including devices for assessing integral quality indicators, somatic cell content, fat concentration, lactose content, gas levels, and indicators of animal diseases. Compact energy-efficient devices designed for stationary use and rapid field analysis are also considered.

The implementation of intelligent non-contact monitoring systems is shown to improve the safety, reliability, and efficiency of water and dairy production, transportation, and processing processes.

Keywords: *Water quality; Milk quality; Monitoring; Non-contact monitoring; Developments in the field of non-contact monitoring of drinking water and cow's milk quality based on the principles of electromagnetic resonance spectroscopy; Water quality control methodology; Milk quality control methodology; Water conductivity; Milk conductivity; Technological conditions; Technology compliance assurance factor*

Inventions in the field of non-contact monitoring of drinking water and cow's milk quality

The quality of drinking water practically determines the quality of life. In all water quality control methodologies, water conductivity is considered a clear indicator of its purity.

The greater the contamination in water, the lower its electrical resistance, while the purer the water, the higher its electrical resistance.

This approach satisfied everyone for a long time, until international terrorism reached the level of prevalence observed today and until general environmental pollution reached the unprecedented scale and magnitude currently being experienced.

These are certainly not all the factors determining the urgent need for more comprehensive water quality control, but they are among the most important.

Practically all existing technologies, instruments, and equipment for water quality control have a very narrow range of technical capabilities and do not cover all the parameters that need to be continuously monitored in order to prevent water from reaching consumers which, due to the reasons listed above, may be contaminated to a degree that poses a danger to human life and health.

Milk is one of the most important products in a balanced diet, and since a significant proportion of its composition is also water, it requires equivalent mobile, reliable, and accurate monitoring technologies adapted both to increasing milk quality requirements and to evolving regulatory quality standards.

When monitoring milk quality, adaptation to new technological conditions and industrial processing procedures is also of great importance.

Based on this incomplete set of information, a reasonable conclusion can be drawn regarding the necessity of continuous monitoring of the quality condition of milk and water before use.

Such technologies have been developed, and a brief description of these technologies is provided below.

1. Device for real-time monitoring of the current quality status of drinking water.

The device is intended for real-time monitoring and evaluation of the current value of a complex digital indicator of the dynamic quality status of drinking water. The device can be adapted for technological water quality control systems at process input stages and for wastewater quality monitoring before discharge into sewage systems or before returning the water to the process after regeneration.

The complex digital indicator of the dynamic state of water and aqueous solutions is an integral parameter which, based on frequency, amplitude, resistance, resonance phenomenon parameters, inductance, and a set of dynamic characteristics of the water flow, represents an integral equivalent of the current value of the content and concentration of components in water, as well as the relationships, including biological relationships, between these components and parameters.

The device for selective real-time identification of the current value of the complex digital indicator of the dynamic quality status of drinking water is a compact device designed for operation as part of water pipeline systems, water flow metering systems, or under field conditions powered by solar batteries.

The device has minimal energy consumption.

The device includes functionally interconnected systems for water input, output, control, and flow transformation, where the water flow transformation system includes an aerodynamic mechanism for removing gases from the specified flow.

The device may be designed for stationary applications as well as for rapid analysis applications.

The device and its operating procedure do not require special training for the operator or user.

2. Device for real-time monitoring of the current quality status of cow's milk.

The device is intended for real-time monitoring and evaluation of the current value of a complex digital indicator of the dynamic quality status of cow's milk.

The complex digital indicator of the dynamic state of cow's milk is an integral parameter which, according to criteria of frequency, amplitude, resistance, inductance, and a set of dynamic characteristics of the milk flow, serves as an integral equivalent of the current content and concentration of components in cow's milk and the relationships, including biological relationships, between these components.

The device for its selective real-time identification is a compact device intended for operation under dairy farm conditions or in field conditions powered by solar batteries.

The device has minimal energy consumption.

The device includes functionally interconnected systems for input, output, monitoring, and transformation of the milk flow, where the milk flow transformation system includes an aerodynamic mechanism for gas removal from the milk flow.

The device may be designed for stationary applications as well as for rapid analysis applications.

3. Complex integral indicator of water and aqueous solution quality and a device for its real-time identification.

The digital indicator of the dynamic quality status of drinking water, which, through comparison of an impulse directed to the sensor according to criteria of frequency, amplitude, resistance, inductance, and corresponding parameters generated in the pipeline by resonance phenomena within the flow, together with a set of dynamic characteristics of the water flow, serves as an integral equivalent of the current content and concentration of components in water.

The device for its selective real-time identification is a compact device intended for operation in urban or main water supply systems or under field conditions powered by solar batteries.

The device has minimal energy consumption.

The device includes functionally interconnected systems for input, output, monitoring, and transformation of the water flow supplied for monitoring, where the water flow transformation system includes an aerodynamic mechanism for gas removal from the flow.

The complex integral water quality indicator also includes a complex integral sensor indicator which, for each sensor type, its design parameters, and the signal parameters supplied to the sensor, is a constant value, as confirmed by the results of a series of tests involving more than 1,000 cycles using four types of sensors.

The device may be designed for stationary applications as well as for rapid analysis applications.

4. Complex integral indicator of cow's milk quality and a device for its real-time identification.

The digital indicator of the dynamic state of cow's milk which, according to criteria of frequency, amplitude, resistance, inductance, and a set of dynamic characteristics of the milk flow, serves as an integral equivalent of the current content and concentration of components in cow's milk.

The device for its selective real-time identification is a compact device intended for operation under dairy farm conditions or in field conditions powered by solar batteries.

The device has minimal energy consumption.

The device includes functionally interconnected systems for input, output, monitoring, and transformation of the milk flow, where the milk flow transformation system includes an aerodynamic mechanism for gas removal from the milk flow.

The device may be designed for stationary applications as well as for rapid analysis applications.

5. Dynamic indicator of the current value of somatic cell count in cow's milk and a device for its selective real-time identification.

The digital indicator of the dynamic state of cow's milk which, according to criteria of frequency, amplitude, resistance, inductance, and a set of dynamic characteristics of the milk flow, serves as an integral equivalent of the current content and concentration of somatic cells in cow's milk.

The device for its selective real-time identification is a compact device intended for operation under dairy farm conditions or in field conditions powered by solar batteries.

The device has minimal energy consumption.

The device includes functionally interconnected systems for input, output, monitoring, and transformation of the milk flow, where the milk flow transformation system includes an aerodynamic mechanism for gas removal from the milk flow.

The device may be designed for stationary applications as well as for rapid analysis applications.

6. Dynamic complex indicator of the current fat concentration value in cow's milk and a device for its selective real-time identification.

The digital indicator of the dynamic state of cow's milk which, according to criteria of frequency, amplitude, resistance, inductance, and a set of dynamic characteristics of the milk flow, serves as an integral equivalent of the current content and concentration of fat or fatty acids in cow's milk.

The device for its selective real-time identification is a compact device intended for operation under dairy farm conditions or in field conditions powered by solar batteries.

The device has minimal energy consumption.

The device includes functionally interconnected systems for input, output, monitoring, and transformation of the milk flow, where the milk flow transformation system includes an aerodynamic mechanism for gas removal from the milk flow.

The device may be designed for stationary applications as well as for rapid analysis applications.

7. Dynamic complex indicator of the current lactose content value in cow's milk and a device for its selective real-time identification.

The digital indicator of the dynamic state of cow's milk which, according to criteria of frequency, amplitude, resistance, inductance, and a set of dynamic characteristics of the milk flow, serves as an integral equivalent of the current lactose content in cow's milk.

The device for its selective real-time identification is a compact device intended for operation under dairy farm conditions or in field conditions powered by solar batteries.

The device has minimal energy consumption.

The device includes functionally interconnected systems for input, output, monitoring, and transformation of the milk flow, where the milk flow transformation system includes an aerodynamic mechanism for gas removal from the milk flow.

The device may be designed for stationary applications as well as for rapid analysis applications.

8. Complex integral indicator of mastitis in cows and a device for its real-time identification.

The digital indicator which, according to criteria of frequency, amplitude, resistance, and inductance, serves as an integral equivalent or indicator of the occurrence of mastitis in cows.

The device for its real-time identification is a compact device intended for operation under dairy farm conditions or in field conditions powered by solar batteries.

The device has minimal energy consumption.

The device includes functionally interconnected systems for input, output, monitoring, and transformation of the milk flow, where the milk flow transformation system includes an aerodynamic mechanism for gas removal from the milk flow.

The device may be designed for stationary applications as well as for rapid analysis applications.

9. Device for selective real-time identification of cow's milk quality during its transportation to a collection tank after milking.

A compact device intended for operation under dairy farm conditions or in field conditions powered by solar batteries.

The device has minimal energy consumption.

The device includes functionally interconnected systems for input, output, monitoring, and transformation of the milk flow, where the milk flow transformation system includes an aerodynamic mechanism for gas removal from the milk flow.

10. Device for non-contact monitoring of cow's milk condition parameters.

The device includes systems for supplying milk for monitoring, removing the milk flow from the monitoring zone, and a sensor-based electronic integrated monitoring module with an interface.

The device may include a signal identification system and a device for rapid comparison of identified signals with a reference standard.

11. Device for simultaneous monitoring of multiple cow's milk condition parameters during transportation.

The device has two configurations.

The first configuration is intended for installation on tanks for monitoring milk quality during transportation and during transfer of milk for processing into dairy products.

The second configuration is intended for installation on flexible or rigid pipelines through which milk is directed into storage tanks; this configuration may additionally include real-time temperature measurement functions.

12. Device for rapid analysis of cow's milk quality.

The device is a mobile compact instrument with an internal chamber into which milk (or any other liquid) is introduced for analysis.

A sensor selectively tuned to a specific parameter of milk or any other liquid is positioned around the chamber.

The device does not require adjustment or calibration and has several levels of protection.

13. Device for selective rapid analysis of cow's milk quality parameters.

The device is a mobile compact instrument with an internal chamber into which milk (or any other liquid) is introduced for analysis.

A sensor selectively tuned to a specific parameter of milk or any other liquid is positioned around the chamber.

The device does not require adjustment or calibration and has several levels of protection.

14. Non-contact milk level sensors in containers.

The device monitors the level of milk (or any other liquid) in a dedicated pipeline section connected to the container in which the liquid level is being monitored.

The device has several configuration options.

It may be located inside the liquid container, outside the container, and may have different sensor configurations.

15. Device for comprehensive monitoring of milk level in containers with simultaneous evaluation of the integral milk quality indicator at that level.

The device monitors the level of milk (or any other liquid) in a dedicated pipeline section connected to the container in which the liquid level is being monitored.

The specified pipeline section simultaneously serves as a resonance sensor configured for monitoring and evaluating the integral quality indicator of milk (or any other liquid) and as a level sensor.

The device may also simultaneously monitor any physical characteristics of milk or liquid, such as conductivity, density, and acidity level.

16. Device for comprehensive monitoring of milk level in containers with simultaneous evaluation of the somatic cell count in milk at that level.

The device monitors the level of milk (or any other liquid) in a dedicated pipeline section connected to the container in which the liquid level is being monitored.

The specified pipeline section simultaneously serves as a resonance sensor configured to monitor the number of somatic cells and as a level sensor.

The device may also simultaneously monitor any physical characteristics of milk or liquid, such as conductivity, density, and acidity level.

17. Device for comprehensive monitoring of milk level in containers with simultaneous evaluation of fat content in milk at that level.

The device monitors the level of milk (or any other liquid) in a dedicated pipeline section connected to the container in which the liquid level is being monitored.

The specified pipeline section simultaneously serves as a resonance sensor configured to monitor fat concentration and as a level sensor.

18. Device for comprehensive monitoring of milk level in containers with simultaneous evaluation of lactose content in milk at that level.

The device monitors the level of milk (or any other liquid) in a dedicated pipeline section connected to the container in which the liquid level is being monitored.

The specified pipeline section simultaneously serves as a resonance sensor configured to monitor lactose concentration and as a level sensor.

19. Device for comprehensive monitoring of milk level in containers with simultaneous evaluation of blood trace content in milk at that level.

The device monitors the level of milk (or any other liquid) in a dedicated pipeline section connected to the container in which the liquid level is being monitored.

The specified pipeline section simultaneously serves as a resonance sensor configured to monitor blood concentration and as a level sensor.

The device monitors the level of milk (or any other liquid) in a dedicated pipeline section connected to the container in which the liquid level is being monitored.

The specified pipeline section simultaneously serves as a resonance sensor configured to monitor parameters and as a level sensor.

20. Device for comprehensive monitoring of milk level in containers with simultaneous evaluation of the concentration of several basic components in milk at that level.

The device monitors the level of milk (or any other liquid) in a dedicated pipeline section connected to the container in which the liquid level is being monitored.

The specified pipeline section simultaneously serves as a resonance sensor configured to monitor parameters and concentrations of components in milk or any other liquid and includes several sensors, each configured to monitor one parameter, with each sensor simultaneously functioning as a level sensor.

21. Device for changing the turbulence level of milk flow.

The device is intended for the conversion and dynamic transformation of a turbulent milk flow with the formation of a local laminar flow zone in which milk monitoring is performed using a resonance sensor.

In addition, during flow transformation, the device releases air from the milk flow and stabilizes its hydrodynamic characteristics.

22. Device for preparing milk flow for real-time monitoring of condition parameters.

The device is intended for the conversion and dynamic transformation of milk flow with the formation of a local laminar flow zone in which milk monitoring is performed using a resonance sensor.

23. Device for real-time monitoring of gas content levels in milk.

The device is a resonance sensor that detects changes in a set of parameters in milk depending on the concentration of air or any other gas contained in it.

The device may simultaneously monitor the filling level of the pipeline through which the milk flow moves and the turbulence level of the milk flow within the pipeline.

24. Milk aeration process control system with real-time monitoring of air content in milk.

The milk aeration process control system with monitoring of air content levels in milk includes feedback with a resonance sensor and changes the parameters of compressed air depending on the concentration of air in the milk.

The system includes a resonance sensor, an interface, and a converter that transforms sensor signals into control signals for the compressed air source, through which the pressure and flow rate of compressed air are adjusted.

The system also includes an aerodynamic function for introducing air into the milk.

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