

Easyprocess:

An AI system to support precision bio-production

by El.Com.It srl

In industrial biotechnology, microbial fermentation is used to produce a wide variety of chemicals used in agriculture, household products, cosmetics, the food and pharmaceutical industries, and as biofuels. Traditional products include organic acids (lactate, citrate), antibiotics, amino acids used as feed additives, vitamins for both humans and livestock, enzymes used in detergents and various industrial processes, and ethanol used as a biofuel.

In recent years, microbial fermentation processes have also been developed to produce basic chemicals used in the manufacture of materials and chemicals as ingredients in food and cosmetics. A key factor in this development is the ability to design microbial cells to produce a specific product, generally known as metabolic engineering. Over the past 20 years, there has been enormous progress in the field of metabolic engineering, with hundreds of studies reported on the production of various chemicals that may have potential market uses. However, for these "academic" projects to progress, it is important to scale the process from the laboratory development phase to the production phase, achieving what is now classified as precision fermentation.

For fermentation control, El.Com.It has developed the EasyProcess system, designed to facilitate the collection, monitoring, analysis, and optimization of industrial production process data via bioreactors. EasyProcess is a user-friendly tool designed to precisely manage and optimize the production process, whose functionalities include:

- Real-time data acquisition via OPC, DB files, REST communication system, data storage.
- Process management with metadata collection, process definition for products, equipments configuration, and process sequence management.
- Data import/export, graphics, trends, reporting.
- Notifications and alerts via Web, Mobile, e-Mail, etc.; QA compliance.
- Sample data management, data import/export, storage, archiving.
- Analysis: statistics, models, and decision support tools.

EasyProcess is also supported by specialist consulting services on bioprocess design optimization and project management.

For the EasyProcess system, El.Com.It is developing additional packages to address the main critical aspects of precision fermentation control and production scale-up with AI-based analysis methods:

1. Fermentation Quality Data Analysis:

This involves studying the parameters related to productivity and production costs. An appropriate set of input parameters allows the development of productivity, cost, and other critical fermentation conditions assessments, aiming to create an adaptive success evaluation system through reference metrics (e.g., TRY: Titer, Rate, and Yield).

2. Fermentation Process Control/Optimization:

Starting from preliminary studies of the relationships between success metrics and process development in terms of the temporal progression of chemical-physical parameters, algorithms are developed to provide predictions, alerts, and controls for optimization according to a chosen metric or one determined as optimal during the system's learning phases.

3. Inoculum Optimization:

Inoculum optimization requires considering competitive processes dependent on the specific microorganism, as well as chemical-physical parameters and production methodology parameters. The project addresses the problem of optimizing timing and development phases.

4. Optimization of Physical Parameters in Fermentation Process Scale-Up:

Specialist literature confirms the usefulness of a tool that allows determining/optimizing physical parameters critical in the transition from pilot plant to production plant. This issue concerns various parameters, such as the scaling of oxygen exchange systems based on the fermenters' shape and volume. The project develops a tool that, given the microorganism and pilot plant specifications, can provide proposals for implementing relevant aspects of the production plant and assessments of their overall efficiency.

The project is based on the expertise of the proposing group, which includes management engineers, chemical engineers, biologists, microbiologists, computer scientists, and experts in advanced data analysis.