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Integration Processes of Benzene-toluene-xylene Fractionation, Hydrogenation, Hydrodesulphurization and Hydrothermoprocessing on Installation of Benzene Unit

Petro O. Kapustenko[a], Leonid M. Ulyev*[b], Mariia V. Ilchenko[b], Olga P. Arsenyeva[a]

[a] AO SPIVDRUZHNIST-T LLC, Krasnoznamenny per. 2, off. 19, 61002, Kharkiv, Ukraine
[b] National Technical University "Kharkiv Polytechnic Institute", 21 Frunze Str., 61002, Kharkiv, Ukraine
leonid.ulyev@gmail.com

Refinery processes are one of the key components of modern industry, but at the same time they are the most power-consuming. The global rising world demand in energy for oil and petrochemical industries requires the energy efficient plant designs with the retrofitting of the existing HENs and application of effective equipment. In the present work the enterprise OOO "Sibur-Kstovo" (Nizhny Novgorod, Russian Federation) is under consideration. The work observes four inter-connected units of petrochemical plant: benzene-toluene-xylene fractionation unit, hydrogenation unit, hydrodesulphurization unit and hydrothermoprocessing unit. Using Process Integration it is possible to integrate their HEN to the common network to provide the less energy consumption of these units.
The basic parameters of technological processes in the observed technological streams, which take part in the integration process, have been determined and the stream table of the process was obtained according to Pinch Analysis methodology. The analyses of the obtained data showed that the heat recovery of existing process equals to 2,930.90 kW if to consider all the heat exchangers involved in the flowchart of the processes for all four units. Such high power consumption needs Process Integration and more energy recuperation between the process streams. The proposed retrofit project has the recuperation load of 10,250 kW, the minimum cold utilities are 826.96 kW, and minimum hot utilities are 3,175 kW, what comparing with the existing process shows the significant increase of the recuperation heat and decrease of the heat loads. For the flowsheet retrofit according to the achieved targeted loads the HEN structural changes were carried out for several possible solutions according to the principles of Pinch Analysis. The most energy and cost effective alternative was obtained and its Grid Diagram was constructed. It corresponds the integration of four units of benzene production plant with the targeted minimum temperature difference is 16 °C, the Hot Pinch for the process is equal to 36 °C and Cold Pinch is 20 °C. The proposed retrofit needs 5 coolers and 5 heaters to provide the heat supply. For this process 15 heat exchangers are required. As all the used heat exchangers are of shell-and-tube type, it was proposed as much as possible to use the existing heat transfer capacities. The obtained retrofit project needs totally 1,170 m^2 of heat transfer surface area, from which 296 m^2 is needed additionally to increase the existing heat transfer surface area. For the case the shell-and-tube units were under consideration.
The proposed retrofit allows reducing the power consumption by 7.3 MW. The hot utilities needed to the process operation are reduced by 69.94 % and cold utilities are 89.84 % less. The proposed retrofit of plant HEN applies the existing heat transfer equipment, and the additional heat transfer surface area comes to 296 m^2. The calculated annual income from the project implementation is 1.56×10^6 USD and the expected payback period is about 6 months.

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