As you can see, we get a series in which all the powers at present, therefore, we can apply the formula (3) and (4), which greatly simplifies the calculation of radius of convergence.

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RESEARCH OF THE ALKYLATION PROCESS OF PHENOL BY TETRAMERS OF PROPYLENE ON ION-EXCHANGE SMOLS

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The article is described the regularity of phenol alkylation process by tetramers of propylene by ion exchange catalyst. This process possesses a current interest in manufacturing of phenol engine additive. Reaction's conversion and selectivity were estimated in different circumstances.

Currently in the process of synthesis of alkyl phenol by phenol alkylation of propylene tetramers used ion exchange the catalyst has a high sensitivity to moisture, even at 3 wt% water using it ineffective until the maximum permissible temperature of operation. Given that the maximum operating temperature sulphocationite TULSJON T-66 is 403 ° K (130 ° C), its application requires the provision of special technological conditions on the content of moisture in the system / 1 /.

Basic physical and chemical properties of the samples of ion exchange resins in passport supplier are shown in Table 1.

Table 1–Basic physical and chemical properties of the samples

Catalyst	Bulk density	Specific surface area, m2 / g	Pore diameter, A	Total capacity, eq / kg	Maximum operating temperature, ° C
Catalyst 1	610	53	300	4,7	120
Catalyst 2	560	50	300	5,0	150
Catalyst 3	770	33	240	5,4	150
Catalyst 4	500	35	450 – 500	4,9	130
Catalyst5	540 – 580	45 – 60	120 – 300	4,7	–

Synthesis alkylphenol based catalysts investigated

Alkylphenol synthesized by apkilirovaniya phenol tetramers of propylene catalyst cation exchange (ion exchange resins) . Temperature range study agreed with the industry and is 130-150 ° C. Diffusion inhibition removable stirrer at a speed above 300 rev / min , and the reaction takes place in the kinetic mode / 1 / . In the studies of the impeller shaft speed was maintained at 350 rev / min.

Study phenol alkylation tetramers of propylene was carried out in a three necked reaction flask using a reflux condenser for condensing the vapor; the reaction temperature was recorded with a laboratory thermometer ; intensive stirring of the reaction mixture was carried out using a laboratory stirrer throughout the alkylation process . The first component introduced into the reaction mixture was phenol. After introduction of the catalyst was filled in phenol required mass quantity by weight of the mixture. The heated mixture was stirred for one hour to prepare the catalyst and swelling ; propylene tetramers further injected into the reaction mixture . Duration of the experiment was 180 min. The ratio of phenol: alkene depending on a series of experiments were on the level:

- 2:1 mol / mol, and a catalyst loading of 20% (wt.) relative to the weight of the reaction mixture - lot 1 ;
- 4:1 mol / mol and a catalyst loading of 20% (wt.) relative to the weight of the reaction mixture - two series ;
- 4:1 mol / mol and a catalyst loading of 10% (wt.) relative to the weight of the reaction mixture - 3 series ;
- 6:1 mol / mol and a catalyst loading of 10% (wt.) relative to the weight of the reaction mixture - 4 series .

Reference points were selected the following indicators:

1) concentration monoapkilfenolov ;

2) the concentration dialkylphenols ;

3) Conversion of propylene tetramer .

As a result, the alkylation of phenol tetramers of propylene to be achieved the highest conversion of alkenes with the highest yield and the lowest yield monoapkilfenolov dialkylphenols . The basic method of analysis is the gas-liquid chromatography / 2 /.

The analysis of the alkylation products Composition of the reaction mass obtained are shown in Tables 2-3.

Table 2 – Results of the chromatographic analysis of phenols in a molar ratio of phenol: propylene tetramers a 2:1 mol / mol and a catalyst loading of 20% (wt.) relative to the weight of the reaction mixture.

The type of the alkylphenol	Content of propylene tetramer	The content of free phenol	Contents of monoalkilpheno l	Contents of dialkilphenol
Catalyst 1	4,59	7,96	70,98	16,47
Catalyst 2	5,88	8,21	71,98	13,93
Catalyst 3	6,01	7,52	73,01	13,45
Catalyst 4	7,31	7,74	68,91	16,05
Catalyst 5	14,43	10,21	69,88	5,48

Table 3 – Results of the chromatographic analysis of an alkylphenol with a molar ratio of phenol: propylene tetramers ratio of 4:1 mol / mol and a catalyst loading of 20% (wt.) relative to the weight of the reaction mixture

The type of the alkylphenol	Content of propylene	The content of free phenol	Contents of monoalkilphenol	Contents of dialkilphenol
Catalyst 1	3,62	25,78	62,63	7,97
Catalyst 2	3,36	28,70	63,91	4,03
Catalyst 3	2,27	27,59	65,71	4,43
Catalyst 4	2,26	22,92	69,56	5,25
Catalyst 5	3,11	28,38	63,81	4,70

According to the results of chromatographic analysis of Table 2 it can be concluded that a molar ratio of phenol: propylene tetramers a 2:1 mol / mol and a catalyst loading of 20% (wt.) relative to the weight of the reaction mixture of propylene tetramer maximum conversion is achieved using catalyst 1, the highest yield of monoalkilfenolov - using sulfonic catalyst 2, the smallest output dialkylphenols - using sulfonic catalyst 3; however, use of catalyst 4 leads to the highest level with the lowest output dialkylphenols conversion of propylene tetramer applying sulfonic catalyst 5 leads to the lower conversion of propylene teramerov ; overall yields alkylphenol fractions and the degree of conversion of alkenes are approximately at the same level for the remaining three catalysts.

According to the results of chromatographic analysis of Table 3 it can be concluded that the molar ratio of phenol: propylene tetramers ratio of 4:1 mol / mol and a catalyst loading of 20% (wt.) relative to the weight of the reaction mixture of propylene tetramer maximum conversion is achieved using catalyst 1 , the highest yield of monoalkilfenolov - using catalyst 2, the smallest output dialkylphenols - using sulfonic catalyst 3; however, use of sulfonic catalyst 2 leads to the highest level of output with the lowest conversion dialkylphenols propylene tetramer . In further series of experiments catalyst 4 excluded from the study of cation exchange resins on the basis of 1 and 2 series of experiments.

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