Software application for research on the organization of cyclic production of multi-assorted products

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In recent years, chemical-technological systems (CTS), which are necessary for the production of a multi-product range of products, have been increasingly used at chemical industry enterprises.

The consequence of this is the high demand for specialists who are able to develop and implement such systems in both new and existing industries.

To prepare such specialists in the educational process, it is necessary to use specialized software, the use of which will help to form the skills necessary in further professional activity.
There is a wide range of software systems created for modeling and synthesis of chemical-technological schemes and each of them has unique functionality.

CHEMCAD allows the engineer to simulate, in addition to the full technological scheme, its separate section.

USIM PAC automatically analyzes energy-saving schemes, methods of disposal, processing and storage of waste.

AspenONE, unlike other programs, is supported not only by Windows, but also Mac OS, as well as mobile platforms Android and iOS.
But after a thorough analysis of the software capabilities of these complexes, it was found that, despite their rich functionality, they are not fully suitable for developing basic skills in the field of synthesis and optimization of flexible CTS.

Therefore, at the department of computer-Integrated systems in chemical technology at the D. Mendeleev University of Chemical Technology of Russia, several years have been developing its own software used in the educational process, for example, the SoF CES software module and Duration module.

But, in addition to the modeling task itself, there is the task of optimizing the output of the assortment of multi-assortment production products, which is no less relevant.
WAYS TO ORGANIZE PRODUCTION:

1. SEQUENTIAL RELEASE

The release of products is made in full one after another. In this case, there are no readjustments in the process of obtaining a single product, which reduces equipment downtime and the total production time.

2. "CYCLIC" RELEASE

It provides for the release of the entire product range for one batch of each product in an arbitrary order within a closed, regularly repeated cycle.

3. RELEASE IN GROUPS

The release of the assortment by groups provides for the distribution by batch of those products for the production of which the same equipment is not used.

To develop the necessary skills, students need to make a manual calculation with each of the presented methods.
A calculation algorithm was developed for the implementation of the software application.

The optimality criteria in this algorithm are the total operating time of one cycle and the downtime of devices that must be minimized.
SOFTWARE APPLICATION FOR RESEARCH ON THE ORGANIZATION OF CYCLIC PRODUCTION OF MULTI-ASSORTED PRODUCTS

INTERFACE OF THE DEVELOPED APPLICATION

After entering the names of all products and devices, the times of the release of products on each of the devices and the times of changeovers we go to the tab “Results”, where the sequences of release of products are formed.
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INTERFACE OF THE DEVELOPED APPLICATION

After clicking on the “Calculation” button, the program calculates the release time of each product sequence, after which it is possible to sort by release time and determine the shortest time required to produce the product range.
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INTERFACE OF THE DEVELOPED APPLICATION

Returning to the “Results” tab and clicking on one of the buttons in the “Chart” column, you can see the Gantt chart that displays the release of this sequence.

After finishing work with the program, all initial data can be saved by clicking on the “Save Project” button. You can use them again by clicking on the “Open Project” button and selecting the necessary database.
To prepare for laboratory work in the discipline "Mathematical Modeling and Synthesis Methods of Flexible Chemical Production" the following documents were developed and placed in an interdisciplinary automated training system: standard report, user manual, work options.

All options are developed taking into account real-life production schemes so that with manual calculation and subsequent analysis, students develop the appropriate skills needed in real production.

Example №2 Study of the options for cyclic production of a combined product range

Determine the best sequence for the assortment release by the total operating time and equipment downtime by the calculation method.

The scheme is fully combined. Do not install containers; if necessary, use transmitting stage devices as containers.

Duration of processing products, $t_{j,i}$, hour ($i$ - product number, $j$ - apparatus stage number).

<table>
<thead>
<tr>
<th>$j$</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>7</td>
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Duration of readjustments on devices: $q_{j,i-1,i}$, hour

<table>
<thead>
<tr>
<th>$Q_{1,i-1,i}$</th>
<th>$Q_{2,i-1,i}$</th>
<th>$Q_{3,i-1,i}$</th>
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</tr>
<tr>
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<td>-11-112-13</td>
<td></td>
</tr>
<tr>
<td>2</td>
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<td></td>
</tr>
<tr>
<td>3</td>
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</table>
CONCLUSION

The software application was tested on the examples of the organization of the cyclic release of four products on six devices. It took several seconds for the application to calculate, while manual calculation of all options for assortment release for this case could take several hours.

In the future, it is planned to add a calculation of time for sequential production and output by groups.

After analyzing all the features of the software application, we can conclude that it can be used in laboratory classes for educational research tasks related to the synthesis of flexible CTS, as well as in the preparation of scientific research and final qualification works of bachelors.
Thank you for attention!

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