

**STUDY OF THE PROCESS OF OBTAINING A CATALYST FOR THE
SYNTHESIS OF BENZENE BASED ON ETHYLENE FOR THE PRODUCTION
OF CYCLOHEXANE**

*O.A. Salikhova, S.G. Shodmonova, *O.Sh. Kodirov, **M.S. Sharipov*

Tashkent Institute of Chemical Technology

email: oybekstudent12@gmail.com

Tashkent Institute of Chemical Technology

**National University of Uzbekistan named after Mirzo Ulugbek*

***Bukhara State University*

ABSTRACT.

Products of petrochemical industries are necessary for every modern person, thousands of enterprises in various industries. A result of the distillation of crude oil, cyclohexane ended up in naphtha, it was sent to catalytic reformers, where it was processed into benzene. Based on the results obtained in the laboratory for the synthesis of cyclohexane using ethylene, tests were carried out in the central laboratories Shurtan gas chemical complex. When analyzing the resulting product using gas chromatography, it was found that about 17.5% cyclohexane was formed. The technical parameters of the products (butadiene-1,3 and cyclohexane), synthesized by the staff of the National University of Uzbekistan and the Central Laboratory of the Shurtan Gas Chemical Complex, give approximate properties to imported cyclohexane at the JSC of the Shurtan Gas Chemical Complex.

KEYWORDS: *Benzene, ethylene, cyclohexane, oil, catalyst, reaction of Dils-Alder.*

Products of petrochemical industries are necessary for every modern person, thousands of enterprises in various industries. These are varnishes, paints, solvents, polymers, detergents and cosmetics, medicines and much more. Interest in cyclohexane arose in 1938 in connection with the development of nylon by DuPont, which proposed the use of cyclohexane as the preferred raw material. After World War II, nylon production increased by 100% per year for some time, so that the cyclohexane contained in crude oil soon became insufficient. The standard crude oil that was supplied to US refineries at the time contained 1% cyclohexane. Moreover, since as a result of the distillation of crude oil, cyclohexane ended up in naphtha, it was sent to catalytic reformers, where it was processed into benzene. And subsequently, while many other substances were also converted to benzene by catalytic reforming, benzene became a good source of cyclohexane.

Cyclohexane (C₆H₁₂) is a cycle of six carbon atoms, each has 2 hydrogen atoms. It is similar to benzene, but it does not have double bonds. It is a colorless, water-insoluble and non-corrosive liquid with a pungent odor. It is combustible, like any product derived from

oil; it is transported in tanks, tank trucks, barges and metal drums, which must have a red mark adopted for flammable liquids. The industry produces technical grade cyclohexane (purity 95% or 99%) and solvent cyclohexane (purity not less than 85%).

Cyclohexane is also used in the Shurtan gas chemical complex as a solvent for the production of various grades of polyethylene. The polymerization catalysts are dissolved in pure cyclohexane and the ethylene polymerization process is carried out; after the process is completed, the cyclohexane is recovered by distillation and returned to the process

Based on the results obtained in the laboratory for the synthesis of cyclohexane using ethylene, tests were carried out in the central laboratories Shurtan gas chemical complex. Under these conditions, several methods have been tried for the synthesis of ethylene-based cyclohexane.

Ethylene dimerizes to form butene-1. Triethylaluminum is used as a catalyst. The product formed in the process is rectified, and unreacted ethylene is returned to the original synthesis process. The cis-, trans-butene-2 and butadiene-1,3 formed in this process are also separated by distillation. Purified butene-1, cis-, trans-butene-2 is subjected to dehydrogenation to obtain butadiene-1,3. The catalyst is chromium (III) oxide; activated and acid-modified Navbakhor bentonite is used as a carrier. The resulting product is purified from butadiene-1,3, but unreacted butenes are returned to the process. Cyclohexene is obtained by a 4+2 cyclocoupling reaction (Diels-Alder reaction) based on 1,3-butadiene and ethylene obtained by distillation. The catalyst is aluminum chloride and aluminum oxide is used as a carrier. The product is purified by distillation, the resulting mixture of cyclohexane, cyclohexadiene and benzene is hydrogenated on a nickel catalyst to obtain cyclohexane. Hydrogen is used for hydrogenation formed during the synthesis of butadiene-1,3.

In the process of synthesis of butene-1 in the Shurtan gas-chemical complex, a mixture of various hydrocarbons is released as a secondary product. This mixture contains 38.0 - 42.0% butadiene-1,3. This by-product is currently sold as a low quality fuel. Butadiene-1,3 was isolated from this mixture by rectification. The resulting product is sent for the synthesis of cyclohexane, as in the first method.

Benzene is synthesized from ethylene. At the same time, activated and acid-modified Navbakhor bentonite was used as a carrier, and chromium oxide (III) was used as a catalyst. From the mixture, benzene is purified by distillation-extraction (the extractant is dimethyl sulfoxide) and rectification. Next, hydrogenation of benzene is carried out, as in the first method, and cyclohexane is obtained.

According to the first proposed method, gaseous products obtained during the synthesis of butene-1 based on ethylene on a granular catalyst impregnated with bentonite, chromium (III) oxide at atmospheric pressure at a temperature of 550–600°C, the catalyzate was reanalyzed by gas chromatography with a yield of 8.74 mol. % butadiene-1,3. The resulting product is separated by distillation with cooling, and the remaining gas mixture is returned to the synthesis.

Table 1

Data File C:\HPCHEM\1\DATA\151221\SIG10004.D

Sample Name: Exsprement-5

Exsprement 5 Time:11:30. Data:15.12.2021

```

=====
Injection Date   : 15.12.21 16:03:03
Sample Name     : Exsprement-5
Acq. Operator   : Eshonqulov G
Vial            : 1
Inj             : 1
Inj Volume     : Manually

Acq. Method     : C:\HPCHEM\1\METHODS\DEF_UPC4.M
Last changed    : 15.12.21 16:35:46 by Eshonqulov G
                  (modified after loading)
Analysis Method : C:\HPCHEM\1\METHODS\DEF_UPC4.M
Last changed    : 22.12.21 14:57:45 by Niyazov SH
                  (modified after loading)
=====

```

Area Percent Report

```

=====
Sorted By      : Retention Time
Calib. Data Modified : 22.12.21 14:53:39
Multiplier    : 1.0000
Dilution      : 1.0000
=====

```

Signal 1: FID1 A,

Peak #	RetTime [min]	Sig	Type	Area [pA*s]	Area %	Name
1	3.090	1		0.00000	0.00000	propane
2	3.532	1		0.00000	0.00000	iso-butane
3	3.636	1		0.00000	0.00000	n-butane
4	4.400	1		0.00000	0.00000	neo-pentane
5	4.440	1		0.00000	0.00000	iso-pentane
6	4.720	1		0.00000	0.00000	Acetone
7	4.819	1		0.00000	0.00000	n-pentane
8	5.024	1	PB	12.67662	0.00138	?
9	5.523	1		0.00000	0.00000	2,2-dimethyl butane
10	6.479	1		0.00000	0.00000	2,3-dimethyl butane
11	6.749	1	PV	40.56224	0.00442	?
12	6.917	1	VB	8.63659	0.00094	2-methyl pentane
13	7.170	1		0.00000	0.00000	3-methyl pentane
14	7.199	1		0.00000	0.00000	MEK
15	8.043	1	PB	33.92939	0.00369	n-hexane
16	8.400	1		0.00000	0.00000	ic7
17	8.637	1		0.00000	0.00000	ic7
18	8.854	1		0.00000	0.00000	ic7
19	9.148	1	PB	120.69862	0.01314	?
20	10.812	1		0.00000	0.00000	ic7
21	10.920	1		0.00000	0.00000	ic7
22	11.012	1		0.00000	0.00000	ic7
23	11.064	1	BV	6.81054e5	74.13089	benzene
24	11.277	1		0.00000	0.00000	ic7
25	11.343	1	VV	2.36650e5	25.75864	cyclohexane
26	11.393	1	VV	8.41990	0.00092	ic7
27	11.537	1	VB	34.23016	0.00373	ic7
28	11.757	1	BV	13.83569	0.00151	?
29	11.854	1	VV	13.48413	0.00147	?
30	11.948	1	VB	11.55218	0.00126	n-heptane
31	12.387	1	BB	12.04707	0.00131	?
32	12.877	1		0.00000	0.00000	methyl cyclohexane
33	12.900	1		0.00000	0.00000	ic8
34	12.947	1		0.00000	0.00000	ic8
35	13.256	1	BB	218.41940	0.02377	ic8
36	13.727	1	BB	17.44350	0.00190	ic8

GC-3 22.12.21 14:57:46 Niyazov SH

Page 1 of 2

Table 2

Data File C:\HPCHEM\1\DATA\091221\SIG10004.D

Eksperiment Butadiyen-1,3 Tim:16:24. Data:09.12.20
21

```

=====
Injection Date : 09.12.21 17:29:09
Sample Name :
Acq. Operator : Islomberdiev S
Method : C:\HPCHEM\1\METHODS\S1401MOL.M
Last changed : 09.12.21 18:18:42 by Islomberdiev S
              (modified after loading)
Vial : 1
Inj : 1
Inj Volume : Manually
=====

```

Normalized Percent Report

```

=====
Sorted By : Retention Time
Calib. Data Modified : 09.12.21 18:18:40
Multiplier : 1.0000
Dilution : 1.0000
=====

```

Signal 1: FID1 A,

RetTime [min]	Sig	Type	Area [pA*s]	Amt/Area	Norm %	Grp	Name
3.296	1	VV	396.49097	4.10703e-3	1.834888		Methane
3.376	1	VV	220.24570	2.16148e-3	0.536423		Ethylene
3.425	1	VV	102.88946	2.13306e-3	0.247299		Ethane
3.780	1	VV	849.08209	1.60514e-3	1.535715		Propylene
3.825	1	VV	47.05563	1.47295e-3	0.078100		Propane
4.074	1	VV	7.05199	1.38672e-3	0.011019		MethylAcetylene
4.100	1	VV	3.14275	1.62506e-3	0.005755		Propadiene
4.531	1	VV	2.89980	1.24835e-3	0.004079		iso Butane
5.083	1	VV S	2.37978e4	1.29791e-3	34.804184		1 Butene
5.168	1	VV S	4334.66260	1.78841e-3	8.735163		1,3-Butadiene
5.301	1	BB X	190.83209	1.12591e-3	0.242105		N-Butane
5.602	1	VV S	1.92096e4	1.22523e-3	26.520774		Tr-2-Butene
6.050	1	VV S	1.70335e4	1.18163e-3	22.679507		Cis 2-Butene
6.500	1						isobutylen
22.123	1	MM	2666.46216	9.20260e-4	2.764991		C5+

Totals : 100.000000

Results obtained with enhanced integrator!
2 Warnings or Errors :

Warning : Calibration warnings (see calibration table listing)
Warning : Calibrated compound(s) not found

```

=====
*** End of Report ***
=====

```

By passing a mixture of purified 1,3-butadiene and ethylene through a catalyst prepared by impregnating aluminum chloride into activated alumina at a temperature of 500-600°C. The product obtained by the Diels-Alder reaction at a temperature of 280-300°C, hydrogenation with hydrogen at a pressure of 2.0-3 MPa. When analyzing the resulting product using gas chromatography, it was found that about 17.5% cyclohexane was formed. Chromatographic analysis of the product of hydrogenation of pure benzene on a nickel catalyst at a pressure of 2.0-3.0 MPa at 250-280°C gives 25.76 mol.% of the product. The results of

the analysis are presented in the following tables (Tables 1 and 2).

The technical parameters of the products (butadiene-1,3 and cyclohexane), synthesized by the staff of the National University of Uzbekistan and the Central Laboratory of the Shurtan Gas Chemical Complex, give approximate properties to imported cyclohexane at the JSC of the Shurtan Gas Chemical Complex. Only for further optimization of this synthesis process, it is necessary to continue joint research to equate its technical parameters with imported cyclohexane.

Literature:

1. Averko-Antonovich L.A. Chemistry and technology of synthetic rubber. - M.: Chemistry, Kolos, 2008. - 357 p.
2. Zhuravleva K.A. Obtaining styrene by dehydrogenation of ethylbenzene / K.A. Zhuravleva, A.A. Nazarov // Bulletin of the Kazan Technological University. - 2012. - V. 15 No. 12. - p. 149-152.
3. Kozienko A.I. Fundamentals of petrochemical synthesis: textbook. allowance / A. I. Kozienko, T. A., Podgorbunskaya, D. V. Gendin. - Irkutsk: Publishing House of ISTU, 2007. - 60 p.
4. Osipov E.V. Reconstruction of vacuum-creating systems of the department for processing waste products from the production of phenolacetone / E.V. Osipov, S.I. Ponikarov, E.Sh. Telyakov, K.S. Sadykov // Bulletin of the Kazan Technological University. No. 18. – 2011.- p. 47-52.
5. Timofeev V.S. Principles of technology of basic organic and petrochemical synthesis: Textbook for universities / V.S. Timofeev, L.A. Seraphim. - 2nd ed., revised. - M.: Higher. school, 2003. - 536 p.
6. Khakimullin R.R. Obtaining isoprene by dehydrogenation of isopentane and isoamylene / R.R. Khakimullin, A.A. Nazarov, S.A. Vilokhin // Bulletin of the Kazan Technological University. - 2012. - V. 15 No. 16. - p. 154-156.