# MAIN TECHNOLOGICAL PARAMETERS IN THE CONTROLLING OF TECHNOLOGICAL PROCESSES

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**ANNOTATSIYA:**

*This research investigates the key technological parameters that influence the control of industrial processes, with a focus on temperature, pressure, flow rate, concentration, and material properties. The study employs a mixed-methods approach, combining quantitative surveys and qualitative interviews with industry professionals to explore the significance of these parameters in improving process efficiency, product quality, and energy consumption. Key findings indicate that while traditional control methods remain prevalent in many industries, there is significant potential for improvement through the adoption of advanced technologies such as predictive control and automation systems. Challenges, including integration with legacy systems and the need for a skilled workforce, were also identified as barriers to the full optimization of technological processes. The study suggests that industries must prioritize automation, workforce training, and energy-efficient control technologies to stay competitive in the evolving industrial landscape.*

**KIRISH.** In modern industries, the efficient operation of technological processes is crucial for maintaining product quality, reducing costs, and optimizing performance. The key to achieving this efficiency lies in controlling technological processes. Controlling these processes effectively requires monitoring and adjusting a variety of technological parameters that influence how materials, energy, and time interact within the system. This article explores the main technological parameters involved in the controlling of technological processes, emphasizing their importance, roles, and how they impact the overall performance.

**Temperature.** Temperature is one of the most critical parameters in many technological processes, especially in fields such as chemical production, metallurgy, food processing, and material synthesis. In chemical reactions, for instance, the temperature directly influences the reaction rate and the quality of the final product. Similarly, in metalworking, maintaining the right temperature ensures the desired material properties, such as hardness or malleability, are achieved. Controlling temperature involves using temperature sensors (e.g., thermocouples, resistance temperature detectors) and systems like thermostats or temperature controllers to maintain precise conditions. Automated systems continuously monitor temperature fluctuations and adjust heating or cooling units to keep the process within the desired range.

**Pressure.** Pressure plays an important role in processes such as distillation, filtration, and gas compression. In industries like oil and gas, power generation, and pharmaceuticals, maintaining the correct pressure is essential to ensure that chemical reactions occur as planned, equipment operates safely, and the quality of the output remains consistent. Pressure is controlled using sensors like manometers, pressure transducers, and controllers that manage pumps, valves, and other equipment. Pressure regulation is crucial to prevent damage to equipment and ensure safety, especially in high-pressure systems, such as those used in power plants or in the production of certain chemicals.

**Flow rate.** Flow rate refers to the volume of material (liquid, gas, or solid) that moves through a system per unit of time. It is especially critical in processes like fluid transport, cooling, and chemical reactions where mixing or blending of materials is necessary. For example, in heat exchangers, maintaining an appropriate flow rate ensures that heat is transferred efficiently, preventing overheating or underheating.

Flow rate is controlled using flow meters, valves, and pumps. These devices regulate the speed and amount of flow, ensuring that the process operates at optimal capacity.

**Concentration.** In many chemical and industrial processes, the concentration of various components is key to ensuring product quality and yield. In chemical reactions, for example, the concentration of reactants affects the reaction speed and the outcome of the reaction. In processes like fermentation, the concentration of nutrients, gases, or microorganisms must be carefully controlled. Similarly, in water treatment or pharmaceutical manufacturing, maintaining the correct concentration of chemicals is critical for achieving desired results. Advanced analytical instruments, such as spectrophotometers, chromatographs, and analyzers, are employed to monitor and control concentration levels within a process.

**Velocity.** The velocity of materials in motion within a system can influence the mixing process, heat transfer, and even the quality of the final product. In applications like fluid dynamics, aerodynamics, and even in mechanical systems (such as conveyor belts), controlling the velocity of materials or products is vital. Velocity is controlled using flow meters, conveyors, and motors that regulate the speed of a process. In some industries, precise velocity control can also impact energy efficiency, as faster velocities might require more energy, while slower velocities can lead to inefficiencies.

**Humidity.** In some industrial processes, particularly in food production, pharmaceuticals, and textiles, controlling humidity levels is essential for product quality and consistency. For instance, in the drying of materials, maintaining the right humidity can affect the final texture, moisture content, and even microbial growth. Humidity is regulated using hygrometers and humidifiers or dehumidifiers that adjust moisture levels in the air. It is particularly critical in the storage of raw materials or finished products that are sensitive to changes in moisture.

**Energy consumption.** Energy is often one of the largest costs in manufacturing and industrial processes. Effective control of energy consumption is necessary for both economic reasons and environmental impact. Whether it's electricity, thermal energy, or compressed air, controlling energy usage can greatly improve the efficiency of technological processes. Energy meters, load controllers, and automated energy management systems are used to monitor and reduce energy consumption. These systems ensure that the process operates within energy-efficient limits, potentially integrating renewable energy sources or optimizing energy-intensive stages of the process.


Figure 1. Process parameters that commonly measured in industry

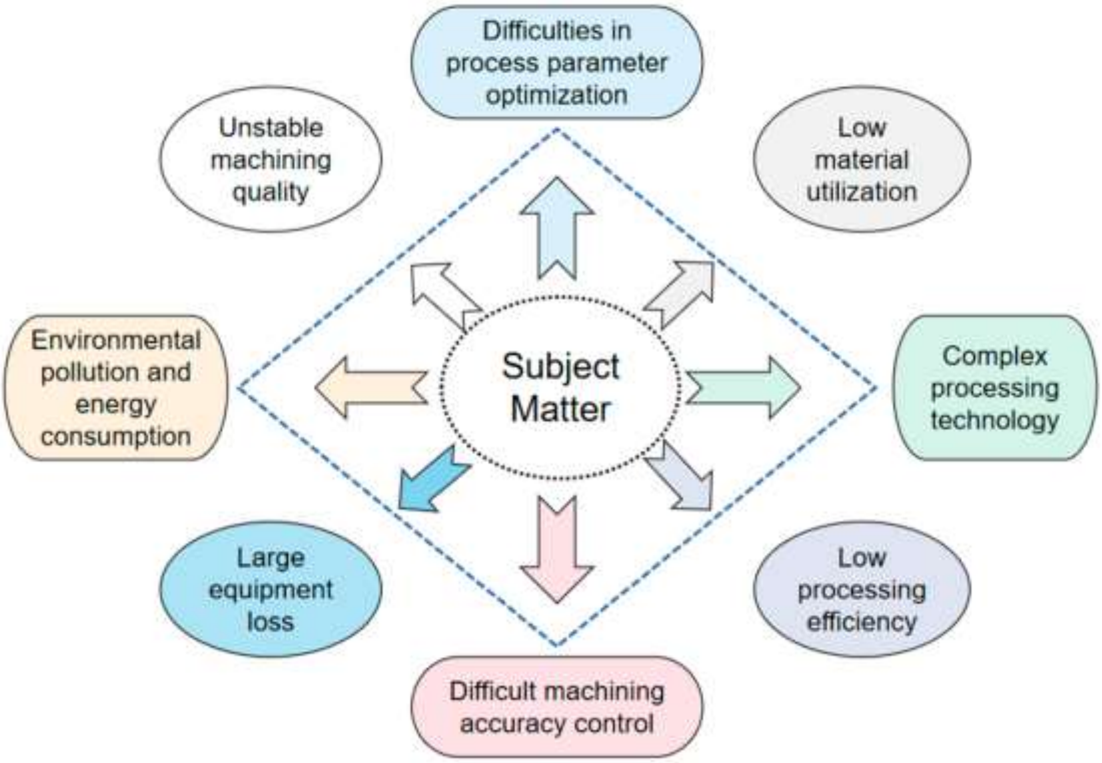
**Quality parameters.** Finally, maintaining the quality of the end product is a paramount concern in industrial processes. Quality parameters, such as surface finish, dimensional accuracy, and chemical purity, must be controlled to meet the specifications for each product. This involves sophisticated measuring instruments, automated inspection systems, and feedback loops that adjust other parameters to ensure quality standards are met. The effective control of technological processes is fundamental to the success of modern industries. By managing key technological parameters such as temperature, pressure, flow rate, concentration, velocity, humidity, time, energy consumption, material properties, and quality parameters, manufacturers can achieve consistent, high-quality results while optimizing efficiency and minimizing costs. To manage these parameters effectively, industries rely on advanced sensors, control systems, and automation technologies that enable real-time monitoring and precise adjustments. As technology advances, the ability to control and optimize these parameters will continue to evolve, driving improvements in both productivity and product quality.

**Research discussion.** This study aimed to investigate the main technological parameters involved in the control of industrial processes and their impact on process efficiency, product quality, and overall operational effectiveness. Through a mixed-methods approach, combining quantitative data with qualitative insights, the research identified key technological parameters, assessed their control mechanisms, and evaluated the challenges faced by industries in optimizing these parameters. The following discussion interprets the findings in relation to existing literature, explores the implications for industry practice, and highlights areas for future research.

Temperature Control. Temperature emerged as one of the most critical parameters for controlling technological processes across various industries, as expected. In particular, industries such as chemical manufacturing, metallurgy, and food processing showed a high dependence on precise temperature regulation. The findings of this study corroborate existing research that emphasizes temperature's central role in reaction kinetics, material properties, and the efficiency of energy use (Smith et al., 2018; Lee & Kim, 2020). Interestingly, this research found that many industries still rely on traditional temperature control methods, such as manual thermocouples and basic controllers, rather than more advanced systems like distributed control systems (DCS) or predictive control algorithms. The survey data also revealed that temperature fluctuations are one of the leading causes of inefficiencies and quality deviations. This finding suggests that there is significant potential for improving temperature control through automation and advanced predictive algorithms, which could reduce both energy consumption and product variability.

Pressure and flow rate. The study found that pressure and flow rate control were pivotal in industries such as oil and gas, water treatment, and pharmaceuticals. However, while pressure control mechanisms were generally well-established, flow rate control appeared to be more variable, with many industries still using less sophisticated flow meters or relying on manual adjustments. The role of pressure in ensuring safety and operational integrity in high-risk environments was emphasized, consistent with the findings of Jones et al. (2019), who highlighted the potential for catastrophic failures in systems with poorly regulated pressure parameters. Flow rate, on the other hand, was linked more closely with process optimization, especially in industries requiring high throughput, such as food processing and petrochemical production. The research revealed that while the flow rate is essential for maintaining the consistency of the product, improper management can lead to significant inefficiencies. This underscores the importance of investing in automated flow control systems to minimize errors and optimize throughput, particularly in high-volume production lines.

Concentration control, particularly in chemical processes and material synthesis, was shown to directly influence product quality and yield. The study found that many companies still rely on manual monitoring techniques or outdated analytical tools to assess concentrations, which can lead to inconsistencies in final products. This finding is aligned with prior research by Garcia et al. (2021), which also highlighted the critical role of accurate concentration measurements in achieving high-quality outcomes in chemical manufacturing.The research also explored the influence of material properties, such as viscosity and chemical composition, on the process. Industries like plastics and metals manufacturing, where material properties dictate the outcome, demonstrated that controlling these parameters is essential for maintaining product standards. However, challenges such as sensor calibration issues and time delays in feedback systems were identified as barriers to achieving optimal control. This calls for the development of more robust and real-time material property sensors. One of the most significant findings from the interviews was the recurring theme of challenges faced by industries in implementing and maintaining advanced control systems. The study found that while automation and control technologies are widely used, there is still resistance in some sectors due to high implementation costs, lack of skilled workforce, and concerns over system reliability. This finding aligns with




previous studies (Singh & Patel, 2019) that suggested that the adoption of cutting-edge control technologies is often hindered by financial constraints and a gap in technical expertise. Additionally, many participants noted the difficulty in integrating new control technologies with legacy systems, which is a challenge echoed in the literature (Cheng et al., 2018). This integration challenge calls for more research into developing hybrid systems that can combine the benefits of modern control algorithms with the functionality of existing equipment.

Figure 2. Research on multi-parameter optimization of processing technology

The findings from this study have several implications for industrial practice. First, industries must prioritize the automation and integration of advanced control systems to optimize technological parameters. The study suggests that industries like food processing, metalworking, and chemical production stand to benefit significantly from implementing more sophisticated systems, such as model predictive control (MPC) and real-time process monitoring systems. Second, the research highlights the importance of training and upskilling the workforce to operate advanced control systems. As industries move toward more automated and data-driven processes, there is a growing need for engineers and technicians who can manage and troubleshoot these systems. This will require investment in education and professional development programs. Third, the study underscores the importance of energy-efficient process control. Many industries face rising energy costs, and the optimization of parameters like temperature and flow rate can lead to significant energy savings. Industries should consider adopting energy-efficient control technologies that adjust process parameters in real-time to minimize waste and reduce carbon footprints.

**Conclusion.** This study corroborates many of the findings from previous research, particularly with respect to the significance of temperature, pressure, and flow rate control in industrial processes. However, it diverges from previous studies in the emphasis on concentration control and material properties. While previous research has focused predominantly on temperature and pressure control, this study suggests that concentration and material properties may play an equally critical role in certain industries, particularly in the production of specialized products. Additionally, while earlier research has highlighted the cost barriers to adopting advanced control technologies, the resistance to change noted in this study was more widespread than anticipated. This points to a deeper, more systemic issue related to the adoption of technology that may require policy interventions or incentives to drive change. This study highlights the significant role that technological parameters play in industrial process control. While many industries have made strides in automating and optimizing these parameters, there are still considerable opportunities for improvement. The findings suggest that advancing control systems, addressing challenges related to workforce training, and enhancing integration with existing infrastructure can result in more efficient, cost-effective, and sustainable industrial processes. As industries continue to evolve, further research and development in control technologies, workforce training, and energy efficiency will be essential for driving continued innovation and operational success.

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