Fall 11-2-2015

Biopharmaceutical capacity planning for batch and semi-continuous bioprocesses under various strategic criteria

Cyrus Siganporia
University College London, c.siganporia@ucl.ac.uk

Thomas Daszkowski
Bayer Technology

Andreas Schluk
Bayer Technologies

Brijesh rao
Bayer Technologies

Lazaros Papageorgiou
University College London

See next page for additional authors

Authors
Cyrus Siganporia, Thomas Daszkowski, Andreas Schluk, Brijesh rao, Lazaros Papageorgiou, and Suzanne Farid

BIOPHARMACEUTICAL CAPACITY PLANNING FOR BATCH AND SEMI-CONTINUOUS BIOPROCESSES UNDER VARIOUS STRATEGIC CRITERIA

Cyrus Siganporia**,** The Advanced Centre for Biochemical Engineering, University College London
c.siganporia@ucl.ac.uk
Thomas Daszkowski, Bayer Technology Services, Leverkusen, Germany
Brijesh Rao, Bayer Technology Services, Baytown, Texas, USA
Andreas Schluck, Bayer Technology Services, Leverkusen, Germany
Lazaros G. Papageorgiou**,** Department of Chemical Engineering, University College London,
Suzanne S. Farid**,** The Advanced Centre for Biochemical Engineering, University College London

Biopharmaceutical companies with expanding portfolios of commercial therapeutics face increasing pressure to meet market demands whilst minimising costs and capital expenditure. Attaining optimal production plans is made more problematic by portfolios containing products with different production modes: batch and semi-continuous. Semi-continuous perfusion-mode products often exhibit a distinct separation of upstream and downstream manufacturing via an intermediate freezing step. This flexibility adds further complexity which needs to be efficiently overcome during the optimisation process. An added complexity to having different process modes is that changeover times are different, leading to computationally expensive sequence-dependent changeover times. Considering the implications of incorrect capacity planning from a business perspective, a framework which can help manufacturers predict capacity bottlenecks whilst concurrently satisfying multiple objectives has great industrial importance.

This presentation describes the development of a mixed integer linear program that incorporates both perfusion and batch processes to produce capacity plans and manufacturing schedules. The mathematical model has expanded on previous work and has been reformulated to consist of a more computationally efficient state task network (STN) which can solve problems faster and obtain lower manufacturing costs. The model aims to help manufacturers decide whether to outsource to a contract manufacturing organisation (CMO), build a new facility, or do both as capacity limits are reached. The advantages of retrofitting existing facilities to accommodate different products as opposed to outsourcing capacity are examined. These different approaches of increasing manufacturing capacity each have trade-offs in terms of cost, time and risks. The complexity of the model is increased by considering the multi-objective nature of this problem, such as optimising the manufacturing cost whilst maintaining facility utilisation targets, or limiting the number of product changeovers so as to minimise contamination risks. An industrial case study is presented with results showing how these factors, including varying the changeover times between perfusion and fed-batch campaigns, can impact the different objectives and manufacturing schedules.