Overview of IndPenSim

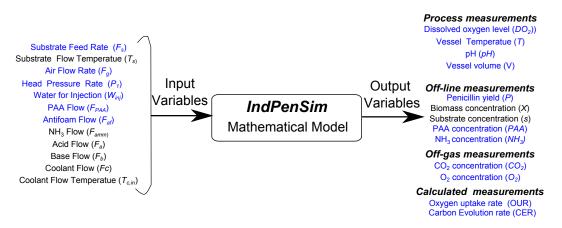
Stephen Goldrick

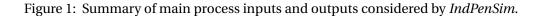
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This document presents an overview of *IndPenSim*, a first principles mathematical simulation of an industrial-scale fed-batch penicillin fermentation. A summary of the main Matlab files implemented in the simulation is given, including html links to the M-files. Specific details regarding the simulation can be found in the paper titled "The Development of an Industrial-scale Fed-batch Fermentation Simulation" (available in the Journal of Biotechnology).

1 INPUTS AND OUTPUTS

The simulation was developed using the batch data recorded on a 100,000 litre penicillin fermentation process. The industrial data is available to download and contains all the main inputs and outputs. A summary of the main inputs and outputs of the simulation is summarised in Fig. 1. All the variables highlighted in blue represent the variables that were recorded by the batch records. The variables in black represent those that were approximated by the simulation.





2 OVERVIEW OF IndPenSim

A flow chart illustrating the main Matlab files implemented by *IndPenSim* is presented below. A detailed description of each M-file is available in the comments of each file. The files can be viewed by clicking on the html links provided.

Indpensimrun.m Runs IndPenSim Links to Matlab code ħη Ind_Batch_data.m Imports industrial batch data getIndBatchLength.m Determines batch length, T loadIndBatch.m Xest_CER.m Loads in Industrial batch data Estimates Biomass using CO_2, X_{CO2} Determines inital condisfull_growth_rates.m tions from industrial data, $X_0, \mu_{P_{max}}, \mu_{X_{max}}$ Retrieves parameter list Parameterlist.m IndPenSim.m Runs industrial Penicillin simulator createBatch.m Generates channels for batch IndPenSim ode.m Provides manipulated fctrl_indpensim.m variables to IndPenSim Runs ODE's in IndPenSim Imports F_a/F_b and F_c/F_h PIDSimple.m Temp and pH PID controllers Xref ODE output of all variables

Overview of IndPenSim Matlab files

3 COPYRIGHT NOTICE

Everything contained in the directories and subdirectories is the property of the Electronic and Electronic Department of The University of Manchester, Biopharmacetical & Bioprocessing Technology Processing Centre at Newcastle University and Perceptive Engineering Limited. This notice excludes the Matlab files smoothn.

Copyright notice:

- The simulation is freely distributed software and may serve as a valuable tool in the development of improved control strategies for industrial fermentations and can also be used for research and educational activities in monitoring, control and optimisation studies.
- Users are encouraged to modify and improve the software.
- The sole restrictions are that in the spirit of academic collaboration, the source code should be appropriately acknowledged in the resulting scientific disseminations. You may cite this code as follows: "Stephen Goldrick, Andrei Ștefan, David Lovett, Gary Montague and Barry Lennox " The Development of an Industrial Scale Fed-batch Fermentation Simulation" available in the Journal of Biotechnology, 2014.
- The source code must accompany compiled distributions of this code
- This notice must remain unchanged.

Please report any bugs related to the code to: Stephen Goldrick © Stephen Goldrick -Newcastle University, Manchester University, Perceptive Engineering

REFERENCES

[1] Stephen Goldrick, Andrei Ștefan, David Lovett, Gary Montague and Barry Lennox *Development of an industrial-scale fed-batch fermentation simulation*, Journal of Biotechnology, 2014.