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CLEANING NITROGEN OXIDES FROM NITROUS EXHAUST GASES USING TRIBUTYL PHOSPHATE SOLUTION

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Summary: *This paper presents the results of absorption of residual nitrous gases using a mixture of water and tributyl phosphate in step absorbers for its subsequent regeneration and production of nitric acid on its basis. The results of the study can find particularly wide application in industries characterized by non-constant emission of nitrogen oxides with a wide range of nitrogen oxide content. The dependence of the degree of absorption and regeneration on the temperature and ratio of the mixture of water and tributyl phosphate is determined.*

Key words: *absorber, nitrous gases, tributyl phosphate, nitrogen oxides, nitric acid, ecology, purification of nitrous gases.*

The paper [1] presents the results of studies of the levels of environmental and public health risks from exposure to various pollutants, such as suspended solids, sulfur dioxide, nitrogen dioxide and oxide, carbon monoxide, and copper. It is shown that all registered pollutants are harmful to the human body, causing damage to the respiratory system, skin, nervous system, eyes, and metabolic disorders. Thus, suspended solids, nitrogen dioxide, and benzopyrene have the greatest impact on endocrine system diseases, eating disorders, and metabolic disorders. Respiratory diseases are affected by sulfur dioxide and nitrogen dioxide, carbon monoxide and nitrogen, and benzopyrene. Diseases of the eye and its adnexa are affected by sulfur dioxide, carbon monoxide, and phenol. Diseases of the nervous system, skin, and subcutaneous tissue diseases are affected by carbon monoxide, nitrogen oxide and dioxide, formaldehyde, and benzopyrene. Recent literature data indicate that the amount of sulfur dioxide, nitrogen dioxide and oxide, carbon monoxide, suspended solids, and copper is increasing. This will lead to adverse effects on both the soil and the human body. The effect of these substances also leads to a change in the pH of atmospheric precipitation (3-15) and, as a result, can affect both the soil and the human body.

$$SO_2 + H_2O \rightarrow H_2SO^-_3 + H^+ \qquad (1)$$
$$CO + H_2O \rightarrow H_2 + CO_2 \qquad (2)$$
$$CO + H_2O \rightarrow H^+ + COOH^- \qquad (3)$$
$$CO + H_2O \rightarrow H^+ + HCO_2^- \qquad (4)$$
$$CO + H_2O \rightarrow O_2 + CH_4 \qquad (5)$$
$$CO + H_2O \rightarrow O_2 + CH_4 \qquad (6)$$
$$CO + H_2O \rightarrow H_2 + CO_2 \qquad (7)$$
$$CO_2 + H_2O \rightarrow H^+ + HCO_3^- \qquad (8)$$
$$NO + H_2O \rightarrow H^+ + HNO_2^- \qquad (9)$$
$$NO + H_2O \rightarrow H_2 + NO_2 \qquad (10)$$
$$3NO_2 + H_2O \rightarrow 2HNO_3 + NO \qquad (11)$$
$$2NO_2 + H_2O \rightarrow HNO_3 + HNO_2 \qquad (12)$$

In the work [2] in order to determine the optimal conditions for the effective absorption of nitrogen and sulfur oxides, the characteristics of ferromanganese nodules, in which the active component is manganese (IV) oxide MnO_2, are considered. This method includes reactions of absorption of nitrogen (II) oxide by manganese (IV) oxide MnO_2 in the presence of nitric acid HNO_3 with the formation of manganese nitrate $Mn(NO_3)_2$; also reactions of absorption of sulfur (IV) oxide SO_2 by manganese (IV) oxide MnO_2 with the formation of manganese sulfate $MnSO_4$. Special installations for the study and development of the sorption process have been developed. The results of experimental studies of the sorption process of nitrogen (II) oxide NO and sulfur (IV) oxide SO_2 by a suspension based on ferromanganese nodules are presented. The possibility of absorption of nitrogen oxide (II) NO from a gas mixture with the degree of extraction up to 85%, sulfur oxide (IV) SO_2 from the corresponding gas mixture up to 99% has been established. The main parameters of influence on the system operation process are specified: time of reaching a constant mode, temperature of the working suspension, mixing method. The most optimal conditions for the most efficient implementation of the process of absorption of nitrogen oxide NO and sulfur oxide SO_2 up to 85% and 99%, respectively, from model mixtures corresponding to exhaust gases are given.

In the work [3] the possibilities of the technology of non-catalytic reduction of nitrogen oxides to reduce the formation of secondary pollutants: ammonia, carbon monoxide and nitrogen oxide (I) are considered. The conditions for the process of nitrogen oxide reduction by products of thermal decomposition of urea with minimal formation of the above pollutants are determined.

The possibility of reducing the release of nitrogen oxides into the gas phase during coal oxidation with nitric acid by introducing urea into the process has been studied. A thermodynamic analysis of the reactions occurring during coal oxidation with nitric acid and in the presence of urea has been performed. It has been shown that when 0.2 parts by weight of urea are added to one part by weight of coal, the content of nitrogen oxides in the gas phase decreases by 95.54%. The possibility of capturing nitrogen oxides with aqueous solutions of nitric acid has been tested. It has been shown that the lower the concentration of nitric acid and the lower its temperature, the more completely nitrogen oxides are captured from the gas phase [4-6].

It should be noted that the chemical industry makes a significant contribution to the development progress of many countries in the world. One of the serious problems of the industry is nitrogen oxide emissions. The maximum permissible average daily content of nitrogen oxides calculated as N_2O_5 in the atmospheric air of populated areas should not exceed 0.1 mg/m^3 while simultaneously complying with the requirement for a one-time maximum content of nitrogen oxides of no more than 0.3 mg/m^3. In the production of nitric acid, the main problem is emissions of nitrous gases. There are various methods for neutralizing nitrous gases: purification of gases from nitrogen oxides in an equal-flow hollow tower; purification of gases from nitrogen oxides in combined-type devices; purification of gases from weakly oxidized nitrogen oxides, absorption of nitrogen oxide with ammonium sulfite solutions; oxidation and absorption of nitrogen oxides with aqueous solutions of oxidizers; purification of gases from nitrogen oxides with aqueous solutions of hydrogen peroxide; absorption of weakly oxidized nitrogen oxides with aqueous solutions of potassium permanganate; absorption of highly oxidized nitrogen oxides; absorption of nitrogen oxides with organic sorbents; adsorption of nitrogen oxides with solid sorbents; purification of gases from nitrogen oxides and other impurities with peat-alkaline sorbents with the production of peat-nitrogen fertilizers; absorption of nitrogen oxide with solutions of ferrous sulfate of tributyl phosphate (TBP) used as an absorber. The application of TBP for the purification of nitrogen oxides is its high absorption capacity and absorption rate, desorption occurs quite easily when the pressure is reduced or heated to 369-378 K. With repeated use of TBP, the absorption rate does not decrease. It has been established that the absorption of nitrogen oxides by TBP is accompanied by the formation of solvates TBP NO_2 or 2(TBP) N_2O_4 and the physical dissolution of NO_2 when dissolved above stoichiometric. With a decrease in gas oxidation, the overall solubility of nitrogen oxides increases due to the absorption of N_2O_3.

The effect of pressure on the absorption process was studied with the following change in physicochemical and hydrodynamic parameters: pressure - 0.35-1.0 MPa, nitrogen oxide concentration - 0.04 - 5.8 vol.%, oxidation degree - 30-95%, acidity - up to 15 wt. %, liquid overflow height on the tray - 0.035-0.1 m, real linear gas velocity (W) in the absorber - 0.25-0.6 m/s, irrigation density - 0.85-5.1 m^3/m^2h, temperature - 293-319 K. It is shown that the absorption rate increases linearly with increasing concentration and oxidation of nitrogen oxides at all studied pressures due to an increase in the driving force of the process with a change in the concentration of nitrogen oxides from 0.2 to 5.8% [7-15].

There is a method for absorbing nitrous gases with nitric acid condensate fed from a refrigerator to the middle part of an absorption column. The absorption is carried out with an additional supply of nitric acid taken from the column baffle plate, regenerated from unreacted nitrogen oxides and diluted to a concentration of 5-10%, in two streams, one of which is directed to the first plate from above in an amount of 1.0-2.0 kg of liquid/kg of gas, and on the other side in an amount of 0.09-0.12 kg of liquid/kg of gas under the baffle plate, and regeneration is carried out by feeding air into the regenerator in an amount of 0.04-0.1 kg of gas/kg of liquid [16].

There is a method for the complete capture of nitrogen oxides from the tail nitrous gases of nitric acid plants. The method consists of absorbing nitrous gases with lead hydroxide and then regenerating it according to the following scheme: Nitrogen oxides are passed through a scrubber irrigated with a suspension of lead hydroxide in a saturated solution of nitrite and sodium nitrite; the resulting basic nitrite and lead nitrate are separated from the mother liquor and treated with nitric acid to convert nitrite into nitrate. The nitrogen oxides released in this process are used to saturate the product nitric acid. After separating the crystals, the mother liquor is mixed with lead hydroxide and fed back into the process; The resulting lead nitrate solution, containing some of the nitrate in the form of crystals, is treated with ammonium nitrate solution to dissolve the crystals and then with ammonia to convert the lead nitrate to ammonium nitrate. The released lead hydroxide is separated from the liquid and, after washing with water, returned to the process. The remaining liquid is a saturated solution of ammonium nitrate and is sent for evaporation [17].

There is a method [18] according to which the obtained solutions of nitrates and nitrites formed after the absorption of nitrous gases are treated with nitric acid in order to oxidize nitrites into nitrates, and the nitrogen oxides released in this process are used in the sulfuric acid system. Nitrogen oxides in the form of various oxides are captured from the tail gases with a soda or alkaline solution until the content in them is no more than 0.06% NO, after which the gases are released into the atmosphere. The solutions obtained after alkaline absorption, which are a mixture of nitrite (80%) and sodium nitrate (20%), containing an admixture of sodium sulfate, are sent to inversion located in the head of the system, where they are converted into solutions of sodium nitrate, released after evaporation, as finished nitrogen fertilizer. In this case, 15-25 kg of sodium nitrate are obtained per ton of sulfuric acid. Losses of nitric acid with exhaust gases are no more than 5 g per 1 ton of sulfuric acid. Fresh nitric acid is used for inversion, the system is fed by nitrogen oxides released after inversion. This will allow inversion to be carried out almost without costs.

In progress [19] sulfocarbon obtained from wood as a sorbent, which allows to obtain a high-quality sorbent, amenable to restoration and replacing calcium or magnesium cations with sodium or hydrogen ions in solutions. The production of sulfocarbon from wood sawdust and its application is as follows. Wood sawdust, released to 8-10% moisture content and freed from impurities, is loaded into a reactor, where it is treated with concentrated sulfuric acid (specific gravity 1.84) at a ratio of 7-7.5 weight parts of acid to one part of sawdust (4 liters of acid per 1 kg of sawdust). The mixture is stirred for an hour, and then the resulting sulfocarbon is washed from the acid. Further processing is carried out depending on the application: with a one-percent solution of H_2SO_4 or a ten-percent solution of NaCl. If the sorbent is to be stored or transported, it should be dried. The use of sulfocarbon obtained from sawdust can be done either by filtering solutions through it or by mixing it with solutions by heating and filtering through filter presses. The dosage of sulfocarbon depends on the content of the salts to be removed, the consistency and color of the solutions. Sulfocarbon is regenerated with a one percent solution of ammonium sulfate or a ten percent solution of NaCl.

In the work [20] the influence of temperature on the degree of purification of exhaust gases from nitrogen oxide and nitrogen dioxide by a urea solution was studied. It was shown that with an increase in temperature the degree of purification increases. The degree of conversion of nitrogen dioxide in the temperature range of 30–80°C is 90–98%, while the conversion of nitrogen oxide is from 13 to 58%. It was found that the addition of an oxidizer, nitric acid, up to 10% to a urea solution increases the degree of conversion of nitrogen oxide by 15–20%. The addition of oxygen increases the conversion of nitrogen oxide into nitrogen by 40%. The influence of the content of active components of the reaction mixture on the degree of conversion of nitrogen oxides in the exhaust gases was studied. The optimal composition of the reaction mixture was selected: 10–20% urea; 5–10% nitric acid. It has been shown that the optimal conditions for the conversion of nitrogen oxide and dioxide are: solution temperature of 30–35°C; urea solution consumption for purification of no more than 4 m^3/h; oxygen content in the gas for purification of at least 7%; the number of revolutions of the rotor apparatus blades of no more than 1500 rpm. It has been shown that at a urea solution temperature of 30–35°C, a urea solution consumption of 4 $m^{3/}h$, and a number of revolutions of the rotor apparatus blades of 1500 rpm, the degree of purification from nitrogen oxides of 98–100% is achieved, which is much higher than when using a sodium hydroxide solution.

In progress [21] It is given that the production of oxalic acid is based on the interaction of nitric acid with sucrose. As a result of this process, up to 200 kg of nitrogen oxides are emitted into the atmosphere per ton of the resulting product. This leads to excessive gas pollution of the atmosphere and deterioration of sanitary and hygienic working conditions in production. Based on theoretical and experimental studies, a new method of thermal decomposition of nitrogen oxides has been developed, providing sanitary cleaning of exhaust gases during the production of oxalic acid to maximum permissible concentrations. During the study on a plasma torch, it was found that by thermal decomposition of nitrogen oxides, their concentration from any to the initial can be reduced to equilibrium at a given temperature. By introducing gaseous reducing agents, the reaction of thermal decomposition of nitrogen oxides can be shifted towards their decomposition into the original elements. The concentration of nitrogen oxides after decomposition can be brought to 0.1-0.3% with an initial concentration of 2-3%. Thermal decomposition of nitrogen oxides in the presence of coke begins at a temperature of 500°C. At 1000°C, the degree of decomposition of nitrous gas approaches 100%, this problem has not yet found its comprehensive solution. A detailed study and analysis of the methods of absorption of nitrogen oxides by water is a chemisorption process that leads to the formation of a multicomponent system containing the initial NO, N_2O_4, NO_2, N_2O_3 and the final products H_3O^+, NO_3^-, NO_2- consists of the following stages: diffusion of nitrogen oxides (NO, NO_2) from the gas phase into the liquid through a two-layer film at the gas-liquid boundary; formation of nitric and nitrous acids as products of the interaction of nitrogen oxides with water; decomposition, or rather disproportionation of nitrous acid and the return of the resulting nitrogen oxide to the gas phase [22].

There is a technology for processing nitrogen oxides into nitric acid by absorption with water and aqueous solutions of nitric acid. However, when processing nitrous gases with a volume content of nitrogen oxides of less than 4%, water absorption is not very effective. In this case, the exhaust gases under industrial conditions contain nitrogen oxides after absorption in quantities (0.1-0.3 vol.%) significantly exceeding the permissible content (0.005 vol.%). This reduces the degree of raw material utilization and requires the use of catalytic purification, which significantly increases the cost of production.

There is a technology which is implemented by catalytic oxidation of ammonia to produce nitrogen oxide, its oxidation to nitrogen dioxide with subsequent two-stage absorption of nitrous gases. At the first stage, nitrogen oxides are absorbed by water and aqueous solutions of nitric acid to a residual content of nitrogen oxides in the gas of 15-2 kPa. The remaining nitrogen oxides are absorbed by a solution containing nitric acid, water and TBP at the following ratio of components by weight%: nitric acid 2-5; water 1.6 TBP the rest with subsequent regeneration of the solvent with water by counter-current washing, feeding the aqueous phase to the acid absorption stage, and the regenerated absorbent for absorption of nitrogen oxides. The method ensures production of 58% acid and extraction of nitrogen oxides from gases to a residual content of 0.005 vol. %. of re-extraction of

HNO_3 in the form of weak solutions of HNO_3 is required. The potential of TBP as a more effective absorber compared to water is not fully utilized, since TBP is used only for the absorption of weak nitrous gases (up to 15 kPa), and at higher concentrations of nitrogen oxides, less effective water absorption is used.

There is a method for obtaining nitric acid, which includes absorption of nitrous gases by a heterogeneous mixture of nitric acid, water and tributyl phosphate, followed by isolation of the target product; absorption is carried out by a heterogeneous mixture of absorbents with a mass ratio of organic and aqueous phases (0.2 - 1.0): 1.0, and isolation of the target product is carried out by settling the resulting mixture with the return of the organic solution of nitric acid to the stage of absorption of nitrous gases.

The ratio of the organic and aqueous phases in the absorption column is selected within the range (0.2 - l): l in such a way that after mixing the nitric acid solution in TBP and the steam condensate in the column, the mass concentration of HNO_3 in the organic solution after their redistribution between the liquid phases is in the range of 2 - 15%. The specified range of acid concentrations in TBP and liquid phase ratios ensures the highest absorption rate. With an organic and aqueous phase ratio of less than 0.2 : 1, as a result of processing nitric acid between the phases, good regeneration of TBP is achieved, but its amount is so small that it does not ensure the required efficiency of the absorption process. With an organic and aqueous phase ratio of more than 1: 1 after mixing with the steam condensate, the concentration of nitric acid in TBP is more than 15% and such a mixture poorly absorbs weakly oxidized nitrous gases. According to the known method, the processing of nitrogen oxides into nitric acid includes three stages: absorption of concentrated nitrous gases with water to a residual content of NO, 2-15 kPa, extraction of nitric acid from TBP with water, absorption of the remaining nitrogen oxides with a mixture of water, nitric acid and TBP. The unit for processing nitrogen oxides according to the proposed method includes two main stages: absorption of nitrogen oxides by the mixture and settling to separate the liquid phases. According to this article, TBP can be considered not as an absorber, but as a catalyst for the absorption process, and not pure TBP is used as a catalyst, but a 28-30 % solution of nitric acid in TBP [23].

The purpose of this work is the absorption of residual nitrous gases and the production of nitric acid. To conduct the experiments, a laboratory setup was used, consisting of six reaction vessels, the first reactor for obtaining nitrogen oxides, five reactors - nitrogen oxide absorbers. In the first reactor, a mixture of nitrogen oxide is formed by the interaction of copper with non-concentrated nitric acid (59%). The remaining reactors absorb the incoming nitrogen oxide from the first reactor. To conduct the experiment, 80 ml of a mixture of TBP and water were placed in five reactors (absorber volume 100 ml). Nitrogen oxides obtained in the first reactor were passed through the solution using a water-jet pump. After the end of the experiment, all solutions were separately brought to the 100 ml mark, from which an aliquot was taken to determine nitrogen. In addition, the solution was regenerated and nitric acid was obtained. The total content of nitrogen oxides in the solutions was determined according to Kjeldahl with subtraction from the total nitrogen contained in the original nitric acid [24].

Table 1

The degree of absorption of nitrous gases in a mixture of water and tributyl phosphate depending on temperature and concentration

Water:TBP ratios	The degree of absorption of nitrous gases in absorbers, in terms of N %					General degree of penetration, %
	absorber No. 1	abs -r No. 2	abs -r No. 3	abs -r No. 4	abs -r No. 5	
Solution temperature, 35ºC						
1:0.1	36.20	26.64	13.75	5.94	1.97	84.50

1:0.2	37.14	26.05	13.98	6.09	1.98	85.24
1:0.4	38.60	26.41	14.28	6.26	2.02	87.57
1:0.6	39.08	26.48	14.31	6.28	2.04	88.26
1:0.8	39.25	26.50	14.33	6.30	2.05	88.43
1:1	39.37	26.57	14.36	6.33	2.07	88.70
1:1.2	39.43	26.61	14.38	6.34	2.19	88,87
Solution temperature, 30ºC						
1:0.1	37.86	27.90	13.94	5.98	1.99	87.67
1:0.2	38.63	28,24	14.11	6.09	2.00	89.07
1:0.4	39.20	28.82	14.36	6.30	2.02	90.70
1:0.6	39.28	28.98	14.40	6.32	2.04	91.02
1:0.8	39.29	29.02	14.42	6.34	2.06	91.13
1:1	39.37	29.59	14.48	6.36	2.08	91.88
1:1.2	39.45	29.69	14.51	6.38	2.10	92.13
Solution temperature, 25ºC						
1:0.1	39.94	28.88	13.99	6.03	2.01	90.85
1:0.2	40.76	30.07	14.67	6.11	2.02	93.63
1:0.4	40.95	30.86	15.39	6.31	2.02	95.53
1:0.6	40.99	30.97	15.60	6.35	2.04	95,95
1:0.8	41.08	31.10	15.85	6.36	2.06	96.45
1:1	41,13	31.17	16.06	6.37	2.09	96.82
1:1.2	41.17	31.23	16.10	6.39	2.10	96.99
Solution temperature, 20ºC						
1:0.1	40.95	29.93	15.08	6.09	2.03	94.08
1:0.2	41.89	31.76	15.34	6.17	2.03	97.19
1:0.4	42,51	32.14	15.59	6.35	2.05	98.64
1:0.6	42.60	32.20	15.69	6.39	2.06	98.94
1:0.8	42.65	32.26	15.86	6.40	2.07	99.24
1:1	42,66	32.27	16.06	6.31	2.08	99.38
1:1.2	42.69	32,31	16.12	6.38	2.11	99.68

Table 2

Dependence of the degree of regeneration on the ratio of water and tributyl phosphate and temperature

Indicators	Water to Tributyl Phosphate Ratios						
	1:0.1	1:0.2	1:0.4	1:0.6	1:0.8	1:1	1:1.2
Regeneration temperature, 75^0C							
Absorber No. 1	34.69	35.62	37.28	39.12	40.10	41.08	42.83
Absorber No. 2	35.50	36,34	38.69	40.05	41.33	42.15	44.57
Absorber No. 3	36.41	37.83	39.14	40.56	42.29	43.97	45.80
Absorber No. 4	37.64	39.15	40.86	42.28	44.03	45.80	48.07
Absorber No. 5	39.26	41.83	43.57	44.89	46.37	48.26	50.19
Regeneration temperature, 80^0C							
Absorber No. 1	56.61	58.80	59.40	59.97	60.88	62.19	63.75
Absorber No. 2	56.98	58.96	59.88	60.59	61,64	63.08	64.53
Absorber No. 3	57.60	59.27	60.46	61.52	62.58	63.84	64.82
Absorber No. 4	58.43	59.81	61.15	61.96	62.94	64.17	65.20
Absorber No. 5	58.85	60.14	61.76	62.24	63.18	64.37	65,60
Regeneration temperature, 85^0C							

Absorber No. 1	75.48	75.94	76.12	76.50	77.09	77.34	77,80
Absorber No. 2	76.04	76.57	77.83	77.98	78.02	78.25	78.46
Absorber No. 3	76.88	77.12	77.95	78.09	78.27	78.51	78.69
Absorber No. 4	77.40	77.68	77.99	78.25	78.49	78,70	78,82
Absorber No. 5	77.55	77,82	78.10	78.33	78.58	78,76	78,89
Regeneration temperature, 90^0C							
Absorber No. 1	93.12	93.18	93.22	93.25	93.30	93.36	93.45
Absorber No. 2	93.25	93.28	93.33	93.38	93.45	93.49	93.56
Absorber No. 3	93.72	93.80	93.87	93.91	93.96	94.04	94.11
Absorber No. 4	94.17	94.25	94.30	94.37	94.42	94.46	94.53
Absorber No. 5	95.18	95.24	95.29	95.33	95.38	95.42	95.47
Regeneration temperature, 95^0C							
Absorber No. 1	99.16	99.37	99.49	99.61	99.63	99.68	99.70
Absorber No. 2	99.29	99.41	99.52	99.64	99.65	99.67	99.71
Absorber No. 3	99.48	99.56	99.61	99.66	99.68	99.70	99.73
Absorber No. 4	99.54	99.57	99.64	99.70	99.74	99.75	99.76
Absorber No. 5	99.58	99.63	99.67	99.69	99.74	99.76	99.79

The results of the experiments are given in Tables 1 and 2. Chemical analysis of the solutions used for absorption and extraction of nitric acid established the degree of absorption of nitrous gases depending on the temperature, ratios of TBP and water. Based on the results obtained, it can be concluded that the absorption of nitrous gases using a mixture of water and tributyl phosphate in step absorbers is 84.50 - 99.38% depending on the cleaning conditions. With a water and TBP ratio of 1: 0.2 and a nitric acid concentration of 5% and a temperature of 35^0C, the absorption degree is 85.24%. A decrease in temperature by 15^0C and an increase in the water and TBP ratio to 1: 1 makes it possible to increase the nitrogen oxide absorption degree by approximately 15% (Table 1). Preliminary research results have shown that using a mixture of water and tributyl phosphate for nitrogen oxide absorption at normal temperatures and pressures in five absorbers, it is possible to absorb up to 97.19% of nitrogen oxides and almost completely regenerate TBP at a temperature of 95^0C, which can be reused for absorbing nitrous gases. Thus, the dependence of the absorption and extraction degree of nitric acid on the temperature and water and TBP ratio and on the number of absorbers has been determined.

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Rezyume: *Ushbu maqolada chiqindi nitroza gazlarini suv va tributilfosfat aralashmasidan foydalanib, uni keyingi regeneratsiya qilish va uning asosida nitrat kislota ishlab chiqarish uchun bosqichli absorberlarda singdirish natijalari keltirilgan. Tadqiqot natijalari, ayniqsa keng doiradagi azot oksidi tarkibidagi azot oksidlarining vaqti-vaqti bilan doimiy chiqindi bo'lmagan emissiyasi bilan tavsiflangan sohalarda ishlab chiqishda keng qo'llanilishi mumkin. Yutilish darajasi va regeneratsiyaning haroratga va suv- tributilfosfat aralashmalari nisbatiga bog'liqligi aniqlandi.*

Резюме: *В данной работе приведена результаты поглощения остаточных нитрозных газов с использованием смесью воды и трибутилфосфата в ступенчатых абсорберах для дальнейшего его регенерации и получения на его основе азотной кислоты. Особо широкое применение результаты исследования может найти в производствах, для которых характерен непостоянный выброс оксидов азота с широким диапазоном содержания оксидов азота. Определена зависимость степени поглощения и регенерации от температуры и соотношении смесь воды и трибутильфосфата.*

Kalit so'zlar: *absorber, azotli gazlar, tributilfosfat, azot oksidi, azot kislotasi, ekologiya, azotli gazlarni tozalash.*

Ключевые слова: *абсорбер, нитрозные газы, трибутилфосфат, оксиды азота, азотная кислота, экология, очистка нитрозных газов.*