

Master's Thesis

Real-Time Process Monitoring in mRNA manufacturing Using Infrared Spectroscopy

Keywords: Infrared Spectroscopy, mRNA manufacturing, Real-Time Monitoring

Project Description

Infrared (IR) spectroscopy is a powerful analytical technique increasingly applied in biopharmaceutical manufacturing for real-time, non-invasive monitoring and control. In mRNA production, particularly during in vitro transcription (IVT) and downstream purification, IR spectroscopy enables label-free detection of key components such as nucleotides, enzymes, and buffer constituents. Its integration into process analytical technology (PAT) framework supports enhanced process understanding, improved product quality, and adaptive control strategies. As mRNA-based therapeutics continue to gain relevance, the need for robust, real-time analytical tools becomes increasingly critical to ensure process efficiency and regulatory compliance.

This project explores the integration of IR spectroscopy into mRNA manufacturing workflows, with a focus on enabling real-time monitoring of component concentrations during IVT and tangential flow filtration (TFF). The work aims to support the development of a modular, data-driven sensor system that enhances process transparency and enables automated control in key production steps.

Tasks

- Conduct a literature review on infrared (IR) spectroscopy, including system functionality, applications in biopharmaceuticals, and tracking/data analysis in IVT processes
- Implement a sensor system for real-time monitoring of component concentrations, including Nucleotides, mRNA, proteins and other impurities
- Development of a component-specific spectral database
- Development of an interface connecting the sensor system with different use cases, such as real-time monitoring during TFF and automated feed control in IVT

Profile

- Enrolled in a master's program in Mechanical Engineering, Process Engineering, Biotechnology, or a related discipline
- Prior experience in laboratory work, ideally with analytical instrumentation or bioprocessing
- Ability to work independently with a structured, solution-oriented, and creative approach
- Basic programming skills (e.g., Python) and familiarity with data analysis are a plus
- Interest in biopharmaceutical manufacturing and process analytical technologies (PAT)

Start: December/January 2025/2026

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The exact scope and content of the thesis may be subject to adjustments based on project developments and ongoing research priorities.