FOG FORMATION IN AIR WHICH HAS PASSED THROUGH A SILENT DISCHARGE.

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The corona discharge has been studied in the Chemical Laboratory[1], [2] and Electrical Engineering Experiment Station[3], [4] of Purdue University with especial reference to the formation of nitric acid and ozone in air. One of the more interesting of the phenomena observed while working under a large variety of conditions has been the formation of fog in the air passed first through a discharge and then through a solution for the absorption of the nitric acid anhydride or the ozone formed in the discharge. An important connection between fog formation and the yield of nitric acid was suspected. This led to a study of fog formation in the corona work during a period of several years, the results of which are recorded here.

A fog, in the first place, may be defined as the suspension of finely divided particles of liquid, (or frozen liquid if the temperature is low enough), in a gas. In order to have a fog there must be moisture in the atmosphere, usually approaching the saturation point. There must be also nuclei on which the fog may be condensed because it has been shown that in the absence of all nuclei a large supersaturation is required to condense the water[5]. Nuclei may be dust particles, ions[5] or chemical substances of a hygroscopic character[6]. The absence of dust particles sufficient to cause formation under the conditions used is shown by the fact that during the sweeping out of the apparatus preliminary to discharge no fog was observed at any time. Ions did not serve as nuclei for the following reasons: C. T. R. Wilson[5] shows that a certain amount of supersaturation is necessary before water vapor will condense on ions. Passing the air coming out of the discharge tube through a large electrostatic field failed to have any effect on the fog either before or after the discharge was turned on.

There remain as nuclei only hygroscopic compounds. That it was due to the chemical substances was proved by dividing the stream of air after leaving the discharge. One-half passed directly into the absorption system and fog was observed as usual. The remainder of the gas passed through a large tube containing asbestos impregnated with silver so that the ozone was decomposed completely and the nitrogen pentoxide reacted with the silver oxide so formed to produce silver nitrate[6]. The air then passed through an absorption apparatus and gave no evidence of either ozone or oxides of nitrogen or fog. Ozone alone in contact with moisture has a slight tendency to produce ioniza-

[1] Anderegg. J. Am. Chem. Soc. 39, 2581 (1917).
[2] Ray and Anderegg. *Ibid.* 43, 967 (1921).
[3] Harding and McEachron. J. Am. Inst. Elec. Eng. April, 1920.
[4] McEachron and George. Purdue Univ. Eng. Exp. Sta. Bull. 9.
[5] C. T. R. Wilson. Phil. Trans. 189A, 265 (1897); 193A, 289 (1899).
[6] Bancroft. J. Phys. Chem. 22, 312 (1918).

"Proc. 38th Meeting, 1922 (1923)."

tion and to cause fog formation[1]. In working with pure oxygen it is possible to secure conditions such that a slight fog is produced on ab-

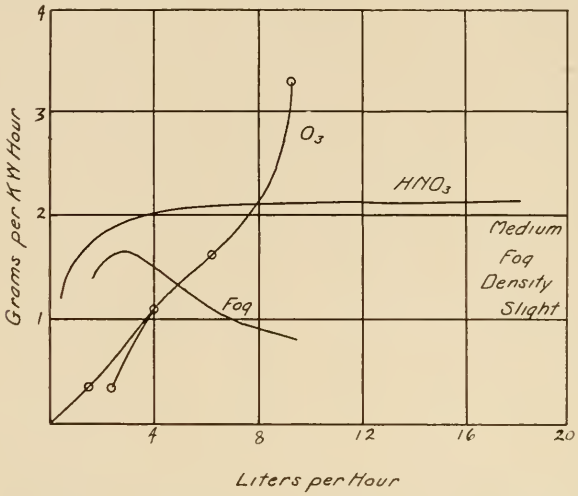

Fig. 1. Formation of nitric acid, ozone and fog in air at 460mm. pressure in a very large discharge apparatus at more than 50,000 volts. The nitric acid curve is given as figure 8 by Harding and McEachron, cit. 3. The other curves have not been published.

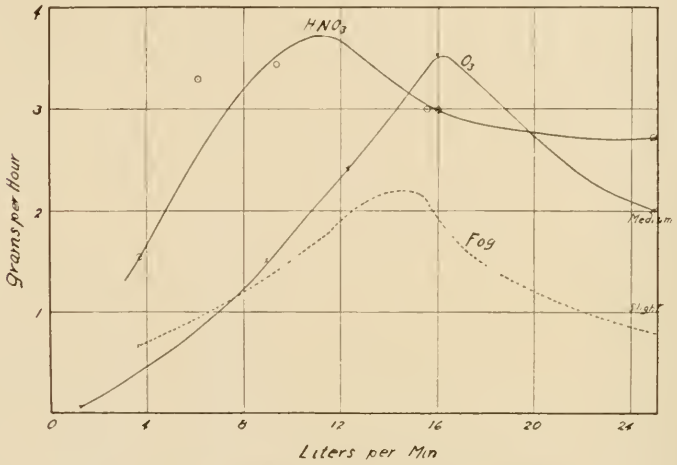

Fig. 2. The same tube was used as in figure 1, but the pressure of the air was 560mm.; cf. figure 9, cit. 3.

sorbing the ozone in potassium iodide solution. But the fog produced by the ozone alone was a very small part of the total observed. That leaves the nitrogen pentoxide which is, like sulfur trioxide, a very hygro-

[1] Pringal. Ann. Physik. 26, 727 (1908). Pringal's explanation is obviously wrong because ozone will not react with unactivated nitrogen, cf. Bieber. ibid. 39, 1313 (1912).

scopic substance. Its ability to condense moisture is indicated by the titration of the fog collected from a small Cottrell precipitator. The acid so obtained had a concentration approximately normal.

Nitric oxide (NO) is first formed in the discharge. This combines quantitatively with the ozone which is also present unless the temperature is too high, to give the nitrogen pentoxide. According to this reasoning those conditions which give the maximum product of the concentrations of ozone and of nitrogen pentoxide should produce the most fog. The curves given, figures 1, 2 and 3, which are typical of a very

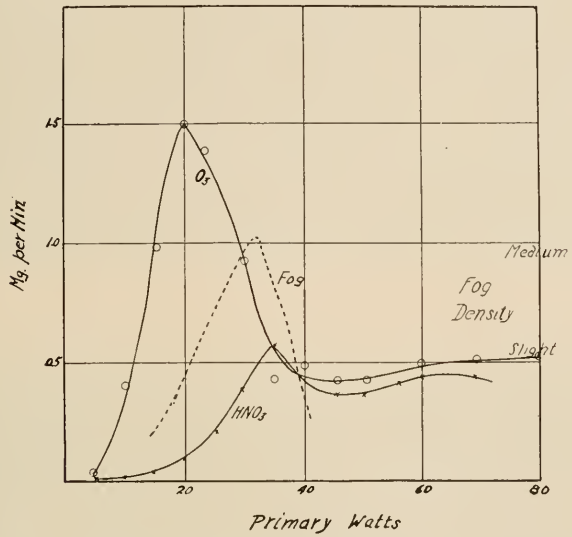

Fig. 3. The formation of ozone, nitric acid and fog in air which was undergone discharge in contact with fragments of quartz glass; cf. Anderegg and Bowers, A Type of Silent Discharge Involving Catalysis, page 177.

large number of similar curves, indicate the validity of this reasoning.

It was observed that the fog developed to a maximum during the course of a run and then gradually diminished in strength at a rate which depended upon the flow rate of the air. The cause for this was the cooling effect of the evaporation of moisture into the air reduced the temperature sufficiently to lower the amount of moisture evaporated below the condensation point.

The reason for the passage of these fume particles has been explained by Bancroft[9] as due to the adsorption of a layer of air on the surface which acts like a cushion to prevent the droplet of nitric acid solution from coming in contact with the alkaline absorbing liquid.

[8] Wulf, Daniels and Karrer. J. Am. Chem. Soc. 44, 2402 (1922).

[9] Bancroft. Applied Colloid Chemistry, pp. 65-78 (1921).