Table 1. Properties of Resins and Resin-Based Coatings

Sample	Adhesion point	Adhesion, kgf/cm^2	Hardness, kg
PPR_{C5O}	4	4.48	0.4
PPR_{C5K}	4	3.99	0.4
PPR_{C5O-10}	U	U	U
PPR_{C5K-10}	2	4.98	0.4
$PPR_{C5K-10(1:0,5)}$	2	6.48	0.4
$PPR_{C5K-10(1:1)}$	1	7.48	0.4

with increased unsaturation of PPR_{C5O} and, probably, the production of a cross-linked structured product in the process of maleinization. A sample of PPR_{C5K} resin is hydrogenated, and maleinization leads to the formation of a soluble products (PPR_{C5K-10}).

Imidization of maleinized PPR_{C5K-10} is carried out with polyethylene polyamine (PEPA) for 2 hours at a temperature of 120 °C and a molar ratio of MAN : PEPA of 1 : 1, 1 : 0.5.

As a result, PPR_{C5K-10} (1 : 0.5) and PPR_{C5K-10} (1 : 1) resins were obtained respectively with improved characteristics of the properties which are listed in Table 1. The coating characteristics were investigated by using standard methods [2–3]: the method of lattice cuts, the method of quantitative determination of adhesion of paints and varnishes by the pull-off force, the method of determining the hardness of a paint and lacquer coating.

Thus, modified PPR_{C5} resins were synthesized by maleinization and imidization.

The comparison of the technical characteristics of coatings based on them showed us a higher adhesion of coatings compared to the coatings with using unmodified resins.

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PROCESS INTEGRATION AND OPTIMIZATION IN CHEMICAL ENGINEERING

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1. Introduction

Process integration is a holistic approach to process design which involves the following general activities [1]:

1) Task definition: expression of the design criterion as a quantifiable function of selected design variables and constraint identification; 2) Generation of alternatives: definition of a search space that includes all the possible alternatives for flowsheet configuration and process conditions; 3) Selection of alternatives: Determination of the optimum – the alternative that best meets the design criterion and constraints

The selection of alternatives can be carried out with optimization techniques. This approach can yield globally optimal design solution, surpassing the limitations of graphical and heuristic decision tools [1].

2. Design task as an optimization problem

In a process integration framework, the design task can be defined as a mixed non-linear optimization program, as shown in equations (1)–(3) [2].

The flowsheet variables express the structure of

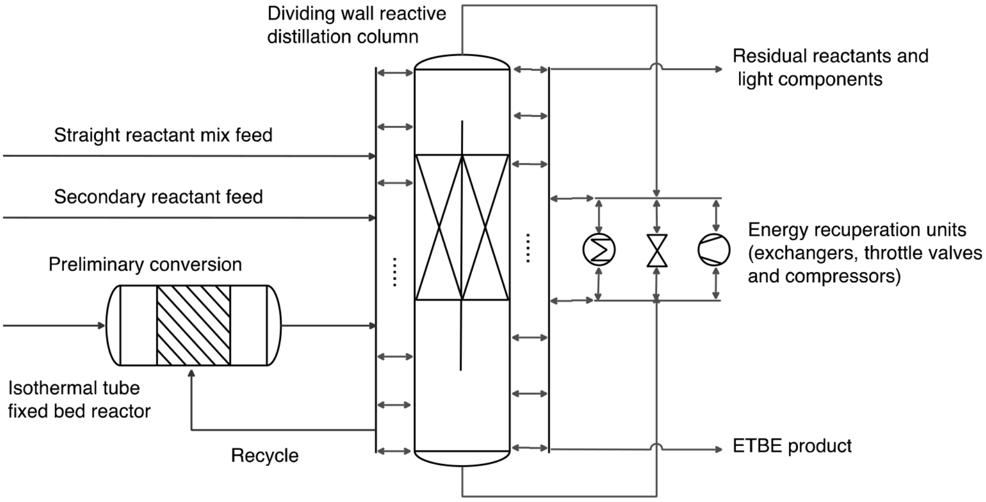
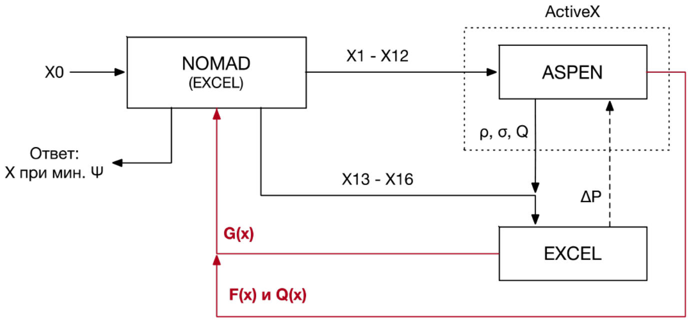


Fig. 1. *Reactive distillation process superstructure for ETBE synthesis*



Constructive and operative optimization variables X (total of 16)

Catalyst load by reactive plate, kg	1	9.00
Number of plates	2	51
Feed plate	3	49
Start – end of reactive part	4–5	22–42
Reboiler heat load, kW	6	4.04
Reflux ratio	7	11.08
Isothermal reactor temperature, °C	8	43.30
Secondary ethanol flowrate, kg/h – feed plate	9–10	120.00–21
Recycle flowrate, kg/h – extraction plate	11–12	715.52–49
Column diameter, m	13	1.65
Distance between plates, m	14	0.50
Perforation diameter, mm	15	4.00
Liquid weir height, mm	16	83.20
Process constraints and target function		
ETBE product purity (mass fr.)	0.958	
Isobutylene conversion degree (mole fr.)	0.981	
Total capital and operative costs (1000$/year)	5029.64	

Fig. 2. *Optimization variables and solution diagram*

$\min\limits_{\omega,y} \Psi = c^T y + p(\omega)$,	Design criterion (target function) Ψ – total cost as a function of flowsheet variables y and process variables ω.	(1)
With constraints:		
$r(\omega) = 0$,	Matter and energy balance constraints.	(2)
$s(\omega) + By \leq 0$,	Purity, performance constraints and flowsheet constraints.	(3)
where $\omega \in R^n$, $y \in \{0; 1\}$		

the flowsheet, with 0 or 1 for the absence or presence of a unit or material stream. Process variables ω indicate process conditions and unit dimensions. The cost matrix c^T and function $p(\omega)$ give the total capital and operative cost of the process.

The matter – energy balance constraints are given by the mathematical model of the process, commonly carried out in commercial simulators. The purity, performance and flowsheet constraints are given arbitrarily.

The solution of the program in (1)–(3) consists in finding the values of the y and ω variables that minimize the total cost Ψ. This is performed by optimization algorithms, which must be capable of handling non-lineal target functions, non-convex constraints and integer variables [3].

3. Application to the design of ETBE reactive distillation processes

Reactive distillation integrates product synthesis and separation in a single distillation column. Ethyl tert-butyl ether (ETBE) is produced by reactive distillation of a mixture of isobutylene (in a typical C4 fraction) and ethanol. Details on the reaction and its kinetics can be found on [4].

As for a process integration design approach, the search space is represented by a superstructure (fig. 1). A preliminary cost-optimal design has been carried out without energy recuperation units, with the variables, results and solution diagram presented in figure 2.

The reactive distillation process was modeled in Aspen Plus, and the optimization problem was solved using the MADS direct search algorithm [5], available as a solver plugin for Microsoft Excel. Aspen Plus and Excel are linked through an ActiveX interface on the Excel side.

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THE INFLUENCE OF PULSED E-BEAM TREATMENT ON PROPERTIES OF PCL SCAFFOLDS LOADED BY PARACETAMOL

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Tissue engineering is a developing area, the purpose of which is to create devices that promote the regeneration of various tissues and organs. To achieve this goal, scaffolds with different physicochemical characteristics can be used both as an extracellular matrix for a new tissue formation, and for delivering various drugs, cells and enzymes. Today, the main problems that need to be addressed in this area are to achieve a correlation between the rate of degradation process and the formation of new tis-