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DETERMINING THE EFFICIENCY OF USING AND CLEANING THE ROTOR-FILTER DEVICE IN NEUTRALIZING HYDROGEN-FLUORITE (2HF) GAS

Xomidov Xushnudbek Rapiqjon o‘g‘li
Assistant., Islom Karimov nomidagi Toshkent davlat texnika universiteti Qo’qon filiali
xomidovxushnudbek207@gmail.com

Abdullayev Zokirjon DJurayevich
Nurmatov Sardorbek Xasanboy o’g’li
O’lmasov Farrux Yorqinjon o’g’li
Xudoberganov Mirjalol Ortiqali o’g’li
No’monov Nodirjon Farhodjon o’g’li
Islom Karimov nomidagi Toshkent davlat texnika universiteti Qo’qon filiali., Doktaranti

Asqarov Javohirbek Abdusalom o‘g‘li
Islom Karimov nomidagi Toshkent davlat texnika universiteti Qo’qon filiali., Doktaranti

Madaliyev Axror Niyzomiddin o’g’li
FarPi Doktaranti

Abstract
The article presents experiments on trapping toxic gases in mixing reactors during superphosphate mineral fertilizer production using a proposed rotor filter apparatus. Experiments were conducted on various absorbents based on gas speed entering the rotor-filter apparatus. Results were presented in tables and graphs. Results of the conducted experiment, a histogram of the dependence of liquid consumption and gas velocity on cleaning efficiency was constructed using EXM. In addition, the selection of the optimal value of the hydraulic resistance in the fan and smoke pipe, which absorbs toxic gases and dusty air, was analyzed with the help of graphs and tables, and the obtained results were cited.

Keywords. superphosphate, rotor filter, filter, calcium-carbonate soda, drum dryer, fan, nozzle, absorbent, histogram.

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Introduction

In the process of production of superphosphate mineral fertilizer, the studies conducted on absorbing the secondary toxic gases (2HF and SO2) released from the three-stage mixing reactors in the absorbent liquid in the rotor filter apparatus and determining the neutrality of the acid in the wastewater are within the following limits; the diameter of the hole of the filtering mesh material is df= 3 mm, the number of revolutions of the rotor is n = 25 rpm, the diameter of the nozzle hole that scatters the liquid is 3 mm, the gas velocity in the device is in the range of yg= 0.31÷34.4 m/s and the temperature of the external environment is 20 It was carried out at ±20C [1,2,3,4,5].

METHOD

Experiments on selected absorbents were conducted depending on the speed of the gas entering the rotor-filter apparatus. The duration of each experiment was 30 minutes. Laboratory analyses to determine the neutrality of gas absorbed into an absorbent liquid environment are presented in Table 1.

Table 1

When there is a 10% solution			
№	Technical white soda with calcium	Calcium carbonate soda	Technical shampoo
0°	6,5	6,14	5,8
30°	6,1	5,9	5,61
45°	5,85	5,67	5,12
60°	5,34	5,1	4,83
90°	5,1	4,79	4,42
When there is a 20% solution			
№	Technical white soda with calcium	Calcium carbonate soda	Technical shampoo
0°	7,9	7,1	6,8
30°	7,4	6,4	6,1
45°	7,15	6,2	5,8
60°	6,8	6,1	5,4
90°	6,3	6,0	5,0
When there is a 30% solution			
№	Technical white soda with calcium	Calcium carbonate soda	Technical shampoo
0°	9,46	8,7	8,1
30°	9,15	8,45	7,6
45°	8,73	8,1	7,19
60°	8,4	7,78	6,84
90°	8,12	7,4	6,5

When the neutrality of the acid content of wastewater produced according to technological requirements is higher than 7 Ph, the wastewater is considered alkaline and can be reused in industry. In the scrubber currently used in the production process, this condition is 3.5÷5.0 Ph [6,7,8,9,10,11].

As can be seen from Table 1, the absorption of poisonous gas by absorbent liquid added to water as a solution of 10, 20, and 30% and increasing the alkalinity of wastewater depends on the speed of gas entering the device.

The following results were obtained in the experiments conducted to determine the effective absorption of poisonous gas into the absorbent liquid.

Water is added to the composition as a 10% solution in the absorbent.

1. In technical white soda with calcium-gas velocity in the range of 0.31÷34.4 m/s, absorption of poisonous gas into liquid is up to 51÷65%.
2. Calcium carbonate soda - absorption of poisonous gas into liquid is up to 47.9÷61.4% in the gas velocity range of 0.31÷34.4 m/s.
2. Technical shampoo - absorption of poisonous gas into the liquid is up to 44.2÷58% in the gas velocity range of 0.31÷34.4 m/s.

Water is added to the composition as a 20% solution in the absorbent.

1. In technical white soda with calcium, the gas velocity is between 0.31÷34.4 m/s, and absorption of poisonous gas into liquid is up to 63÷79%.
2. Calcium carbonate soda - absorption of poisonous gas into liquid is up to 60÷71% in the range of gas speed 0.31÷34.4 m/s.
2. Technical shampoo - absorption of poisonous gas into the liquid is up to 50÷68% in the range of gas speed 0.31÷34.4 m/s.

Water is added to the absorbent as a 30% solution.

1. In technical white soda with calcium-gas velocity in the range of 0.31÷34.4 m/s, absorption of poisonous gas into liquid is up to 81.2÷94.6%.
2. Calcium carbonate soda - absorption of poisonous gas into liquid is up to 74÷87% in the range of gas speed 0.31÷34.4 m/s.
2. Technical shampoo - the absorption of poisonous gas into the liquid is up to 65÷81% in the range of gas speed 0.31÷34.4 m/s.

Based on the obtained experimental results, a graph of dependence of absorption efficiency on the sheber grade installed on the device ventilator was constructed (Fig.1).

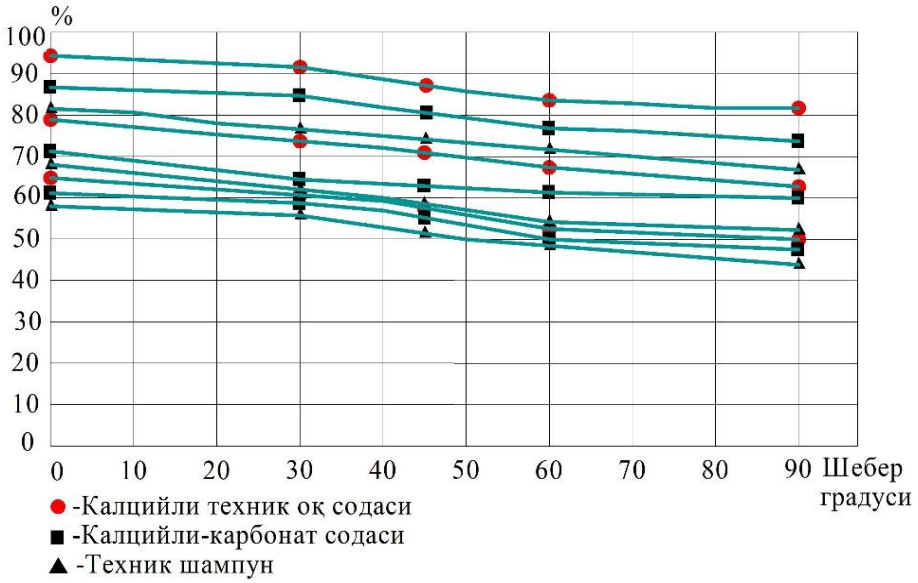

Figure 1. The effect of the Sheber degree installed on the device fan on the cleaning efficiency.

1-30% solution prepared liquid; 2-20% solution prepared liquid; 3- liquid prepared with 10% solution;

Experimental studies were conducted on the cleaning of fertilizer dust coming out of the drum dryer-granulator in the rotor-filter apparatus. The following parameters were chosen for the study: the diameter of the filter mesh material hole df = 3mm, the number of revolutions of the rotor n = 25 rev/min, the diameter of the nozzle hole for dispersing the liquid dish = 1.2.3 mm, the gas velocity in the apparatus yg = 7.67÷34.4 m/ in the interval of s, the consumption of liquid supplied to the device is 72÷178.2 l/h, the temperature of the external environment is 20±20C, the temperature of the dusty air coming out of the technological smoke pipe is 80-1200C.

Cleaning and purification of the gas entering the rotor-fili apparatus was determined experimentally. Many ANKT-41 brand gas analyzers were used in the composition for cleaning. The results obtained are shown in Table 2.

Table 2

The diameter of the nozzle hole d=1mm					
№	υ_1 ShEBER 90^0	υ_2 ShEBER 60^0	υ_3 ShEBER 45^0	υ_4 ShEBER 30^0	υ_5 ShEBER 0^0
	34,4	28	23,8	18,79	7,67
Tozalash samaradorligi					
0	79.8	81.4	82.4	83.8	84.7

10	89.7	92.9	93.5	94.7	95.6
20	90.8	93.7	94.8	95.9	96.3
30	92.3	94.5	95.1	96.4	96.9
The diameter of the nozzle hole d=2mm					
№	υ_1 ShEBER 90^o	υ_2 ShEBER 60^o	υ_3 ShEBER 45^o	υ_4 ShEBER 30^o	υ_5 ShEBER 0^o
	34,4	28	23,8	18,79	7,67
Tozalash samaradorligi					
0	81	82.3	83	84.2	85.4
10	90.4	93.6	94.7	95.3	96
20	91.8	94.2	95.2	96.4	96.9
30	93.2	95.1	95.6	96.9	97.1
40(36)	93.6	95.8	96.4	97	98.2
The diameter of the nozzle hole d=3mm					
№	υ_1 ShEBER 90^o	υ_2 ShEBER 60^o	υ_3 ShEBER 45^o	υ_4 ShEBER 30^o	υ_5 ShEBER 0^o
	34,4	28	23,8	18,79	7,67
Cleaning efficiency					
0	84	84.7	85.3	87.1	88.2
10	93.6	95.2	95.9	96.7	97.8
20	94	95.7	96.2	97.1	98.3
30	94.3	96	96.9	97.8	98.5
40(42)	94.8	96.5	97.6	98	98.9

Based on the results of the experiment, a histogram of the dependence of liquid consumption and gas speed on the cleaning efficiency was built. In the histogram, the growth lines separated by color indicate the liquid consumption determined by the readings of the scale of the liquid ratometer installed in the device
(Figures 2, 3 and 4).

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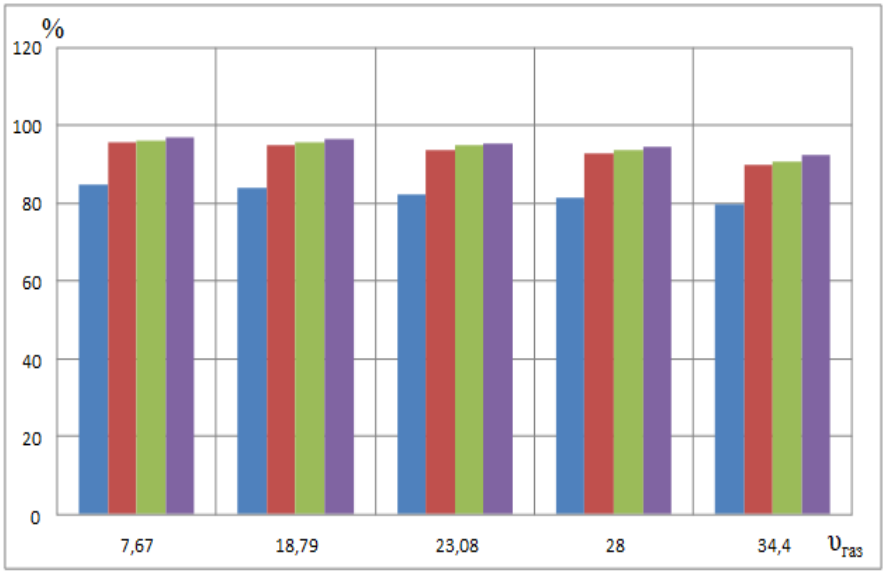

Fig. 2. Dynamics of cleaning efficiency depending on liquid consumption and gas speed when the diameter of the nozzle of the rotor-filter apparatus is 1 mm.
→Liquid consumption 68.1 l/hour; → Liquid consumption 85.3 l/h; → Liquid consumption 124.7 l/hour; → Liquid consumption 141.7 l/h;

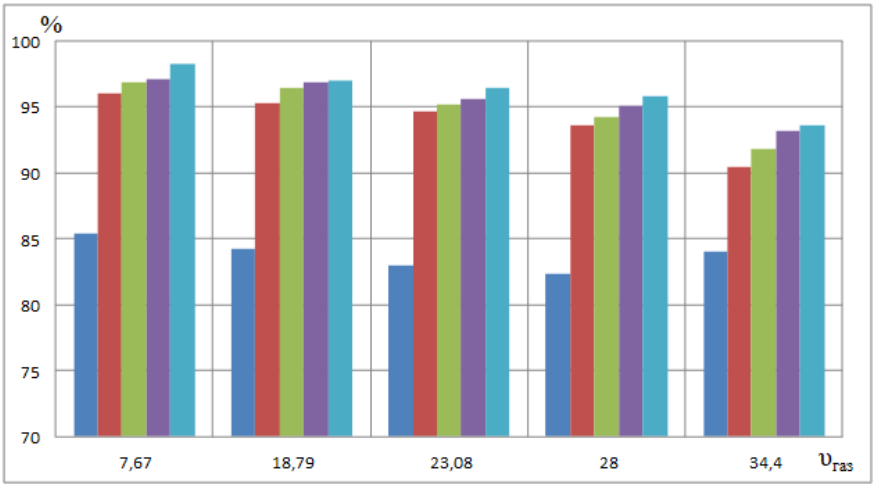

Fig. 3. Dynamics of cleaning efficiency depending on liquid consumption and gas speed when the diameter of the nozzle of the rotor-filter apparatus is 2 mm.
→Liquid consumption 71 l/h; → Liquid consumption 86.95 l/h;
→ Liquid consumption 130.45 l/h; → Liquid consumption 147.54 l/h;

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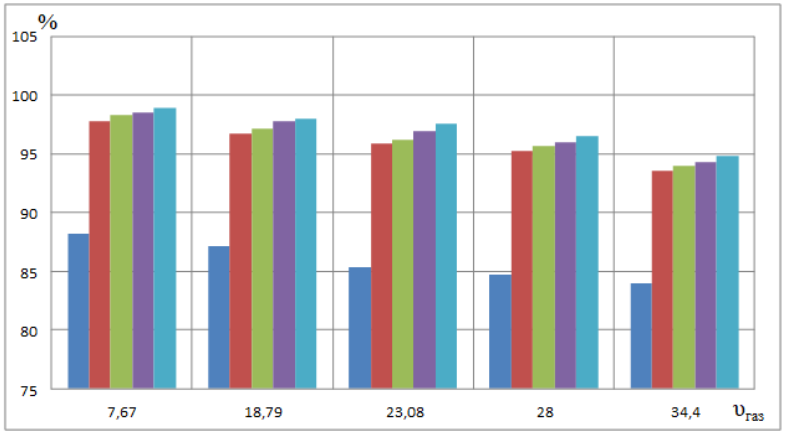

Figure 4. Dynamics of cleaning efficiency depending on liquid consumption and gas speed when the nozzle diameter of the rotor-filter apparatus is 3 mm.
→Liquid consumption 72 l/h; → Liquid consumption 89.55 l/h;
→ Liquid consumption 135.33 l/h; → Liquid consumption 152.5 l/h;
→ Liquid consumption 178.2 l/h;

The selection of the optimal value of the hydraulic resistance in the smoke pipe absorbing toxic gas was analyzed according to the graph presented above (see Figure 8). According to it, it was determined that when the gas velocity at the entrance to the device is 23.8 m/s, the cleaning efficiency is higher than the technical requirement, and the hydraulic resistance in the smoke pipe is at an acceptable value [12,13,14,15].
The selection of the optimal value of the hydraulic resistance in the exhaust fan and smoke pipe was analyzed according to the table 2 presented above. According to it, it was determined that when the gas velocity at the entrance to the device is 18.79 m/s, the cleaning efficiency is higher than the technical requirement, and the hydraulic resistance in the smoke pipe is at an acceptable value [16,17].

Summary

The test results obtained when the rotor-filter apparatus was used to clean the hydrogen-fluoride gas and phosphorite dust in the air produced in the mixing reactors of the superphosphate production process, as well as to clean the fertilizer dust coming out of the drum granulator-dryer showed that cleaning efficiency is 4.6% higher compared to the existing wet cleaning scrubber, 2.5 times less liquid is used to clean 1m3 of air, and the neutrality (Ph) of the waste water produced during the cleaning process has increased from 5.4 to 9.6, i.e. It was found that it increased 1.8 times, and in return 271.19 mln. Soum annual economic benefit is obtained.

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