Elimimation of Organic Solvent in Air by Means of Plasma Technique

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Abstract

An investigation on elimination of organic solvent in air by means of plasma technique has been done in our Laboratory. The experinent results show that after treatement in plasma the content of organic solvent decreased; the content of water increased and some new compounds appeared.

1. Introduction

Gases discharged from petro-chemical plant and print shop or print-works traditionaly carry a lot of vapor of organic solvents such as petrol, benzene, xylene, toluene etc, which polluted environment seriously. By tradionary way, these waste gases were cleaned by means of absorption on active carbon or regeneration of steam if the concentration of the organic solvent was as high as a few percents, or treatment by catalytic oxidization if the concentration of these solvents were on the order of 10^{-2} ppm[1]. However the large, complex and expensive equipments were necessary for them and the results were not satisfied.

In order to look for a simple and economical method to elininate this kind pollution, a plasma oxidization method was developed in our laboratory. The experiments were carry out with a special corona discharge device, operated under air pressure. The gas samples were tested by gas chromatograph and IR. spectrum. The working gas was air containing vapor of toluene. In this paper the experinent device and results will be reported in detail.

2. Experiment Device

A corona discharge device was used in our research work. The construction and arrangement of it was shown in Fig. 1 (a), (b). The source of power was a pulse equipment with frequency of 20-40 KHz and power of 1kw. The discharge chamber was composed of a rotating electrode covered by silicic rubber, two knife-like electrods and wall. The arrangement of this device was shown in Fis 1

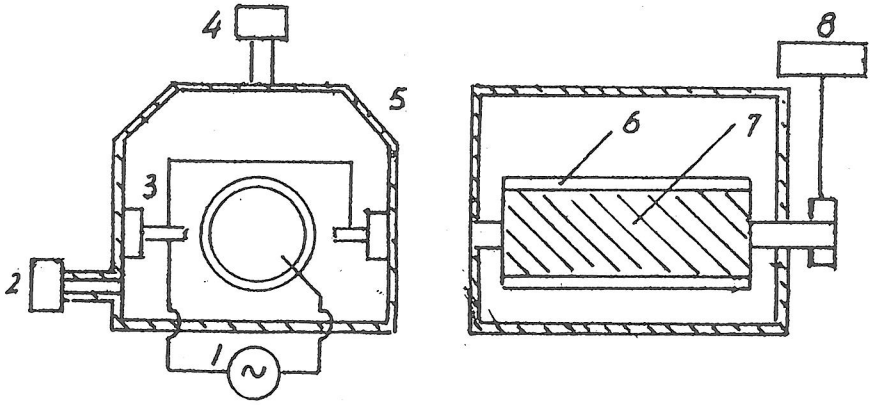

Fig. 1. Arrangement of experiment system
1. power. 2. injection valve 3. electrods. 4. output valve. 5. wall of discharge chamher 6. rubber. 7. rotating electrode. 8. motor.

In our research work, the vapor of toluene was used as a source of pollution. The operating procedure of experiment was following: 1. Inject some vapor of toluene into discharge tube, then close the input and output valves. 2. Take sample of contaminated gas from chamber. 3. Discharge. 4. Take sample of treated gas from discharge tube. 5. Analyse the composition of treated and untreated samples by using a Gas Chromatograph and IR spectrometer, and compare the tested results obtained from two kinds of samples.

3. The Experimental Results

The esperinental results were tested by IR spectrometer and gas chromatograph.

(1) After discharge in polluted gas. some oil-like matters were produced on the surface of rotating electrode. we analysed them by using of IR spectrometer. The results was shown in Fig. 2.

It is clear that there were two large peaks appeared on the IR pattern on the wavenumber ranges of 2400—3600cm^{-1} and 1600—

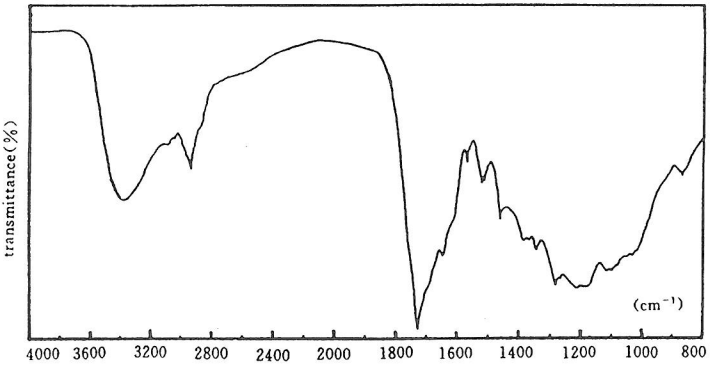

Fig. 2. The infrared specirum pattern of deposition on sarface of rotating electrode.

1800cm^{-1}. compare them with references[2] we knew that the first peak was correspondeng to active groups such as benzalcohol, benzaldehyde, benzoic acid, benzene carboxylic acid (benzophenid) and benzophenone etc. comparing these results with conference,[3] we knew that these new gronps were produced by oxidization reaction under plasma conditions. It means that under plasma condition the molecule of toluene can be destroyed and produce some new matters.

(2). The products in gaseous state were tested by gas chromatograph. The results were shown in Fig. 3.

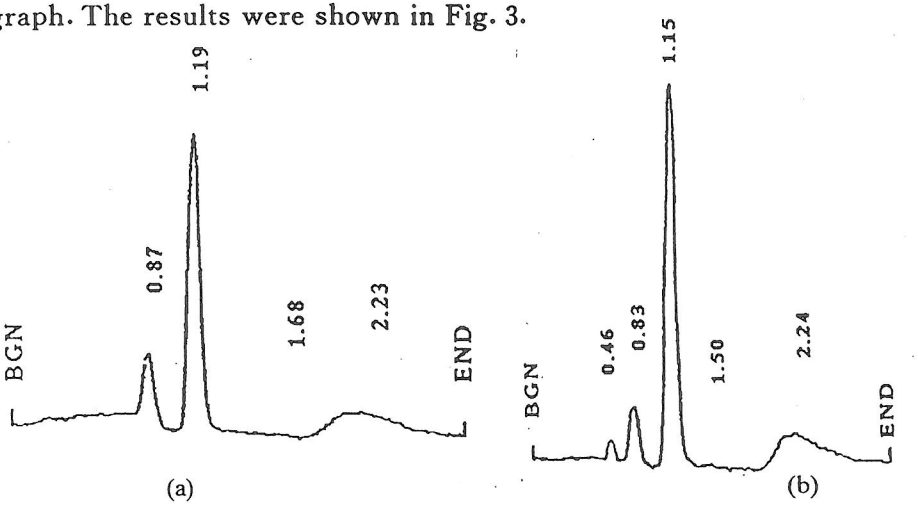

Fig. 3 Chromatographies of untreated (a) and treated (b) working gases.

In Fig. 3, I and T represented the strength of signals and retain-

ing time of compounds in analysis chamber respectively. The position of peak on time axis corresponded to a certain compound. The area of a peak was proportional to the content of corresponding compound [3]

Comparing the chromatographies of toluene with Fig. 3 we know that the peak at t=0.83 in Fig. 3 a and t=0.87 in Fig. 3 b were corresponding to the peaks of toluene; the peaks at t=2.24 (Fig. 3 a), t=2.32 (Fig. 2. b) were signals of water. The areas of every peaks in Fig. 3 were shown in table 1 and table 2. In tables 1 and 2, A(t) represented area of a peak, R represented ratio of area of one peak to the sum of all peaks in same picture.

From Fig. 3, tables 1 and 2 we can find:

Table 1 The areas of peaks in Fig. 3(a):

t(min)	A(t)	$R=A(t)/\sum A_i(\%)$	Compounds
0.87	0.2196	32.2453	toluene
1.19	0.3636	53.3799	unknown
1.68	0.0097	1.4237	unknown
2.32	0.0882	12.9509	water

Table 2 The areas of peaks in Fig. 3(b)

t(min)	A(t)	$R=A(t)/\sum_i A(\%)$	Compounds
0.46	0.0336	0.6660	unknown
0.83	0.0928	10.6588	toluene
1.15	0.5170	59.3240	unknown
1.50	0.0141	1.6218	unknown
2.24	0.2137	24.5288	water

a. After treatment in plasma, the value of area of toluene peak decreased from 0.2196 to 0.0336, and corresponding ratio R decreased from 32.2453% to 0.6660%. It means that after discharge the content of toluene reduced.

b. In fig. 3 (a) there were 4 peaks only, but 5 peaks appeared in Fig. 3 (b). Comparing them we can see that the peak at t=0.46 in

fig. 3 (b) was a new one. Although we have not known what kind of compounds was represented by this peak, but it is clear that after treatment in plasma a new compound produced •

c. After treatment in plasma the area of peak of water increased from 0. 0882 (fig. 3. a) to 0. 2137 (fig. 3. b), and the corresponding value of R increased from 12. 9509% to 24. 5288%. It illustrated that after treating in plasma the content of water increased.

3. Conclusion

Because of the discharge chamber was airtight in the period of discharge, so following conclusion can be obtained: Under plasma condition the construction of toluene can be decomposed and form water and other compounds.

Although our experiment is a primary research work and the conclusion was obtained only from toluene, but it gave us a possibility to clean polluted air by means of plasma. The continuous research work on this subject will be done in our laboratory in detail.

4. Reference

[1]UK Patent GB 2177 020

[2]Wang Cong ming et. al, applied Infrared Spectroscopy. 1987.

[3]Xing Qi yi, basic organic chemistry vol. 1, p30 3.