Development of a deethanizer rectification column computer model in Aspenhysys software environment

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Abstract. A computer model of the deethanizer rectification column in the Aspenhysys software environment has been developed. All input necessary parameters were entered and the output target product ethane was obtained. This paper provides results of research related to modelling of distillation columns based on example typical Deethanizer.

1 Introduction

In modern technology, the separation of natural gas, while obtaining the fractionation of ethane, the presence of which greatly complicates the calculations of distillation columns. In order to solve this problem, the Aspenhysys program was used.

The development of a control system for modern technological processes and the optimal control of existing industries is impossible without the use of simulation programs that have a high accuracy in describing the parameters of technological processes and allow you to study these processes without significant material and time costs. These modeling studies are of great importance not only for the design, but also for the functioning of existing industries, since they allow taking into account the influence of external factors on the functioning of existing industries.

In the article, to create a computer simulation of a deethanizer distillation column, the Aspen HYSYS program, a leader in software for modeling and optimizing technological processes in the oil and gas industry, was used [1,3].

Aspen HYSYS software products for engineering calculations and simulations are the basis for the design of new technological processes or the modernization of existing technological processes in order to improve their performance. Aspen HYSYS software products are used to build models and make decisions based on simulation results, providing: linking design, management and business processes. Due to the open architecture of Aspen HYSYS software products, the scope of application of models created for engineering calculations is significantly expanded [2]. These models can also be used for factory settings, real-time optimization. All models in Aspen HYSYS software products are based on knowledge of technological processes and combine all previous engineering innovations and

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information technology achievements, and give reliable results, tested on real industrial installations [4].

Let us consider the calculation of the deethanizer distillation column. To calculate the deethanizer, the following is performed.

2 Main part

According to the description of the technological process, the bottom product of C2+ hydrocarbons above enter the distillation column of the demethanizer. The temperature at the outlet of the gaseous liquid is measured by an indicator and a local thermometer. The heated liquid is fed into the C-1401 deethanizer column above the 19th plate.

C-1401 is a vertical column-type apparatus equipped with 41 valve trays. Plates are counted from top to bottom.

Fractionation takes place in the column i.e. separation of lighter C2 (ethane) and heavy C3+ higher (distillation residue) by distillation.

The gas flow of the deethanizer column at the exit is sent to the E-1402 condenser.

Starting AspenHYSYS is as follows Start/All Programs/AspenHYSYS. After launching the AspenHYSYS program, a window opens.

After opening a new window, you must complete the File / New / Case sequence. Before defining a property package, ASPENHYSYS creates a list of components for the model. In the article, the list of components contains hydrocarbon components. First you need to add hydrocarbons from the library of pure components HYSYS [2] to the list of components. Click on the Component List navigation bar. On the Component List tab, click the down arrow next to the Add button and select HYSYS from the drop down list. A new Component List window has appeared – 1 (Figure 1)

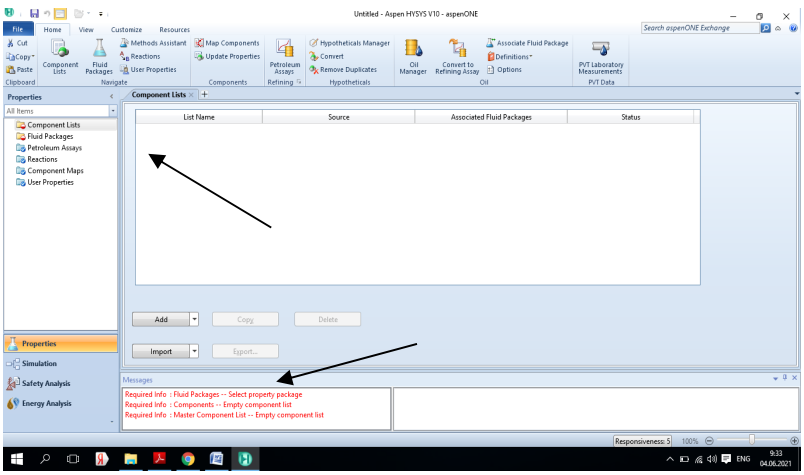

Fig. 1. New window HYSYS.

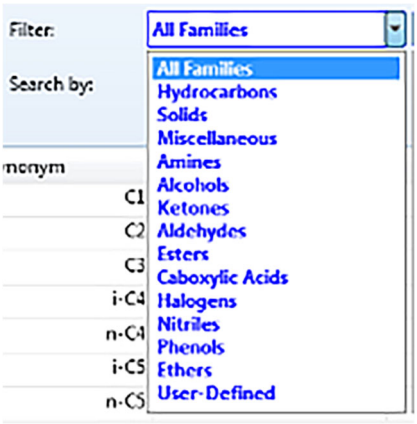

Fig. 2. Filter the list of components.

Select the first component to add. Hold down the SHIFT key and click the last component in the list. All components "methane", "ethane", "propane", "i-butane", "n-butane", "i-pentane", "n-pentane", "n-hexane", "carbon dioxide" are highlighted. Release the SHIFT key. Use the SHIFT key to select consecutive components.

Press <Add. The required component will be displayed on the left side of the picture (Figure 3).

The property package contains the components and their property calculation methods that HYSYS will use to determine the flowsheet parameters. The property pack will contain the performance pack (Peng Robinson) for the pure components "methane", "ethane", "propane", "i-butane", "n-butane", "i-pentane", "n-pentane", "n-hexane", "carbon dioxide".

Click the Fluid packages tab on the navigation bar to select equations for this list of components. Click the Add button and the window shown in Figure 4. The Peng-Robinson equation is used to develop a computer model of the deethanizer distillation column. Add a Peng-Robinson equation in the Property Pack-age Selection group and HYSYS creates a property pack named Basis-1.

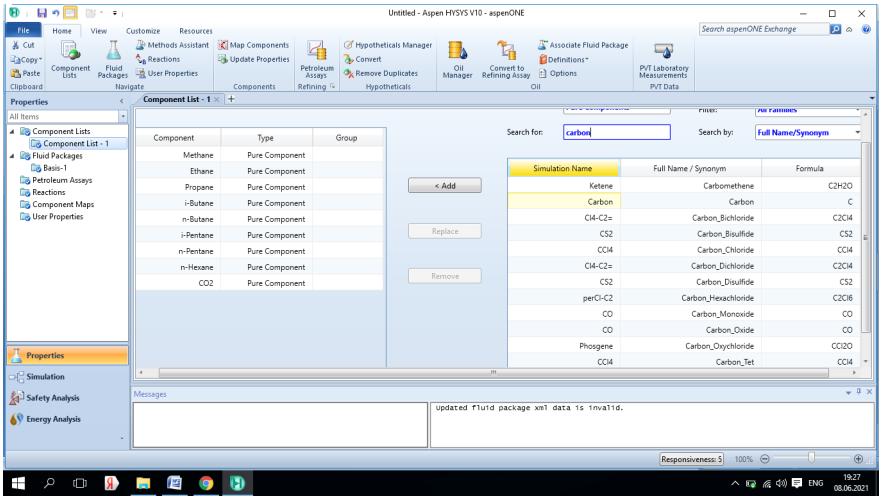

Fig. 3. Creating a list of components.

If the selected list of components contains a component that is not suitable for this property package, HYSYS opens the Components Not Recommended for Property Package window (the component is not recommended for the property package).

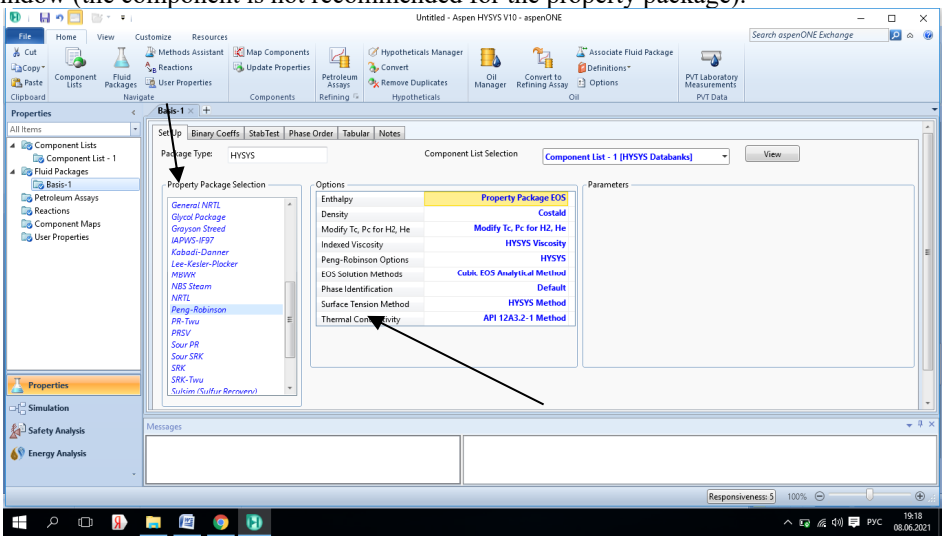

Fig. 4. Choice of HYSYS calculation method.

Basically, the first step in the simulation environment is to set up one or more power streams. After selecting an equation, go to the Simulation tab. A window opens and in the Model palette section the incoming molasses is specified. With the left mouse button, click on the blue arrow Streams and drag it into the window of which the technological scheme will be built (Figure 5).

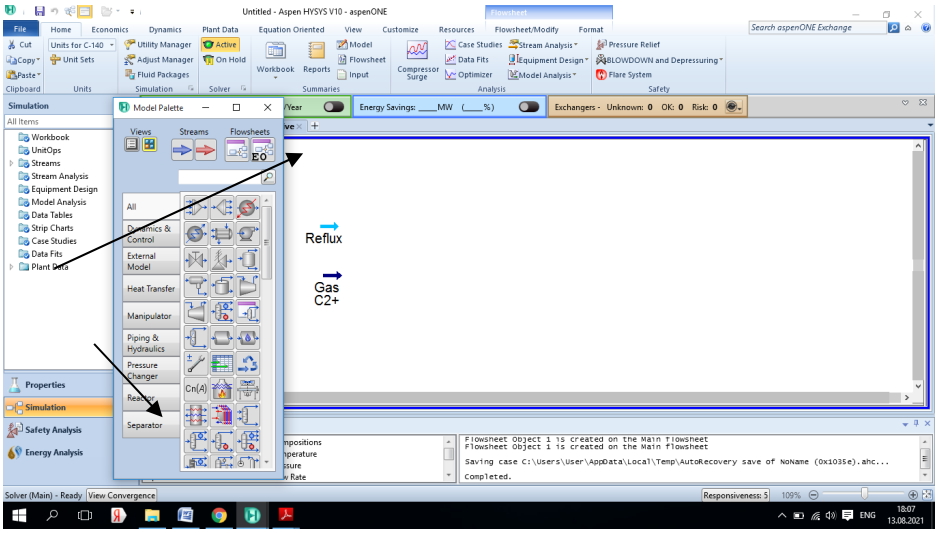

Fig. 5. Entering molasses parameters.

To set the properties of the molasses, double-click on the incoming molasses with the left mouse button. The material stream window will open. It sets all data from table 1 for Gas C2+ molasses and Reflux (irrigation). The distillation column of the Deethanizer receives

Gas C2+ and Reflux (reflux). All properties of the molasses Temperature, Pressure and Mass flow can be entered in the Conditions section (Figure 6).

Table 1. Molasses Gas C2+ and Reflux.

Molasses name	Feed	Reflux
Temperature, °C	24.2	-0.8
Pressure, bar	25.17	25.03
Mass flow, kg/h	89333	68711

3 Input of the component composition

Here, when the conditions of the auxiliary flows are set, the next step is to enter the component composition. And the component composition of the molasses can be entered in the Composition section. Components are presented in mole fractions. In the Bottom Steam column, click on the cell for the components "methane", "ethane", "propane", "i-butane", "n-butane", "i-pentane", "n-pentane", "n-hexane" , "carbon dioxide". It sets all data from table 2 for Gas C2+ molasses and Reflux (irrigation). If the sum of all component compositions is equal to one, then at the bottom of the window you can see a green bar with the inscription "OK"

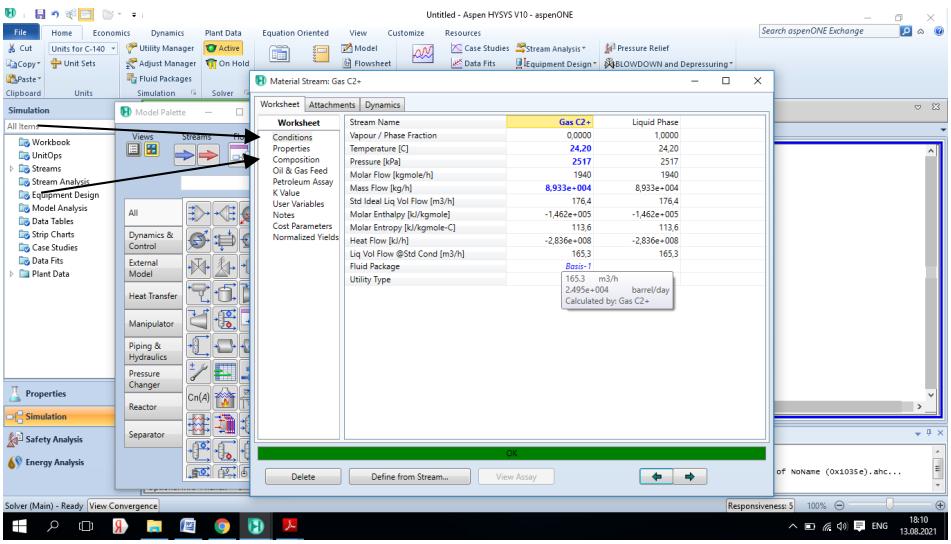

Fig. 6. HYSYS molasses properties.

Table 2. Gas and reflux content.

Molasses name	Feed	Reflux
Content, mol.		
Methane	0.666	0.378
Ethane	37.628	84.751
Propane	25.404	6.689
i-butane	5.372	0.00
n-butane	6.446	0.00
i-pentane	5.842	0.00
n-pentane	4.431	0.00
n-hexane	6.842	0.00
Carbon dioxide	7.369	8.179

4 Entering column parameters

In order to select a distillation column from the model palette, go to the separator tab. In the separator tab, create a reboiled absorber with 41 plates, place the object on the workspace by clicking the left mouse button twice. The window shown in Figure 10. In the Inlets matrix, click the <<Stream>> cell. Click the arrow to open the drop-down list of available streams. Choose Gas C2+ from the list. This stream appears in the Inlets matrix and the <<Stream>> designator automatically moves down to the new free slot. In top stage inlet select Reflux. Here it is necessary to set the following parameters: number of plates - 41; molasses gas (Gas C2+) enters plate 19 and molasses Reflux enters plate 1. The top molasses of the distillation column is ethane (C2) and the bottom molasses is C3+ liquid.

After you have set all the required incoming and outgoing molasses in the lower window (Distillation column input expert), the next button lights up.

Next, you will proceed to enter the following parameters. At the 2nd stage of development, all parameters are unchanged, at the 3rd stage, an increase in the level of production and an increase in pressure in the reboiler are set. The overhead pressure is 2448 kPa and the reboiler pressure is 2503 kPa. Press the next button after you set the product pressure increase and the reboiler pressure and you will proceed to enter the next parameters. (Figure 7)

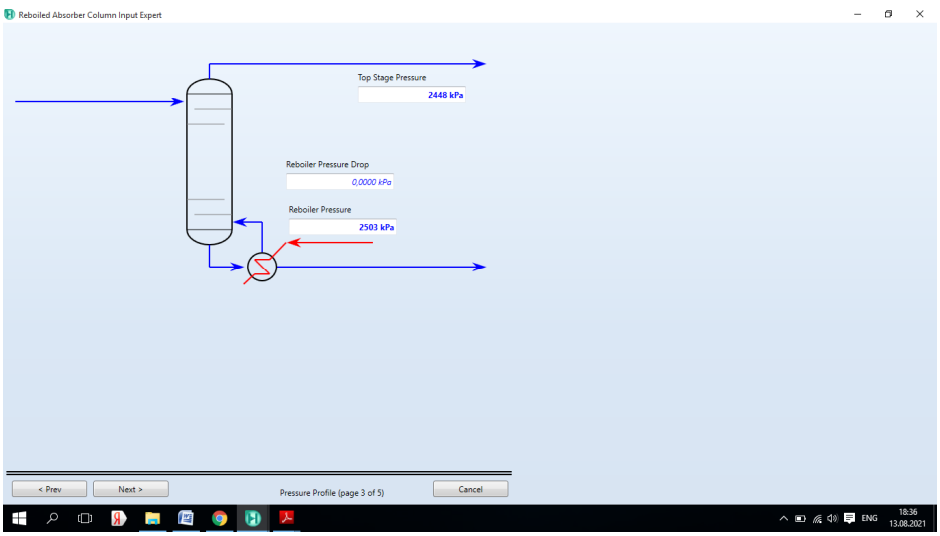

Fig. 7. Entering column pressure.

At step 4, the temperature of the top and bottom of the column is set, the temperature of the top of the column is 3.7 C^0, and the temperature of the bottom of the column is 94 C^0. At step 5, leave everything unchanged and click on the Done button.

After the main parameters are set, the window shown in Figure 8 will open. The parent scheme specifies the main characteristics of the column.

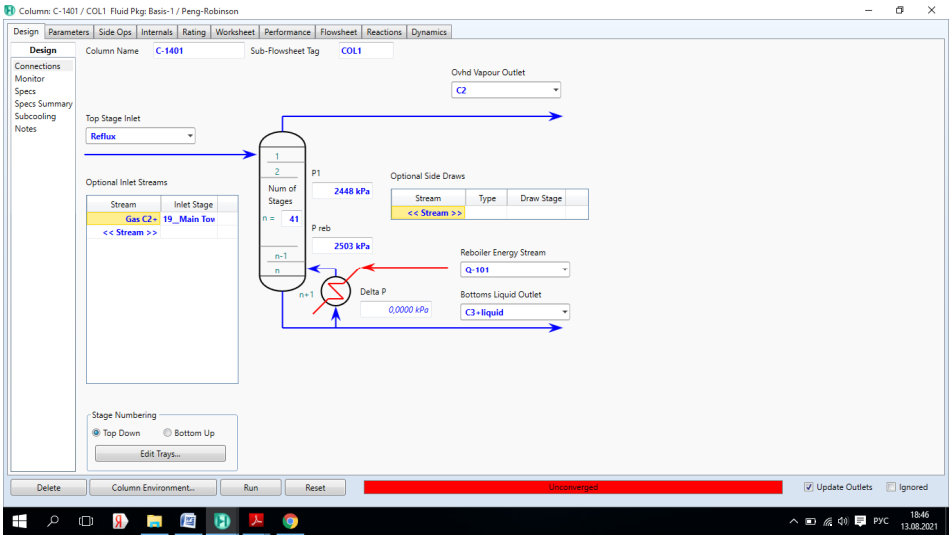

Fig. 8. Parent Schema.

Click the Column environment button to open the Column Characterization Table window.

From flowsheet/Modify click on go to parent and the parent schema window will open. In order to set the main characteristics of the column, go to Design/Monitor.

Set the Ovhd prod rate here. The consumption of the top product is equal to 110444 kg/h. After you set the flow rate of the upper product, click on the Run button to calculate. A warning window will appear (Figure 9) in which you must enter the missing parameters (Figure 10).

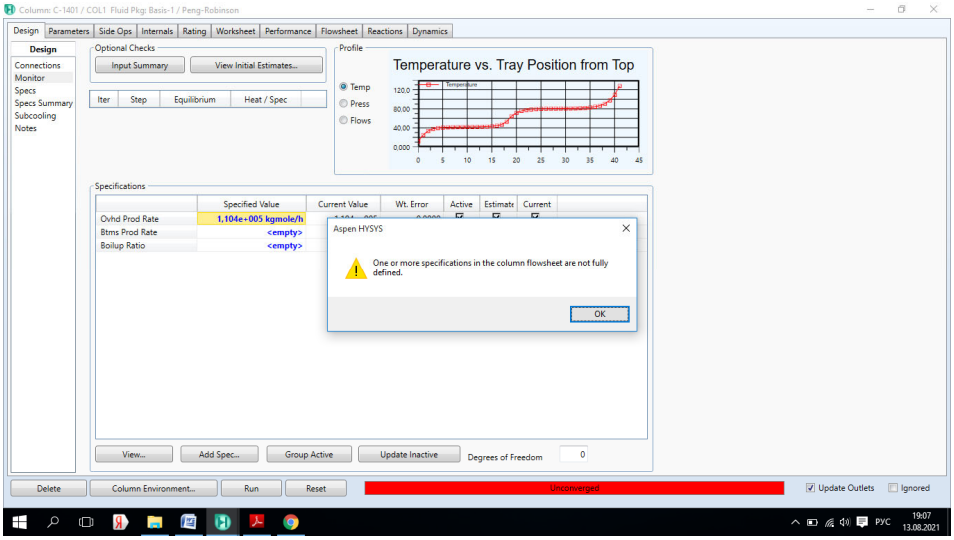

Fig. 9. Window – Warning.

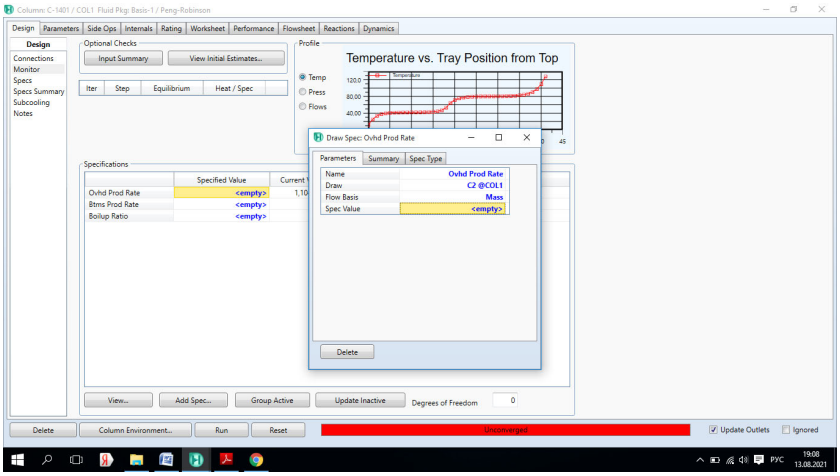

Fig. 10. Entering missing parameters.

After you set all the missing parameters, click on the Run button to start the calculation. Now you can see a green bar at the bottom of the column parameters window [5]. (Figure 11) Go to the performance tab and see the ethane content at the bottom of 0.7646%.

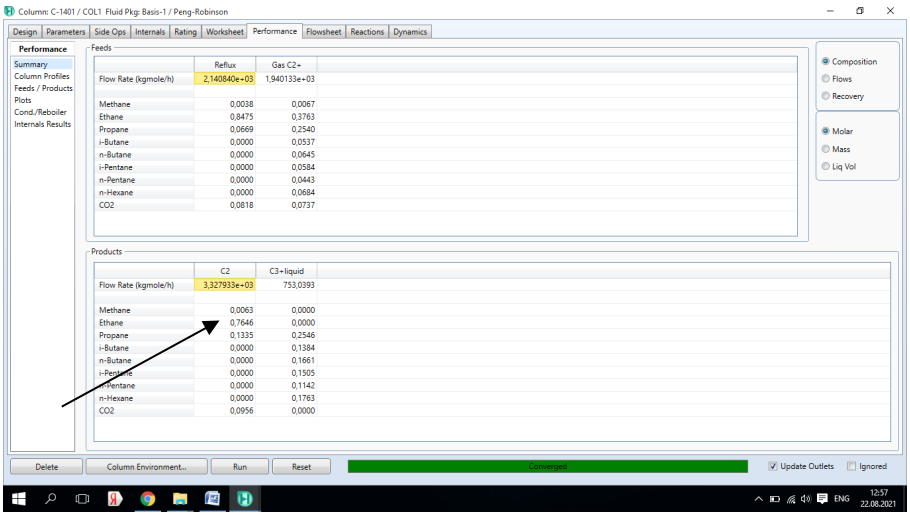

Fig. 11. Viewing Calculation Results.

5 Conclusions

In this article, a computer model of a deethanizer distillation column was developed in the Aspenhysys software environment (Figure 12). The article uses the Peng-Robinson equation to create a computer model of a deethanizer distillation column.

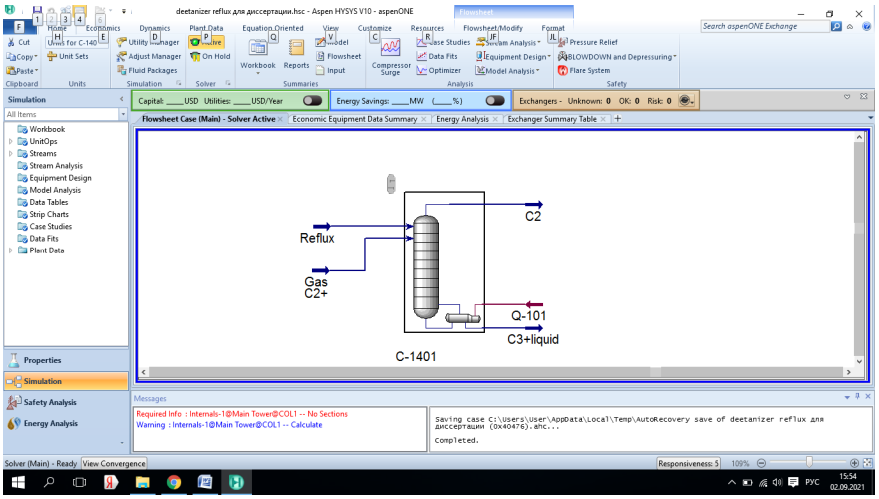

Fig. 12. Computer model of the Deethanizer.

References

1. D.A. Krasnoborodko, R.Yu. Kulishenko, V.A. Kholodnov, Modeling of extractive distillation using the information modeling program aspen hysys (2018)
2. O.A. Kuznetsov, Fundamentals of work in the aspen hysys program (2015)
3. O.A. Kuznetsov, Getting started in aspen hysys **8**, 68 (2015)
4. O.A. Kuznetsov, Modeling of natural gas processing scheme in aspen hysys **8**, 116 (2015)
5. J.A. Aytbaev, Scientific journal Universum **1(3)**, 45-5 (2023)
6. G. Plancque, D. You, E. Blanchard, V. Mertens, C. Lamouroux, *Role of chemistry in the phenomena occurring in nuclear power plants circuits*, Proceedings of the International Congress on Advances in Nuclear power Plants, ICAPP, 2-5 May 2011, Nice, France (2011)