Резюмета

на публикациите по конкурса за професор
на
доц. Боян Иванов

ONE APPROACH FOR DETERMINING OPTIMAL SCHEDULING IN A MULTIPURPOSE CHEMICAL INDUSTRIAL SYSTEM

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This paper describes an approach for the determination of the optimal scheduling for the operation of the units in a multipurpose chemical industrial system (MCIS) in order to obtain the best utilization of the production units.

The basic stages that are to be performed are also determined:

— Determination of the equivalent units,
— Determination of the variants of location of each chemical industrial production (CIP) in the MCIS,
— Determination of the optimal scheduling.

For each stage, the algorithms that are to be used in order to reach the object, are given.

The basic conditions, which a given programme system has to satisfy, so that it can realize the proposed approach, are determined.

OPTIMAL SCHEDULING IN MULTI-PURPOSE CHEMICAL INDUSTRIAL SYSTEMS

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The paper deals with a class of optimal scheduling for the units in a multi-purpose chemical industrial system (MCIS). It is proved that structure-determining and non-structure-determining chemical industrial processes (CIP) exist and a method is presented for their assessment. The results show that the structure determinig CIPs do not allow changes in the optimal time limits for the realization, while the non-structure determinig CIPs allow changes in these limits to a certain degree. For second class CIPs, the optimal volumes, that guarantee maximum loading of all the units in the MCIS, are determined.

An original method for the determination of the optimal scheduling for class, with optimality criterion—minimum time for realization of the given production programme is given. A corresponding programme system is developed.

AN AUTOMATIC OPTIMAL DESIGN OF MULTIPRODUCT CHEMICAL PLANTS*

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Multiproduct chemical plants are designed for the sequential production of several products. The problem for the optimal design of such plants is reduced to the determination of their structure, volume and number of parallel working units of one and same type. The optimality criterion is the minimal cost of the equipment for the production of a prescribed volume for prescribed time. A method is proposed to determine the structure of the chemical plant, which is based on heuristic rules accounting for the technological characteristics of separate productions. The problem for the determination of the design parameters of the apparatuses and the number of parallel working units of a fixed type is formulated in the terms of MINP. The problem is solved by adaptive methods of NP. A strategy of an automatic optimal design of multiproduct chemical plants is proposed, and a dialogue programme system "DESIGN" is developed to realize this strategy.

НАПРАВЛЕННАЯ РЕНОВАЦИЯ ТЕПЛООБМЕННЫХ СИСТЕМ ПРИ ЖЕЛАТЕЛЬНОМ ИЗМЕНЕНИИ ПАРАМЕТРОВ СУЩЕСТВУЮЩЕЙ СИСТЕМЫ

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В настоящата работа са разгледани проблемите на оптималната реконструкция (реновация) на рекуперативни топлообменни системи в случаите, когато са зададени желателни направления на изменение на част от параметрите на съществуващата система. Предложен е метод за решаване на тези проблеми и разработка на оптимални предложения за реновация, които се характеризират с максимално изменение на неточно фиксираните параметри в желаните направления, с цел максимална рекуперация на топлината, оптимално използуване на неамортизираното топлообменно оборудване и връзките между елементите му. Предложеният метод решава задачата чрез последователна итеративна структурно-параметрична оптимизация, комбинирана с етапи на термодинамичен анализ. Осъществява се направлявано (контролирано) движение от началното приближение — старата система, към оптимума. Предложен е изчислителен алгоритъм, който е илюстриран с реален пример.

OPTIMAL LOAD OF ENERGY SUPPLY SYSTEMS (ESS) DURING THE PERFORMANCE OF MULTIPURPOSE CHEMICAL PLANS*

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A decription of a method to optimize the load of the energy supply system [ESS] for the parallel production of several products in a multipurpose batch chemical plant for a fixed period of time is proposed.

The energy consumption for a single production – the partial energy consumption and for all N productions – and the total energy consumption are assumed to be periodic functions of time. The methods of Fourier analysis were used to formulate and solve the corresponding mathematical model. An optimization problem was formulated as a nonlinear programming problem without restrictions. Standard procedures were used to solve a problem.

The brief description of FORTRAN–77 implementation of the method and a simple test example are also discussed.

A SIMPLIFIED METHOD FOR DETERMINATION OF THE HEAT TRANSFER AREA IN CASE OF HEAT INTEGRATION OF TWO BATCH TANKS

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A simplifed method is proposed for determination of heat exchange parameters in cases of heat exchange between fluids in batch processing tanks available simultaneously. Three versions of heat integration are considered. A two-step procedure for determination of the heat parameters is discussed and an example is given to illustrate the application of the method proposed.

Kew words : batch processing tanks, heat integration, heat transfer area.

HEAT INTEGRATION OF BATCH VESSELS AT FIXED TIME INTERVAL I.
SCHEMES WITH RECYCLING MAIN FLUIDS
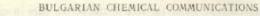
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The problem of heating and cooling of batch vessels is considered. Heat integration opportunities in a hot-cold reactor system are discussed. A method is proposed, which combines simultaneously heat recuperation and temperature correction by external heating and/or cooling agents.

Three heat exchange arrangements for realization of the method proposed are presented and mathematical models for these cases of heat exchange are developed. Analytical relationships for the vessel temperature variation in time are elaborated which contain the main design and performance parameters explicitly.

A method of parametric synthesis of such heat integration systems is proposed by formulating the problem in terms of non-linear programming. The task is solved by the method of creeping tolerance. An example is given to illustrate the method proposed.

SYNTHESES OF BATCH SYSTEMS WITH HEAT STORAGE TANKS. DESIGN AND RETROFIT PROBLEMS

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The syntheses of batch systems with heat storage tanks is discussed. Two separate systems — a heat recovery system and a system of autonomous external heating and cooling by using external utility are considered. They are intended to carry out the heat integration process, and temperature corrections if required.

Two schemes of heat integration (1) with two heat storage tanks, and (2) with a common storage tank, are proposed and an analysis of the heat exchange prosses is carred out.

The main design parameters of both heat recovery system and the system for autonomous external heating and cooling are determined in the design problem, while in the retrofit problem the main design parameters of the heat recovery system only are obtained. Both the design and the retrofit problems are formulated in terms of non-linear programming. The optimal criterion used is the maximal profit obtained from the reduced external energy consumption by accounting for the capital costs.

An illustrative numerical example is considered.

Key words: desing, retrofit, batch system, heat storage, integration.

A NEW APPROACH FOR DETERMINATION THE HORIZON CONSTRAINTS

FOR DESIGN PROBLEM OF MULTIPURPOSE BATCH CHEMICAL PLANTS

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Abstract

Referring to the multiperiod design model of multipurpose batch chemical plants, a novel approach for determination of the equivalent horizon constraints based on graph theory, and in particular, on obtaining a family of maximum independent vertex sets, is considered. A suitable method to find a family of maximum independent vertex sets, is proposed.

DETERMINATION OF THE HORIZON CONSTRAINTS IN MULTIPURPOSE CHEMICAL PLANT DESIGN

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In this paper, a method of finding the proper horizon constraints in multipurpose batch chemical plants design, is proposed. The method covers the complex scheduling task involving the design problem and determining the horizon constraints, to be solved. It is characterized by using a solution search tree upon a search area consisting of those groups of compatible productions which are of maximum size. The method includes three main stages 1) determining of the search area, 2) determining of the optimum or near to the optimum schedules, and 3) determining of the horizon constraints. An example from literature is used to illustrate the opportunities of the method.

HEAT INTEGRATION IN BATCH REACTORS OPERATING IN DIFFERENT TIME INTERVALS PART I.
A HOT-COLD REACTOR SYSTEM WITH TWO STORAGE TANKS

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The present study addresses the problem of determining heat integration opportunities in a system of two batch reactors operating in different time intervals. In three successive parts different aspects of the use of heat storage tanks are considered. In the first part of the study cases using two storage tanks are discussed, the second deals with cases using one common heat storage, and the third part is devoted to the problems of synthesis and reconstruction of integrated systems with heat storage tanks.

In the present first part of this study three different arrangements of heat integration are proposed, which are suitable for cases of regular performance of batch processing lines where the number of appearances of both hot and cold vessels is equal. Mathematical models describing the heat exchange in such cases are developed. Temperature time-variation relationships as explicit function of the main design and performance parameters are obtained.

HEAT INTEGRATION IN BATCH REACTORS OPERATING IN DIFFERENT TIME INTERVALS PART II.
A HOT-COLD REACTOR SYSTEM WITH A COMMON STORAGE TANK

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In the first part of this work [1] a method of heat integration of hot-cold batch reactor system which operates in different time intervals by using heat storage tanks was considered. This paper deals with cases using one common heat storage. Three different schemes are discussed suitable for cases where the number of heating and cooling steps is not equal. Mathematical models are developed and analytical relationships defining temperature time variations of the process fluid as an explicit function of the main parameters of the heat exchange equipment are obtained.

HEAT INTEGRATION IN BATCH REACTORS OPERATING IN DIFFERENT TIME INTERVALS PART III.

SYNTHESIS AND RECONSTRUCTION OF INTEGRATED SYSTEMS WITH HEAT TANKS

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In the previous two parts of this work [2,3] the use of heat storage tanks for energy accumulation in the system were discussed.

This paper is devoted to the problems of optimal synthesis and reconstruction of such heat integrated systems. Mathematical formulae is given, containing the reactor temperature time-course as explicit function of the main design and performance parameters of the heat exchange equipment employed. The problems under consideration are formulated as nonlinear programmes. An example is given to illustrate the applicability of the method proposed.

OPTIMAL RECONSTRUCTION OF BATCH CHEMICAL PLANTS WITH REGARD TO MAXIMUM
HEAT RECUPERATION

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Abstract

A strategy for optimal reconstruction of batch chemical plants for maximum heat recuperation based on the principle of decomposition is proposed. Scheduling with maximum heat integration power is considered in detail as a subproblem of the overall design procedure. The problem is interpreted in terms of the binary linear programming technique.

Keywords

Batch Chemical Plant; Reconstruction problem; Energy Integration; Schedules; Binary Linear Programming.

OPTIMAL RECONSTRUCTION OF BATCH CHEMICAL PLANTS WITH REGARD TO MAXIMUM HEAT RECUPERATION

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Abstract

A strategy for optimal reconstruction of batch chemical plants for maximum heat recuperation based on the principle of decomposition is proposed. Scheduling with maximum heat integration power is considered in detail as a subproblem of the overall design procedure. The problem is interpreted in terms of the binary linear programming technique.

Keywords

SYNTHESIS OF HEAT EXCHANGE NETWORKS FOR HOT-COLD BATCH REACTOR SYSTEMS

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A method for heat integration of hot-cold batch reactor systems with several heating and/or cooling agents available at various prices and temperatures is considered. A generalised heat exchange network structure including a heat integration block and a block for external heating and cooling is presented. A heat exchange mathematical model is developed. The synthesis problem is formulated in terms of non-linear programming. The cost of the heat exchange network is accounted for. The method proposed is illustrated by a numerical example.

AN APPROACH FOR SOLVING A SCHEDULING PROBLEM FOR MULTIPURPOSE BATCH CHEMICAL PLANTS

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An approach for solving a scheduling problem relevant to a multipurpose batch chemical plant with multiple production routes is proposed in the article. A mixed campaign operation mode is regarded. One mixed campaign may include both different routes of different products and more than one route for the single product. By selecting a suitable class of schedules, i.e. schedules involving consecutively carried out campaigns of compatible production routes and minimisation of the schedule duration as a criteria for an estimation, a scheduling problem is formulated as a covering problem in terms of binary linear programming. An approximation method for solution of a scheduling problem which is intended to cope with two basic problems: (i) to avoid the large dimension of the initial task, and (ii) to obtain rapidly the optimal or near to optimal schedules of the desired class is presented.

The first task of avoiding the high dimension of the initial problem is achieved by determination of the superstructure of the schedules of the desired class. The optimal or near to optimal schedules are determined by using the solution method based on the search tree applied to the superstructure obtained. The theoretical bounds of the desired schedules and the branching function are formulated. An algorithm is proposed to find the solutions. The procedure under consideration is illustrated by solving a simple example.

Keywords: multipurpose batch chemical plant, multiple production routes, optimal scheduling problem, search tree solution method

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OPTIMAL ENERGY INTEGRATION IN BATCH ANTIBIOTICS MANUFACTURE

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ABSTRACT

In this paper the optimal energy integration problem for an existing antibiotics plant is discussed. An appropriate scheme for a direct heat integration is proposed. The optimal operation and scheduling problems for the integrated scheme are solved. The overall energy cost is thus decreased by 39%.

KEYWORDS

Batch processes, Optimal operation, Scheduling, Energy integration, Antibiotics manufacture.

HEAT EXCHANGER NETWORK DESIGN FOR MULTIPURPOSE BATCH PLANTS

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Abstract—A mathematical programming approach to the design of heat exchanger networks for multipurpose batch plants is presented, aiming to determine the minimum total cost network while satisfying given product demands.

Only the direct mode of heat integration is considered. The plant is assumed to operate in a zero-wait overlapping mode, where each product must pass through a subset of the equipment stages, and production is organized in a series of long campaigns. The formulation presented takes account of the additional scheduling complications that arise out of energy integration between different products in the same campaign. The overall formulation results in a mixed integer linear programming problem that can be solved to global optimality using standard techniques.

WASTE WATER REDUCTION FROM THE CULTURE MEDIUM PREPARATION STEP OF AN ANTIBIOTIC PRODUCTION

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This paper deals with the problem for waste water reduction from the culture medium step of an antibiotic production in a case of a heat integrated fermentation stage. The heat integration of the fermentation stage introduces a heat integration cycle time that decreases the time between consecutive inoculation phases of the fermenters and arises as a precondition for redistribution of the seed fermenters used in a way the waste water from the process to be decreased. To explore this potential for waste reduction, a scheduling procedure for the culture medium step is introduced involving the following main steps: determination of a time horizon for the seed preparation step; creation of schedules with a zero-release of waste water, called basic schedules and, relaxation of the basic schedules to ensure a success of inoculation.

Finally, different schedules are created for the culture medium step, according to proposed procedure, and investigated from the waste reduction and the required pieces of equipment points of views.

DESIGN OF A HEAT EXCHANGER NETWORK FOR A SYSTEM OF BATCH VESSELS

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The paper considers a heat integration problem in a system of hot/cold batch vessels available in a given time interval, H, repeated several times in the planning period. The aim of the study is to propose a design procedure which exploits the system heat integration potential and ensures the desired vessel final temperatures at minimum total cost. It is assumed that matching between different pairs of hot/cold vessels is carried out in sequential subintervals within H including heating and cooling supplied by external utilities. In order to characterise the heat exchange equipment required for a given system, a generalised engineering parameter called conditionally Power of the Heat Exchanger (PHE) representing the basic heat exchange impact parameters, is introduced. The heat exchanger network design problem is formulated as a mixed integer non-linear programming (MINP) task under constraints of heat integration feasibility, order and duration of matching, installed PHE, external utility requirement and required temperatures. The approach is illustrated by an example.

Keywords: batch system, energy integration, scheduling, heat exchanger network, design.

Waste Minimization Through Optimal Plant Retrofit

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Abstract:
A problem for optimal plant retrofitting, aiming to minimize the acrylonitrile released in the atmosphere from a Gas Treatment Department at Acrylic Fibre Plant, is considered. The applied retrofit policy involves (i) substitution of a used solvent with an appropriate selected mixture; (ii) flowsheet superstructure definition; and (iii) process parameters and mixture composition determination, so as the environmental regulations at minimum total retrofit cost to be reached. The pointed steps are described and the results obtained are discussed.

Keywords: waste minimization, optimal retrofitting, acrylic manufacture.

OPTIMAL RETROFIT OF HEAT EXCHANGE NETWORKS (HEN) USING HEURISTIC PATHS AND SUPERSTRUCTURES

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*Dedicated to Professor Georgi M. Bliznakov on the occasion of the 80th
anniversary of his birth*

In the presented study a new methodology for optimal, heat exchange network (HEN) retrofit is proposed. It involves a two-stage procedure for a correct solution of the optimization problem. At the first stage an appropriate HEN retrofit superstructure is to be built by using the pinch analysis and heuristic paths construction, while at the second one the optimal set of retrofit modifications is obtained using mathematical programming. The advantage of the proposed methodology is demonstrated by using a real case study.

Key words: optimal HEN retrofit, heuristic paths, superstructure, mathematical programming

APPLICATION OF FOURIER TRANSFORMATION FOR WASTE MINIMIZATION IN BATCH PLANTS. 1. ANALYSIS OF PRODUCTION RECIPES

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In the present study an alternative system oriented approach for determining the environmental impact assessments is proposed. It is based on the application of Fourier transformation for presenting the discontinuous functions of waste-w mass rates as continuous ones. Using the Fourier transformation the respective environmental impact indices are presented as functions of time and the environmental impact assessments for the given pollutant and for the entire plant are obtained.

The approach is used for environmental impact analysis of production recipes based on the example of curd processing. The optimal milkfat content is obtained so that the Global BOD generated in the process is minimal. The distribution of the environmental impact level into the production cycle is presented.

Keywords: environmental impact assessment, Fourier transformation

Minimization of wastes from batch plants for compatible manufacturing of products

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The batch plants bring about numerous complications concerning waste minimization problems due to discreetness of the production, existence of multiple production routes etc. The aim of this paper is to deal with the waste minimization problems in a particular case of compatible and cyclic manufacturing of a group of products in multipurpose batch plant. The formulated optimization problem takes into account both the composition of raw materials and the scheme of production routes. Sets of constraints control the feasibility and compatibility of the production routes and justify the accomplishment of production demands in the time perspective. Aiming to avoid the problem of discreetness, an approach developed earlier, based on the application of Fourier transformation, is extended to model the waste emissions of plant. Global and Local Environmental Impact Assessments are proposed to be used as the objective functions.

An example, concerning simultaneous manufacturing of two types of curds in a dairy, is used to illustrate the considered problem. The aim is to determine the milkfat content for both products and the equipment applied, in such a way to fulfil a given demand for a specified time interval at minimal biological oxygen demand *BOD* "generated" from the process. The BOD "generated" by inherent losses also is taken into account in the formulated problem.

Key words: Waste minimization, Fourier transformation, Multipurpose batch plants, Dairy processing.

Multi-objective Optimization of Curds Manufacture

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Abstract

In this paper, an important profit/environmental impact trade-off problem in dairy is presented as a multi-objective optimization problem. A Genetic Algorithm (GA) is used to find the conditions leading to the best compromise between both objectives. Two cases, at different weighting coefficients are considered to illustrate an enhanced effect of the environmental impact on the multi-objective function.

Keywords: Multi-objective optimization, Genetic algorithms, Dairy, Profit, Environmental impact.

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Multi-Objective Optimization of Dairy Supply Chain

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Abstract

In this paper, an important profit/market demands/milk vendors' satisfaction trade-off problem in dairy supply chain is presented as a multi-objective optimization problem. The Pareto Frontier is generated to present the front of the optimal compromise. The obtained Pareto Frontier contour plot is proposed to support the planning managers for quick plant profit estimation in case of priorities changing in dairy supply chain.

Keywords Supply chain, Multi objective optimization, Dairy complex

Supply chain optimization of batch chemical plants comprising continuous flexible process networks

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The problem of optimal management of multipurpose and multiproduct batch plants (MPBP) and their complexes in the chemical industry has been studied. The work was focused on the merging of multipurpose plants into corporations aimed at achievement of sustainable results of the unified system. In particular, the merging of pharmaceutical plants that exhibit specific features and the relevant problems of optimal performance has been targeted. The main objective solved is formulation of a planning strategy and schedules of multipurpose chemical plants, while accounting for the basic commercial requirements. A strategy, based on the decomposition approach, grounded on a two-stage optimal control task of the multipurpose system, has been proposed. Stage 1 considers definition of product portfolios corresponding to each individual plant of the complex

The feasibility of the suggested approach and its mathematical background in solving the first stage of the strategy are demonstrated by an example approximation of reality, based on software generated by MATLAB version 6.50.

Key words: Supply chain optimization, multipurpose and multiproduct batch plants.

Control of production campaigns with optimal loading of the power systems during multipurpose and multiproduct batch chemical plants operation

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The paper is devoted to the problem of optimal loading of the joint systems of power supply of multipurpose and multiproduct batch chemical plants (MMBCP) operating in regime of production campaign. Mathematical method is proposed for determining the control independent variables that ensures minimum deviation of the loading characteristics of power demand of the related power systems from the ideal ones. The models developed for power consumption of the individual productions that belong to a production campaign were based on Fourier series. The task of optimum control was formulated as a non-linear mathematical programming one. The method proposed is verified by a test example.

Key words: multipurpose and multiproduct batch chemical plants, optimal loading of the power systems.

BATCH CHEMICAL PLANTS. II. THE OPTIMAL DESIGN OF BATCH CHEMICAL PLANTS

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A review of the optimal design problems for batch chemical plants is presented in this paper. Three general cases of the desing problem are discussed: (1) the design of individual batch productions, (2) the design of the multiproduct batch chemical plants, and (3) the design of the multipurpose batch chemical plants. The connections between these problems are outlined. It is mention that the multipurpose design problem has to be considered with the scheduling problem. The review of the mathematical methods used to solve above problems is done.

BATCH CHEMICAL PLANTS. I. THE PROBLEMS OF OPTIMAL OPERATION

Vaklieva-Bancheva, N., Hr. Boyadjiev., B. Ivanov

A review of the optimal operation problems for batch chemical plants is presented in this paper. Three levels of the problem are discussed: (1) the overall production planning, (2) the internal production planning and (3) the scheduling of a machine allocation plan. The chemical engineer is familiar with first and third levels of the above problem. For the first level, many problems and theirs application are introduced. For the second level the problems are generally economical. It is shown that the methods applied to solve the scheduling problems depend much on the manufacturing product organization in the time, concerning the third level. Thus, the scheduling problems are divided into two types: (1) for the multiproduct chemical plants, and (2) for the multipurpose chemical plants. These problems and theirs application are regarded separately. Finally, the field for further investigation is drawn.

МЕТОД ЗА ПОСТРОЯВАНЕ НА МАКСИМАЛНО НЕЗАВИСИМИ МНОЖЕСТВА ОТ ВЪРХОВЕТЕ НА ГРАФ ПРИ ЗАДАЧИ ЗА ОПЕРАТИВНО УПРАВЛЕНИЕ НА МНОГОЦЕЛЕВИ ХИМИКО-ТЕХНОЛОГИЧНИ СИСТЕМИ

Наташа Ваклиева-Банчева, Петър Константинов, Боян Иванов

УВОД

Много задачи от теорията на графите, създаването на производствени разписания, а така също и от инженерната химия (проектиране на многоцелеви химико-технологични системи) са свързани с построяване на максимално независими множества (МНМ) от върхове на граф.

Изхождайки от определението за максимално независими множества от върхове в граф, на пръв поглед задачата изглежда лесно решима с използване на метода на пълния преглед, придружен с едновременна проверка на всяко множество за максималност. Представата за простотата на задачата е действителна, но само за малък брой върхове. С увеличаване на броя на върховете този метод от изчислителна гледна точка се превръща в тромав и неудобен за ползване. Ето защо в зависимост от практическата значимост на задачата са потърсени други методи, с които да се заобиколи гореспоменатата трудност. Един от тях е методът на Брон и Кербош [1], явяващ се съществено опростен метод на пълния преглед, използващ дърво на търсенето. Преимуществото му се състои в това, че в процеса на построяването на МНМ не е необходимо на всяка стъпка от изпълнението му генерираното множество да се запомня и да се проверява за максималност чрез сравнение с по-рано формирани множества. Това от своя страна води до икономия на памет и машинно време.

МЕТОД ЗА ПОСТРОЯВАНЕ НА МАКСИМАЛНО НЕЗАВИСИМИ МНОЖЕСТВА ОТ ВЪРХОВЕТЕ НА ГРАФ ПРИ ЗАДАЧИ ЗА ОПЕРАТИВНО УПРАВЛЕНИЕ НА МНОГОЦЕЛЕВИ ХИМИКО-ТЕХНОЛОГИЧНИ СИСТЕМИ

Наташа Ваклиева-Банчева, Петър Константинов, Боян Иванов

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A PROGRAM PACKAGE FOR TECHNOLOGICAL PROCESSES SIMULATION IN PETROLEUM TERMINALS AND FUEL AND OIL DEPOTS

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ABSTRACT

The main features of a program package HYSYSIM for technological processes simulation in petroleum terminals and fuel and oil depots are considered in this paper.

The simulation approach for complex chemical systems is used. A five level hierarchical mathematical model is created, involving: functional element models, linear hydraulic sector models, hydraulic line models, hydraulic system models, and petroleum terminal and fuel and oil depot models.

The program package HYSYSIM structure and the main problems that can be solved are described. The brief description of used menus for user-computer interaction is made.

The program package HYSYSIM is tested for a real petroleum terminal.

Keywords: petroleum terminals, hydraulic modelling, simulation, program package.

bottleneck places and ways to overcome them; an engineer designing has to be done as well.

The other direction concerns improving the organisation and controlling the technological processes connected with petroleum product supply and distribution. It is accompanied by adopting new methods and tools for a PT&FOD staff and petroleum product users interaction. Thus, a necessity of tool development for impartial assessment and analysis of alternative variants concerning the technological process organisation and control is imposed.

I order to solve successfully the above-mentioned problems, a program package for HYdraulic SYstem SIMulation, named HYSYSIM, has been created. The goal of the present paper is to describe the general mathematical methods used and the structure and possibilities of HYSYSIM intended for PT&FOD technological processes simulation.

SIMULATION OF PETROLEUM BASES AND FUEL AND OIL DEPOTS

PLANNING AND SCHEDULING FOR MULTIPURPOSE BATCH CHEMICAL PLANTS IN PROCESS INDUSTRIES

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Abstract

The problem of optimal management of multipurpose batch chemical plants (MBCP) and complexes there of in the chemical industry has been studied. The work was focused on cases of merging of one-type multipurpose plants into corporations aimed at achievement of sustainable performance of the unified system. In particular, merging of pharmaceutical plants that exhibit the specific features and the relevant problems of optimal performance has been targeted. The main goal that has been achieved with the present work is the generation of a method for planning and scheduling of complexes, comprising of multipurpose plants, taking into consideration the requirements of the market. The model offered is based on a strategy of solving the problem using the compositional approach, according to which the problem of optimal management of multipurpose complexes and the problem optimal production scheduling of the work of the multipurpose plants are solved simultaneously. This problem is formulated as a problem of the mathematical programming with a quality criterion – the total profit of the system. The effectiveness of the offered approach and the mathematical formulation are demonstrated via solving an example that is as close as possible to reality with the help of the created software using the language MATLAB 6.50.

Keywords: Batch process, Scheduling, Supply Chain, Multipurpose plants.

DESIGN OF MIXERS FOR CHEMICAL AND BIOCHEMICAL INDUSTRY

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[2]Institute of Chemical engineering, BAS, Sofia, Bulgaria.

ABSTRACT

This paper examines the design of mixers for the chemical and biochemical industry. Depending on the mixing phases mixers possess different construction features. The design of mixers includes technological and strength calculations of these sets, able to create stable emulsions and suspensions used as raw materials in a number of productions or as finished products intended for consumers. The calculation and sizing of these facilities are made by means of specific algorithms, which are carried out in peer-reviewed software products. The use of such software helps facilitate most calculations for various types of mixers: a liquid-liquid, solid-liquid and liquid-gas.

Key words: Mixers, design, chemical and biochemical industry.

Energy integration in antibiotic production using heat tanks

Desislava Nikolova, Boyan Ivanov, Dragomir Dobruzhaliev

Резюме: В настоящата разработка се разглежда проблема за редуциране на потреблението на енергия чрез топлинна интеграция в система биореактори при производството на антибиотици. Предложена е схема за топлинна интеграция с два топлинни резервоара, осигуряваща работа в различни времеви интервали. Създаден е метод за управление на процесите на топлинната интеграция. Задачата е формулирана в термините на смесеното нелинейното непрекъснато програмиране (MINLP). Удачността на предлагания метод е показана с пример от практиката.

Key words: Heat integration, Batch reactors, Heat storages, Antibiotics

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Key words: Heat integration, Batch reactors, Heat storages, Antibiotics

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BIOMASS-THE TASK OF ECOLOGY AND FACTOR IN ENERGY

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Abstract

Constantly decreasing primary energy sources and environmental issues are part of the reason to seek alternatives by developing new technologies. Biomass as organic matter of vegetable origin and animals can be recycled, processed and used for the extraction of energy. In the presented work looking at the different types of biomass as a potential source for energy. A rating of the energy potential of different types of biomass. Furthermore, an overview of the main methods for processing and to generate energy. The final result of the work is a classification of different types of biomass and grouping in terms of their efficient processing to produce energy on a particular method.

IMPROVING THE ENERGY EFFICIENCY OF INDUSTRIAL BATCH PROCESS USING HEAT INTEGRATION

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Abstract

Energy efficiency has become a very important term for evaluating the sustainability of industrial processes. Due to environmental, but also economical reasons, the readiness for optimizing a process is gaining ground. In this study the problem of reduction of energy consumption in bioreactors system of antibiotics production by means of energy integration is considered. An energy integration scheme is proposed, which provides both to the process of cooling a reactor after its sterilization and preparation of Substrate to another reactor. A mathematical model of processes in both reactors is developed. By using this model a method for managing the processes of heat integration is created. The problem is formulated in the terms of MINLP. The efficiency of proposed approach is illustrated on the example of the industry.

Key words: *Heat integration, Batch reactors, Optimal control, Quasioptimal control*

optimal design, multiproduct
chemical plant

ONE APPROACH FOR AN AUTOMATIC OPTIMAL DESIGN OF MULTIPRODUCT CHEMICAL PLANTS

B.B.Ivanov; N.G.Vaklieva-Bantcheva; Chr.B.Boyadjiev*

Multiproduct chemical plants are designed for the sequen-
tial production of several products. The problem for the optimal
design of such plants is reduced to the determination their
structure, volume and number of parallel working units of one and
same type. The optimality criterion is the minimal cost of the
equipment for prescribed volume for prescribed time. A method
is proposed to determine the structure of the chemical plant.
The problem for the determination of the design parameters of the
apparatuses and the number of parallel working units of a fixed
type is formulate in the terms of MINP. The problem is solved by
adaptive methods of NP. A strategy of an automatic optimal design
of multiproduct chemical plants is proposed, and a dialogue pro-
gramme system "DESIGN" is developed to realize this strategy.

HEAT INTEGRATION IN REACTOR SYSTEMS 'AT FIXED TIME INTERVAL

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Until recently most of the research projects relevant to batch plants treated predominantly problems associated with optimal operation control and optimal design, without taking into account energy consumption and energy cost reduction. The concept of heat integration was considered to have almost no application to batch processes. This was due to certain potential obstacles to heat recovery realisation as:
- discrete heat fluxes, which means that not all heat sources and sinks are always simultaneously available;
- the low share of energy in the total production costs, etc.

Only lately some papers appeared, where process integration oriented to reduce the utility consumption in batch chemical plants has been discussed. In one of the first papers devoted to this problem [1] an heuristic is given, showing that it leads to optimal solutions for certain instances in which the desired final temperatures do not restrict the exchanges. For cases with target temperatures limiting some exchanges, a MILP formulation is proposed. The authors assume that the sequence of matches takes place consecutively in time. The additional cooling and/or heating required in cases when after a given match the desired final temperatures are not reached, as well as the fixed length of time for a given exchange, are not considered in this work.

HEAT INTEGRATION IN A BATCH BIOREACTOR SYSTEM

K.Peneva, B.Ivanov and V.Bancheva1)

Heat integration opportunities in a system of two batch bioreactors intended for biotransformations, are considered. The emphasis is in the practical background of such a technique which complete heat utilization in a system while taking into account the particular requirements of the individual batch vessel categories. Three different versions of heat exchange arrangements were suggested to solve the problem of heating or cooling of a biomass in a bioreactor. In all cases a system of external and jacket or immersion heat exchangers was to obtain the desired final temperature avoiding transfer of bioreactor consistencies in other vessels.

Two possible ways of biomass heating or cooling are considered:

a) a two-step procedure, i.e. a first step of heat integration is carried by using intermediate heating agents, avoiding external heating agents, and a second step in a series of further cooling/heating by using external heating/cooling agent in the next time interval, and

b) a single-step procedure, following a combined heat recuperation, by using intermediate heating agents, and a temperature correction through additional auxiliary heating/cooling agent.

The advantage of the second approach is evaluated.

Mathematical models were developed to describe the heat exchange process following different schematics. Analytical formulas were found to define vessel temperature variations as a function of design and performance parameters.

A method of parametrics synthesis of the systems under consideration was proposed to carry out recuperation heat exchange, which allowed the task to be reduced to a mere determination of the main design parameters of the utilized heat exchange equipment and to the circulation fluids flow rates. The problem was formulated on the basis of non linear porgramming at an optimality criterion of a minimum price. The problem was solved by the method of creeping tolerance.

An example is given which illustrates the feasibility of the method proposed.

HEAT RECOVERY IN BATCH SYSTEMS WITH HEAT STORAGE TANKS. DESIGN AND RETROFIT PROBLEMS

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1. Introduction

Problems related to heat integration in batch chemical plants have not been discussed so far because of the discontinuous character of heat fluxes and the low share of energy costs in the overall plant expenditure. It was not until the last decade that they attracted the investigators attention. Studies appeared devoted to application of various methods analysing the opportunities for heat integration (Kemp & MacDonald [1,2], Kemp & Deakin [3,4,5], Linhoff, Ashton & Obeng [6], Obeng & Ashton [7], Petela [8]). Despite the differences in the various approaches employed, their common feature has been the assumption of limited changes in the schedules [4,1,2,7,8] or limited technology alterations [7,8], both being accepted in order to ensure simultaneous heat source and heat receiver availability. Methods for determination of optimal parameters of the heat exchange equipment required, has been proposed (Ivanov et al [9,10,11])

However, in the prevailing cases the best reactor pair which could ensure maximum heat recuperative is not available simultaneously. In such cases accumulation of the energy becomes necessary.

The present study deals with the problems of heat integration in batch reactors by using heat storage tanks. Its objective is to propose a suitable integration decision for a system of two reactors and to determine the design parameters of the relevant heat exchange equipment ensuring maximum heat recovery at a minimum capital cost.

SUPPLY CHAIN OPTIMIZATION IN THE MULTIPURPOSE BATCH CHEMICAL INDUSTRY

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Abstract: The problem of optimal management of multi-purpose and multi-product batch chemical plant is examined in this paper. A new planning strategy and scheduling of batch plants is offered, the main objective is maximum profit for the system as a whole and also taking into market demand. This task is solved using new mathematical formulation which finding to the optimal manufacture portfolio. The efficiency of the procedure is demonstrated by an illustrative example from the pharmaceutical industry.

Key words: Supply chain, Optimal scheduling, Multipurpose Batch Chemical Industry

Use of CAPE-OPEN standards in the coordinated optimization of plant production scheduling and supply chain planning

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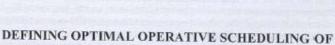
1. Summary

Following different specific needs and research programs during last years, a considerable number of simulating packages and components for chemical engineering have been created. However, it has been accounted that these pieces of software are not straightforwardly suitable for integration with other complementary applications, which constitutes a basic need from the perspective of industrial use. Aiming to respond to this need, the CO-LaN (http://www.colan.org) laboratory was created in order to develop common standards (CAPE OPEN standards) which should allow transparent communication between different applications. On the other hand, although the historical trend in the management of single manufacturing sites has been driven by the integration of aggregate planning and detailed scheduling[1], current Advanced Planning and Scheduling (APS) systems support the decision making process at specific levels and functions, so that the consideration of their co-operative supply chain network (SC) requires a revised perspective and complementary decision making structures. Furthermore, additional SC key considerations (e.g. environment, finances, marketing), are not adequately covered or even disregarded by current approaches. Under such circumstances, CO standards for interfacing software components seem an adequate answer and proper strategy to propose a framework made up of a flexibly envelope of diverse applications to assess SC decisions at different hierarchical levels and functions. The structure proposed in this work is thus in consonance with the trend towards enterprise wide modeling (EWO) which aims to integrate all the functional decisions into a global model driven by an overall key performance measure.

Keywords: CAPE-OPEN; supply chain management; decision support systems

DEFINING OPTIMAL OPERATIVE SCHEDULING OF MULTIPURPOSE BATCH CHEMICAL PLANTS AT LIMITED RESOURCE CONSUMPTION

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Abstract: The problem of optimal operation of multipurpose batch chemical plants (MBCP) and mainly the defining of optimal production scheduling for equipment operation is considered. The procedure ensures the completion of a certain production portfolio for minimum time and guarantees the allowed work load of the systems for resource consumption. The optimal operative scheduling is defined by a mathematical method comprising consecutively completed activities. The problem is brought down to the class of mixed linear programming problems. The efficiency of the method is illustrated by a test example.

Key words: Optimal scheduling, Multipurpose Batch Chemical Plants.

SUPPLY CHAIN PLANNING AND SCHEDULING FOR MULTIPURPOSE BATCH CHEMICAL PLANTS IN PROCESS INDUSTRIES

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Abstract: The present work discusses the problem of optimal management of Multipurpose batch chemical plants (MBCP) нand complexes of them used in chemical, biochemical and pharmaceutical industries.

The main goal was to develop a method for planning and scheduling in complexes of multipurpose plants where the market requirements are taken into account. It is based on a strategy for solving the problem using the composite approach where the tasks for optimal management of multipurpose complexes and working out optimal production schedules are solved simultaneously. The problem is formulated as a task for mixed-integer nonlinear programming (MINLP).

Key words: Supply chain, Optimal scheduling, Multipurpose Batch Chemical Industry

Optimal control of heat integrated batch reactors

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Abstract: In the paper some problems of the optimal control of processes of heating and cooling in a pair of heat integrated batch reactors are discussed. A mathematic approach is suggested to determine the control variables by which a minimum cost of the received energy from additional energy sources is achieved. The problem is formulated to be solved by mixed integer nonlinear programming (MINLP).

Key words: Batch reactors, Scheduling, Heat integration.

PORTFOLIO OPTIMIZATION FOR MULTIPURPOSE BATCH CHEMICAL PLANTS (MPBP)

Boyan IVANOV, Dragomir DOBRUDZHALIEV, Angel ANGELOV

Abstract: The presented work reviews the problem of optimal management of MPBP from the chemical industry and complexes of them. Object of research are the integrations of the plants form the chemical, biochemical and pharmaceutical industries, in which these peculiarities are observed and the problems resulting from their optimal functioning. The model offered is based on a strategy of solving the problem using the compositional approach, according to which the problem of optimal management of MPBP complexes and the problem optimal production scheduling of the work of the MPBP are solved simultaneously. This problem is formulated as a problem of the mathematical programming. Subject of the present work is the 5-echelon SC shown on Fig.1. It consists of multitudes of resources suppliers, MPBP, warehouses, distribution centers and consumers (S-P-W-D-C). The MPBP as elements of SC can produce multitude of products simultaneously in the same time interval.

Keywords: Portfolio optimization, Supply chain, Scheduling, Batch plants

EQUIPMENT AND TECHNOLOGIES FOR TREATMENT OF BIOMASS

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Abstract: The deepening of global, financial and energy crises have increasingly frequent use of alternative sources of heat and energy. Biomass is organic non-fossil material of plant and animal origin. Undergoes appropriate processing, it can be used to generate energy.In the present work are presented methods for converting biomass to useful target product. Detailing the processes and apparatus for converting biomass raw material and facilities for power, heat or liquid fuels.

Keywords: biomass boiler, bio-reactor, the energy complex, power plants, resource security chain

MANAGING ENERGY CONSUMPTION IN THE PRODUCTION OF ANTIBIOTICS

DRAGOMIR DOBRUDZHALIEV, BOYAN IVANOV, DESISLAVA NIKOLOVA

Abstract: In this study the problems of managing energy consumption in the production of antibiotics is discussed An energy integration scheme of the processes „Heating-Cooling" in a pair of batch bioreactors is shown and a mathematical model describing the processes is developed. By using this model a method for optimal control the processes of heat integration is created. The task is formulated in terms of Nonlinear Programming.

Key words: Heat integration, Batch reactors, Optimal control

Планиране и управление водещо до оптимално използване на ресурсите при работата на многоцелеви заводи от химическата и хранително-вкусовата промишленост. Ресурсно-осигурителни вериги

Кирил Минчев, Боян Иванов

Процесите свързани с нарастващата глобализация във всички сектори на икономиката в това число и в хранително–вкусовата и химическа промишленост налагат внедряването на нова стратегия за тяхното управление. Настоящата работа демонстрира прилагането на нов метод за планиране и разписания на ресурсите при работата на многоцелеви заводи от хранително-вкусовата и химическата промишленост имплантиран успешно в създадения потребителски ориентиран софтуерен пакет "Supply chain".

Planning and scheduling lead in to optimal use of resource consumption of multipurpose plants in food and chemical industry. Supply chain

Kiril Mintchev, Boyan Ivanov

The processes connected with the ever growing globalization in all economy sectors, the food and chemical industries included, force the adoption of a new strategy for their management. The present work demonstrates the application of a new method for planning and scheduling of the resources in the operation of multipurpose plants from the food and chemical industries, which was successfully implanted in the developed consumer oriented software "Supply chain".

Оптимално управление на топлинно интегрирани периодични реактори, използувани в хранителната промишленост

Боян Иванов, Никола Гинов

Резюме: Работата третира проблеми на оптималното управление на процесите "Нагряване-Охлаждане" в двойка периодични реактори в случаите на топлинната интеграция между тях. Предложен е математичен метод за определяне на управляващите променливи, които осигуряват минимум на стойността използуваната енергия от външните енергоизточници. Задачата е формулирана в термините на смесеното нелинейното програмиране (MINLP).

Optimal control of heat integrated periodic plants used in food industry

Boyan Ivanov, Nikola Ginov

Abstract: In the paper some problems of the optimal control of processes of heating and cooling in a pair of heat integrated periodic plants are discussed. A mathematic approach is suggested to determine the control variables by which a minimum cost of the received energy from additional energy sources is achieved. The problem is formulated to be solved by mixed integer nonlinear programming (MINLP).

Оптимално управление на топлинно интегрирани биореактори
I. Управление при непрекъснати променливи

Боян Иванов, Десислава Николова, Драгомир Добружалиев

Резюме: Работата третира проблемите на оптималното управление на процесите "Нагряване-Охлаждане" в двойка периодични биореактори в случаите на топлинната интеграция между тях. Предложен е метод за определяне на управляващите променливи, осигуряващи минимум на използуваната енергия. Задачата е решена с използуване на метода на динамичната оптимизация.

Optimal control of heat integrated bioreactors
I. Managing continuous variables

Boyan Ivanov, Desislava Nikolova, Dragomir Dobruzhaliev

Abstract: The work deals with problems of optimal control of "Heating-Cooling" processes in a pair of batch bioreactors in cases of heat integration between them. A mathematical method for determining the control parameters that ensure minimum energy consumption from external energy sources is proposed. Problem is solved by using the dynamic optimization method.

Оптимално управление на топлинно интегрирани биореактори
II. Квазиоптимално управление на процесите

Боян Иванов, Десислава Николова, Драгомир Добружалиев

Резюме: Работата третира проблемите на квазиоптималното управление на процесите "Нагряване-Охлаждане" в двойка периодични биореактори в случаите на топлинната интеграция между тях. Предложен е метод за квазиоптимално управление, което осигурява минимум на използуваната енергия.

Optimal control of heat integrated bioreactors.
II *Quasioptimal* process management

Boyan Ivanov, Desislava Nikolova, Dragomir Dobruzhaliev

Abstract: The work deals with issues of quasioptimal process control if "Heating-Cooling" in a pair of batch bioreactors in case of heat integration. A method of quasioptimal control that which ensures maximum energy-saving is proposed.

СОФТУЕР ЗА ОПРЕДЕЛЯНЕ НА ПРОИЗВОДСТВЕНИ РАЗПИСАНИЯ ПРИ РАБОТАТА НА МНОГОЦЕЛЕВИ И МНОГОПРОДУКТОВИ ХИМИКОТЕХНОЛОГИЧНИ СИСТЕМИ, ОСИГУРЯВАЩИ ОПТИМАЛНО НАТОВАРВАНЕ НА СИСТЕМИТЕ ЗА РЕСУРСОПОТРЕБЛЕНИЕ

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Предлаганият софтуерен пакет е предназначен за оптималното управление осигуряващо най-добро натоварване на системите за ресурсопотребление при работа на многоцелева или многопродуктова химико-технологична система в режим на производствена кампания.

С помощта на пакета ЕСАМ се определя разписанието за работа на всяко едно от производствата, включени в кампанията спрямо дадено базово производство. Критерият за оптималност на производственото разписание е най-добро натоварване на избрана система за ресурсопотребление (ел. захранване, захранване с пара, и т.н.) при зададени ограничения по отношение на останалите системи и при гарантиране изпълнението на производствената програма.

Този програмен пакет се базира на оригинален авторски метод за намиране на оптимални разписания при работа в производствена кампания, свеждащ проблема до решаване на задача на смесеното нелинейно програмиране. За описание на кривите на ресурсопотребление във времето се използва Фурие трансформацията.

Интерфейсът е разработен така, че лесно да бъде използван от неговите потенциални крайни потребители – специалистите по управление на производства от този тип. Пакетът работи под управлението на Windows2000 и Windows XP, а за неговата разработка е използуван езикът MATLAB.

Резултатите от решението на задачата се представят в подходящи графични и таблични форми. За анализ и вземане на решение от специалиста по планиране и управление, наред с полученото оптимално решение, се представят и най-лошото и най-вероятното, когато не се използва управление на разписанието. Важна част е възможността за използване на пакета за симулиране и анализ на различни производствени разписания, зададени от потребителя и тяхната сравнителна оценка по отношение на оптималното решение.

Работоспособността на софтуера е проверена в'редица тестови примери, които се доближават до реалната производствена практика.

Рационално и ефективно използуване на енергия при производствени процеси в химическата, биохимическата и хранително-вкусовата промишленост
I. *Анализ на възможностите за директна топлинна интеграция*

Б. Иванов, Д. Добружалиев, А. Ангелов, Д. Николова

Abstract: The problem of heat integration of batch reactors is considered. Heat integration opportunities in a hot-cold reactor system are discussed. A method of analysis is proposed, which combines heat integration and correction by external heating and/or cooling agents.

Key words: Batch reactors, Heat integration, Method of analysis.

Рационално и ефективно използуване на енергия при производствени процеси в химическата, биохимическата и хранително-вкусовата промишленост
II. Схеми и *метод за синтез при директна топлинна интеграция*

Б. Иванов, Д. Добружалиев, А. Ангелов

Abstract: The problem of heating and cooling of batch reactors is considered. Heat integration opportunities in a hot-cold reactor system are discussed. A method is proposed, which combines simultaneously heat recuperation and temperature correction by external heating and/or cooling agents. A method of parametric synthesis of such heat integration systems is proposed by formulating the problem in terms of non-linear programming.

Key words: Batch reactors, Heat integration, Non-linear programming.