

РЕЗЮМЕТА НА ПУБЛИКАЦИИТЕ

**на гл. ас. д-р инж. Елисавета Георгиева Кирилова (Шопова),
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I. ПУБЛИКАЦИИ ИЗВЪН ДИСЕРТАЦИОННИЯ ТРУД

1. Vaklieva-Bancheva, N.G., *Shopova, E.G.*, Espuña, A. & L. Puigjaner, (2006). **Product Portfolio Optimization for Dairy Industry**, *Proceedings of International Mediterranean Modelling Multiconference*, (October 4th-6th, 2006, Barcelona, Spain), pp. 101-110.

International Mediterranean Modelling Multiconference

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2006

**October, 4-6, 2006
Barcelona, Spain**

PRODUCT PORTFOLIO OPTIMIZATION FOR DAIRY INDUSTRY

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KEYWORDS

Short-term planning, Product portfolio feasibility, Supply chain, Genetic algorithms, Dairy complex.

ABSTRACT

This paper deals with the short-term planning problem of a dairy complex. In it, a new time based approach for assessing the product portfolio feasibility is proposed. It takes into account the multipurpose and batch characteristics of dairies and employs the time resource distribution over the processing nodes and products.

The deterministic MILP supply chain model involving the portfolio feasibility constraints is formulated for the short-term planning of the dairy complex. The model accounts for market demands and milk provisions from distribution centers. The total site profit is used as an objective function. A genetic algorithm is used as a solution technique.

Manufacturing and distribution of three products in the production environment comprising two dairies, two markets and two milk distribution centers is solved as a case study. Optimal product portfolio is found and all obtained results are discussed in detail.

appropriate mix of products to be offered on the market. In most of the suggested models for short and middle-term planning the supply chain is assumed as already designed. In these cases, the integration of plants capacities and process planning is very important and the accent is in "how to define the feasible work frame of product portfolio for each plant". Integration of SC planning and production capacities requires, from one side more general product descriptions, while from the other increased flexibility and efficiency. In this context, Camm et al. (1997) have discussed product distribution in the production environment for the case of one product planning. Further, Timpe and Kallrath (2000) and Kallrath (2005), have presented the planning models, with the purpose to create enough clear picture for the production capacities, while Hurtubise et al. (2004), proposing hierarchic two-stage planning models, have used a generalized product description for the aggregated planning phase and detailed scheduling to improve the resolution time in the second stage. Levis and Papageorgiou (2004) have assumed, that the equipment at each site is organized in blocks involving a number of manufacturing suits with identical capacities, whereas Guillen et al (2005) have exploited the lower and upper bounded plant capacity to manage the capacity of mixed products manufacturing. Further

2. Vakkliava-Bancheva, N.G., Espuña, A., *Shopova, E.G.*, Puigjaner, L. & B.B. Ivanov, (2007). **Multi-Objective Optimization of Dairy Supply Chain**, *Proceedings of European Symposium on Computer Aided Process Engineering – 17 (ESCAPE 17)*, (Bucharest, Romania, May 27th - May 30th 2007), book series on Computer Aided Chemical Engineering, Elsevier, Volume 24, Pages 781-786.

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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

3. Adonyi, R., *Shopova, E.G.* & N.G. Vaklieva-Bancheva, (2009). **Optimal Schedule of the Dairy Manufactory**, *Chemical and Biochemical Engineering Quarterly (CABEQ journal)*, Volume 23, Issue 2, Pages 231-237.

Optimal Schedule of a Dairy Manufactory

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This paper deals with short-term scheduling of the dairy industry. Two different approaches are proposed for obtaining the minimal makespan schedules. According to the first, S-graph framework is proposed to find the optimal solution of the flow-shop scheduling problem. The problem is solved by applying the branch and bound technique. The second approach uses the integer programming formulation of the scheduling problem and BASIC genetic algorithm has been used to solve the optimization problem. Both approaches take into consideration volumes of units assigned to perform tasks, and respective size factors that affect the size of batches and their number must be produced to achieve production goals and thus on the schedules duration. Manufacturing of two type curds is used as a case study. The results obtained show that both approaches provide comparable solutions. Both approaches could be seen as a good alternative to project manager to find appropriate schedule of the dairy industry.

Key words:

Scheduling problem, S-graph framework, integer programming formulation, dairy industry

4. Vaklieva-Bancheva, N.G., *Kirilova, E.G.*, Zhelev, T.K. & J. Rojas-Hernandes, (2010). **Modeling of Energy Integrated ATAD System**, *Journal of International Scientific Publications: Materials, Methods & Technology*, Volume 4, Part 1, Pages 220-232.

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MODELING OF ENERGY INTEGRATED ATAD SYSTEM

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Abstract

The idea for energy efficiency improvement in Autothermal Thermophilic Aerobic Digestion (ATAD) batch processes follows the observation that the fresh sludge load to bio-treatment reactors causes a thermal shock of microorganisms. This study focuses on opportunities for the thermal shock reduction in conventional ATAD systems through recovery the heat from the effluent stream, which can lead to substantial savings of the time required for operating temperature recovery, less foaming and quicker bio-degradation. Mathematical model for energy integration of ATAD system using two heat storage tanks is proposed. Solution of the formulated optimization problem gives a response for energy efficiency improvement and thermal shock reduction in bioreactors.

Key words: Modeling, Energy integration, ATAD system.

5. **Kirilova, E.G. & N.G. Vaklieva-Bancheva, (2012). Modeling of Two-Stage ATAD Bioreactor System by Using Artificial Neural Network, Proceedings of European Symposium on Computer Aided Process Engineering – 22 (ESCAPE 22), (London, UK, June 17th - June 20th 2012), book series on Computer Aided Chemical Engineering, <https://pdfs.semanticscholar.org/3837/6dd042e5faa785fac62928d5cdf6e05586e8.pdf>**

Ian David Lockhart Bogle and Michael Fairweather (Editors), Proceedings of the 22nd European Symposium on Computer Aided Process Engineering, 17 - 20 June 2012, London.
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Modelling of two-stage ATAD bioreactor system by using Artificial Neural Network

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Abstract

This study deals with modelling of two-stage Autothermal Thermophilic Aerobic Digestion (ATAD) bioreactor system by using Artificial Neural Network (ANN). Accounting for the interconnections between batches and bioreactors the model comprises two separate ANN models designed for modelling bioreactors at each stage and organizes correct transfer of calculated data between them. Thus designed model is able to capture the uncertainties of the inflow sludge parameters and to predict the operational temperatures that could be reached in bioreactors. The latter makes it suitable for involving in energy saving framework under uncertainties.

Keywords: Modelling, Artificial Neural Network, Two-Stage ATAD Bioreactor System.

6. Vaklieva-Bancheva, N.G. & *E.G. Kirilova*, (2013). **Reduction the Impact of Peak Emissions of Pollutants from Multipurpose Batch Chemical and Biochemical Plants**, *Bulgarian Chemical Communications*, Volume 45, Number 1, Pages 47-54.

Bulgarian Chemical Communications, Volume 45, Number 1 (pp. 47 – 54) 2013

Reduction of the impact of peak emissions of pollutants from multipurpose batch chemical and biochemical plants

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The study presents a system-oriented approach for reduction of the impact of peak emissions of pollutants from batch chemical or biochemical plants through appropriate managing of the manufacturing starting times of the respective products. It deals with the problem by proposing novel assessments of the environmental impact of the peaks that account only for these instantaneous values of the pollutant emission strengths that exceed a given limit level and allow the pollutants to be unified by the medium of their emission. Using these assessments an optimization criterion and optimization problem are formulated. As a result, the most appropriate shifting of the starting times of manufacturing for one or more of the products within the time horizon is determined. The efficiency of the approach is illustrated on a case study of dairy industry.

Keywords: Batch plants, environmental impact peaks reduction, peaks assessments, shifting of production starting times, dairy industry

7. Adonyi, R., *Kirilova E.G.* & N.G. Vaklieva-Bancheva, (2013). **Systematic Approach for Designing and Activities Scheduling of Supply Chain Network**, *Bulgarian Chemical Communications*, Volume 45, Number 3, Pages 288-295.

Bulgarian Chemical Communications, Volume 45, Number 3 (288 – 295) 2013

Systematic approach for designing and activities' scheduling of supply chain network

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The present work introduces a two-level systematic approach for optimal Supply Chain (SC) Management. At the first level the SC design problem is solved by applying the mathematical programming; while at the second level the scheduling of the SC activities is modeled and solved by the S-graphs framework. The proposed systematic approach is tested on a tree echelon supply chain example. As a result both, the network of the supply chain corresponding to the optimal total site products portfolio is obtained and the optimal schedule ensuring fleet's assignments so as to implement the portfolio within the production horizon.

Key words: design, activities scheduling, supply chain, S-graph, mathematical programming

8. Vaklieva-Bancheva, N.G., *Kirilova, E.G.* & R.K. Vladova, (2014). **Capturing Uncertainties for Sustainable Operation of Autothermal Thermophilic Aerobic Digestion Systems**, *Proceedings of European Symposium on Computer Aided Process Engineering – 24 (ESCAPE 24)*, (Budapest, Hungary, June 15th - June 18th 2014), book series on Computer Aided Chemical Engineering, Volume 33, Part B, Pages 1729-1734.

Jiří Jaromír Klemesš, Petar Sahev Varbanov and Peng Yen Liew (Editors)
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Capturing Uncertainties for Sustainable Operation of Autothermal Thermophilic Aerobic Digestion Systems

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Abstract

This study deals with a problem for the sustainable operation of Autothermal Thermophilic Aerobic Digestion (ATAD) systems. The problem is presented as a design of heat integrated batch processes under uncertainties. Heat integration framework is defined and a respective mathematical model is discussed. Two-stage stochastic optimization is formulated. A scenario decomposition concept and Genetic Algorithm are used for problem solution. Real sets of data are used to simulate the heat-integrated ATAD system and demonstrate the resulting sustainability of the operational temperatures in the bioreactors.

Keywords: ATAD systems, Uncertainties, Heat integration, Two-stage stochastic optimization, Genetic algorithm.

9. **Kirilova, E.**, Yankova, S., Ilieva, B. & N. Vaklieva-Bancheva, (2014). **A New Approach for Modeling the Biotransformation of Crude Glycerol by Using NARX ANN**, *Journal of Chemical Technology and Metallurgy*, Volume 49, Issue 5, Pages 473-478.

Journal of Chemical Technology and Metallurgy, 49, 5, 2014, 473-478

A NEW APPROACH FOR MODELING THE BIOTRANSFORMATION OF CRUDE GLYCEROL BY USING NARX ANN

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ABSTRACT

*In this study a new approach for the modeling of a biotransformation process of crude glycerol to formation of 1,3-propanediol by the help of bacteria *Pseudomonas denitrificans* 1625 is proposed. Results obtained from the experimental studies of the process are presented for the first time. For the purpose of modeling dynamic Nonlinear AutoRegressive with exogenous input – NARX Artificial Neural Networks are developed. They are used for prediction of the change in the time of the concentration of the substrate and the product as a function of their previous values. The models are trained and validated with real data samplings, obtained from parallel batch experiments carried out at three different initial concentrations of the substrate selected for this purpose. The obtained results show an acceptable coincidence between the measured and the predicted from the model values.*

*Keywords: modeling, NARX ANN, glycerol, 1,3-propanediol, *Pseudomonas denitrificans* 1625*

10. Petrova, T., *Kirilova, E.*, Becker, W. & J. Ivanova, (2015). **Monitoring of Adhesive Joint Used in Lightweight Devices**, *Pliska Studia Mathematica*, Volume 25, Pages 119–128.

Pliska Stud. Math. **25** (2015), 119–128

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STUDIA MATHEMATICA

MONITORING OF ADHESIVE JOINT USED IN LIGHTWEIGHT DEVICES*

T. Petrova, E. Kirilova, W. Becker, J. Ivanova

The excellent performance of the shear lag method for modeling smart pre-damaged bi-material structures under static and dynamic loading lies on the obtained important analytical formulae. The authors developed this method and applied it to investigate the piezoelectric response of a smart structure consisting in a piezoelectric patch over a host layer under static load and affected by electrical load at environment conditions. The interface delamination is investigated and the analytically calculated debond length is found, which is not considered in the typical local techniques. The numerical examples are oriented to the real materials used in the solar cells and other devices. The results are presented in figures and discussed in detail.

11. Petrova, T., Becker, W., *Kirilova, E.* & J. Ivanova, (2015). **Interface Delamination in Solar Energy Devices**, *Proceedings of the 5th International Science Conference "Education, science, innovations" ESI'2015*, (10th June, 2015, Pernik, Bulgaria), pp. 476-485.

Fifth International Scientific Conference "Education, Science, Innovations" • ESI'2015

Пета международна научна конференция „Образование, наука, иновации“ • ESI'2015

INTERFACE DELAMINATION IN SOLAR ENERGY DEVICES

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Abstract. Analytical shear lag method for modelling of the piezoelectric response of the smart structures (like solar panels, aircraft and others) consisting in a piezoelectric patch over a host layer under static load and affected by electrical load at environment conditions, is applied in the present paper. The interface delamination is under consideration and the analytically calculated interface debond length is found. Some criterion about the value of the electric gradient of the patch and detection of the corresponding interface debond length is formulated and discussed with respect to determine the safety zones.

Keywords: interface delamination, safety zone, shear lag model, smart structures, solar cell

12. Vaklieva-Bancheva, N.G., Vladova, R.K. & *E.G. Kirilova*, (2015). **Genetic Algorithm Approach for Optimization of Energy Integrated ATAD Systems under Uncertainties**, *Proceedings of the 17th International Symposium on Thermal Science and Engineering of Serbia "Energy-Ecology-Efficiency"*, (October 20th -23th, 2015, Sokobanja, Serbia), pp. 851-870.



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Society of Thermal Engineers of Serbia Faculty of Mechanical Engineering in Niš

Genetic Algorithm Approach for Optimization of Energy Integrated ATAD System under Uncertainties

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Abstract: Autothermal Thermophilic Aerobic Digestion (ATAD) is a wastewater treatment process using aerobic thermophilic microorganisms for biochemical oxidation of organic matter. It is carried out in parallel series of batch bioreactors at different operating temperatures. ATAD systems are subjected to daily uncertainties coming with each portion of raw sludge filled in first bioreactor. The latter causes decrease of operating temperatures and a thermal shock on microorganisms. To reduce the impact of the thermal shock, energy integration between the outgoing and incoming flows is applied by means of heat storage. Resulted redesign problem is two-stage stochastic optimization. A set of scenarios is generated for its presentation. Genetic algorithm with a specially constructed chromosome is applied for problem solution. Numerical results obtained by using industrial data show increased temperatures of incoming flows and sustainability of the operating temperatures in bioreactors.

Keywords: ATAD system, Energy integration, Genetic algorithms, Stochastic optimization, Uncertainties

13. **Kirilova E.G., Vaklieva-Bancheva N.G. & R.K. Vladova, (2016). Prediction of Temperature Conditions of Autothermal Thermophilic Aerobic Digestion Bioreactors at Wastewater Treatment Plants, *International Journal Bioautomation*, Volume 20, Issue 2, Pages 289-300.**



Prediction of Temperature Conditions of Autothermal Thermophilic Aerobic Digestion Bioreactors at Wastewater Treatment Plants

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Abstract: Energy integration plays a significant role in increasing energy efficiency and sustainability of production systems. In order to model real energy integrated systems, sometimes we don't need rigorous models for involved units, but easily implemented and fast ones instead. This study presents an approach based on Artificial Neural Networks (ANNs) for predicting the main parameters of Industrial Autothermal Thermophilic Aerobic Digestion (ATAD) bioreactors that are crucial for their energy integration.

To create such predictive ANN model, four architectures with different number of hidden layers and artificial neurons in each one of them have been investigated. The developed ANN architectures have been trained and validated with data samplings obtained through long-term measurements of the operational conditions of real ATAD bioreactors. To train the models, BASIC genetic algorithm has been implemented. Using three independent measures for validation of the models, the best ANN architectures were selected.

It is shown that selected ANN models predict with sufficient accuracy these ATAD parameters and are suitable for the implementation in an energy integration framework.

Keywords: *Wastewater treatment plant, Autothermal thermophilic aerobic digestion bioreactor, Parameters prediction, Artificial neural network, Genetic algorithm.*

14. Petrova, T., *Kirilova, E.*, Becker, W., Vaklieva-Bancheva, N. & J. Ivanova, (2016). **Optimal Analysis of Adhesive Lightweight Joints**, *ZAMM - Journal of Applied Mathematics and Mechanics / Zeitschrift für Angewandte Mathematik und Mechanik*, Volume 96, Issue 11, Pages 1280-1290.

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Optimal analysis of adhesive lightweight joints

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Key words Shear-lag analysis, smart structure, genetic algorithm, multiparametric optimization, interface delamination, minimal debond length.

In the present paper the behavior of the piezoelectric response of smart lightweight structures consisting in a piezoelectric patch over a host layer under static load and affected by electrical load at environment conditions is studied. The shear lag analysis is applied to investigate the possible interface delamination and to calculate analytically the interface debond length. It has been demonstrated that the roots of respective characteristic equation play a leading role for place of the interface delamination in the overlap zone of the structure under consideration. This leads to the conditions for the actual debonding existence and opens the possibility of an optimal analysis. The proposed approach consists in involving the shear lag model in a global optimization framework where simultaneously the investigation of all model parameters can be carried out. The solution of that problem gives the values of the parameters at which a vanishing/minimal debond length is ensured. The efficiency of the proposed method is proved on three different examples as the optimal geometrical characteristics and effects ensuring no delamination in the structures are obtained.

15. Ivanova, J., Petrova P., *Kirilova E.* & W. Becker, (2017). **Optimal Parameters of a Dynamically Loaded Patch/layer Structure Against the Elastic-brittle Interface Debonding**, *Engineering Transactions*, Volume 65, Issue 1, Pages 97-103.

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Optimal Parameters of a Dynamically Loaded Patch/Layer Structure Against the Elastic-Brittle Interface Debonding

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A one-dimensional shear-lag model was developed to study the high frequency, dynamic, time-harmonic mechanical behavior of the overlap zone of a piezoelectric patch attached to an elastic host layer and subjected to electric, temperature and moisture excitation. It was interesting to see that the change of the geometry of the overlap zone leads to different solutions after same frequency, which is responsible for different dynamic behavior of the considered structure. Furthermore, the model was involved in an optimization framework (genetic algorithm-GA) in order to find the optimal values of the model parameters of the patch/layer configuration.

Key words: PZT-4/glass-fiber epoxy, shear lag model, genetic algorithm.

16. Kirilova, E., Petrova P., Becker, W. & J. Ivanova, (2017). **Influence of the Geometry and the Frequency Range on the Interface Delamination in Smart Patch/layer Structures under Combined Dynamic Loading**, *ZAMM - Journal of Applied Mathematics and Mechanics/Zeitschrift für Angewandte Mathematik und Mechanik*, Volume 97, Issue 9, Pages 1136-1146.

Influence of the geometry and the frequency range on the interface delamination in smart patch/layer structures under combined dynamic loading

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Key words Shear-lag model, time harmonic loading, thicknesses ratio, frequency interval, interface debonding.

The paper deals with the interface behavior of a smart patch/layer lightweight structure subjected to combined time harmonic mechanical loading, electric field and environmental conditions. The applied dynamic shear-lag and Fourier method refer to the overlap zone of the considered structure. It gives a possibility to obtain solutions in a closed form for axial and shear stresses of the structure. The types of solutions obtained depend mainly on the adherends' thickness, the frequency interval of applied dynamic loading and the shear modulus of the used adhesive. At a given constant ratio of thicknesses of the adherends, the frequency interval of the dynamic load can change drastically the type of solution of the considered system of ordinary differential equations.

Theoretical predictions for single debond length of patch/layer structure at an elastic-brittle interface behavior are provided. The influence of the ratio of thicknesses of the adherends in PZT-5H/CFRP patch/layer structure and the frequency range of applied dynamic mechanical loading on the interface delamination is investigated. All results are illustrated in figures and tables and are discussed.

17. Kirilova, E.G. & N.G. Vakiieva-Bancheva, (2017). **Environmentally Friendly Management of Dairy Supply Chain for Designing a Green Products' Portfolio**, *Journal of Cleaner Production*, Volume 167, Pages 493-504.

Journal of Cleaner Production 167 (2017) 493–504



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Environmentally friendly management of dairy supply chain for designing a green products' portfolio



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ABSTRACT

The study proposes an optimization approach for design of "green" products' portfolio of a supply chain for curd production. It includes three interconnected models for describing curd production, supply chain and its environmental impact. The latter is assessed in terms of wastewater and CO₂ emissions associated with the curd production and the transportation of raw material and products. The models are included in a broader optimization framework whereby the environmental criteria are defined in terms of costs such as the best trade-off between total profit and environmental impact to be achieved. The proposed approach is applied to a Bulgarian case study for production of two types of curd in dairy supply chain involving suppliers, dairies and markets. Two optimization problems for "green" products portfolio and profit products' portfolio design are formulated and solved. The obtained results show that the "green" products portfolio is limited by the environmental impact consideration and the optimal profit products' portfolio is limited by the plants' capacities. The successful implementation of the proposed approach opens the prospect of expanding not only to the whole range of dairy products but also the entire supply chain that includes players which are in a competition with each other.

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II. ПУБЛИКАЦИИ ВКЛЮЧЕНИ В ДИСЕРТАЦИОННИЯ ТРУД

18. Vaklieva-Bancheva, N.G., *Shopova, E.G.*, & B.B. Ivanov, (2002). **Application of Fourier Transformation for Waste Minimization in Batch Plants, 1. Analysis of Production Recipes**, *Hungarian Journal of Industrial Chemistry*, Volume 30, Pages 199-206.

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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

19. *Shopova, E.G., & N.G. Vaklieva-Bancheva, (2003). Short-Term Scheduling of Curd Processing for Environmental Impact Minimization, Journal of the University of Chemical Technology and Metallurgy, XXXVIII, 3, Pages 779-784.*

Journal of the University of Chemical Technology and Metallurgy, XXXVIII, 3 (2003), 779-784

SHORT-TERM SCHEDULING OF CURDS PROCESSING FOR ENVIRONMENTAL IMPACT MINIMIZATION

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ABSTRACT

This study considers a short-term scheduling in curds processing for environmental impact minimization. The aim is to find the best tradeoff between production requirements and the environmental impact assessed by BOD "generated" in the whole batch plant. The problem is formulated as MINLP. The contribution of the inherent losses in the GBOD is taken into account.

Keywords: short term schedules, MINLP, dairy industry, global BOD minimization.

20. Vaklieva-Bancheva, N.G., *Shopova, E.G.*, & B.B. Ivanov, (2004). **Minimization of Wastes from Batch Plants for Compatible Manufacturing of the Products**, *Bulgarian Chemical Communications*, Volume 36, Number 4, Pages 253-262.

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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 discreteness 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 discreteness, 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.

21. Vaklieva-Bancheva, N.G., Espuna, A., **Shopova, E.G.**, Ivanov, B.B., & L. Puigjaner, (2005). **Multiobjective Optimization of Curds Manufacture**, *Proceedings of European Symposium on Computer Aided Process Engineering – 15 (ESCAPE 15)*, (Barcelona, Spain, May 29th - June 1st 2005), book series on Computer Aided Chemical Engineering, Volume 20, Part 2, Pages 1183-1188.

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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.

22. *Shopova, E.G., & N.G. Vaklieva-Bancheva, (2006). Basic – a Genetic Algorithm for Engineering Problem Solution, Computers and Chemical Engineering, Volume 30, Issue 8, Pages 1293-1309.*



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BASIC—A genetic algorithm for engineering problems solution

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Abstract

This paper introduces in details a genetic algorithm—called BASIC, which is designed to take advantage of well known genetic schemes so as to be able to deal with numerous optimization problems. BASIC GA follows all common steps of the genetic algorithms. It involves real representation schemes for both real and integer variables. Three biased selection schemes for reproduction; four for recombination and three for mutation are applied in it and a new selection scheme for replacement is approached.

BASIC GA can be easily adjusted to the concrete problems by fitting its global and local parameters. It provides an opportunity to the genetic operators to be extended with new schemes.

A range of various optimization problems has been solved to test its capability. To handle all sorts of constraints the static and dynamic penalty functions are used. The solutions obtained are commensurable with other genetic algorithms and solution techniques.

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Keywords: Genetic algorithm; Real representation; Selection; Recombination; Mutation; Replacement; Optimization problems

23. Vakkieva-Bancheva, N.G., & E.G. Kirilova, (2010). **Cleaner Manufacture of Multipurpose Batch Chemical and Biochemical Plants. Scheduling and Optimal Choice of Production Recipes**, *Journal of Cleaner Production*, Volume 18, Issue 13, Pages 1300-1310, (11 цитата).

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Cleaner manufacture of multipurpose batch chemical and biochemical plants. Scheduling and optimal choice of production recipes

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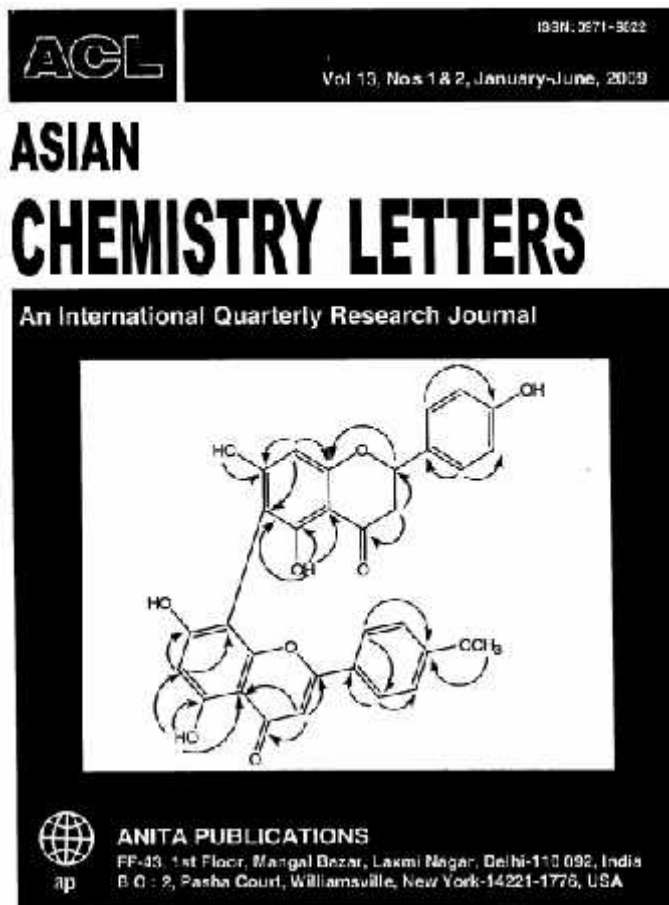
ABSTRACT

This study presents an approach for cleaner management of multipurpose batch chemical or biochemical plants. Given that manufacture of most of the products could be carried out in multiple ways depending on chosen production recipes, the scheduling framework is extended by involving the choice of appropriate production recipes. Using as optimization criteria the Global or Local Environmental Impact Assessments defined in Minimum Environmental Impact Methodology, the mathematical formulation that results in multi-objective optimization problems is presented for a special class of schedules.

The approach is implemented on an example from dairy industry. Production of two types of curds by selection from two available recipes for each one of them is considered. The problem is translated to a single objective. Two most reliable solutions are obtained, which differ in chosen production recipes, milkfat content and units involved for tasks implementation. Comments on the impacts on the load of Biochemical Oxygen Demand at the end of each production cycle due to simultaneous curds manufacturing and contributions of individual dairy wastes in Global Biochemical Oxygen Demand are also provided.

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24. Vaklieva-Bancheva, N.G., & E.G. Kirilova, (2010). Working Frame for Environmental Benign Management of Multipurpose Batch Chemical and Biochemical Plants, *Asian Chemistry Letters*, ANITA Publications, Volume 14, Numbers 2, ISSN 0971-9822.



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Working frame for environmental benign management of multipurpose batch chemical and biochemical plants

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Abstract

The aim of this paper is to propose a working frame of systems-oriented approach for environmentally benign management of multipurpose batch chemical and biochemical plants. It provides opportunities i) to find the minimal environmental impact of the production recipes; ii) to choose management policies of the production systems; and iii) to manage the peaks of released pollutants. Proposed working frame uses the Local and Global Environmental Impact Assessments as optimization criteria. It was implemented on the examples from dairy industry.