**References and Notes**

1. M. D. Banus, R. E. Hanneman, M. Strongin, K. Gooen, *Science* **142**, 662 (1963).
2. C. B. Sclar, L. C. Carrison, C. M. Schwartz, *ibid.* **143**, 352 (1964).
3. S. Geller, A. Jayaraman, G. W. Hull, *Appl. Phys. Letters* **4**, 35 (1964).
4. A. J. Darnell, A. J. Yencha, W. F. Libby, *Science* **141**, 713 (1963).
5. A. J. Darnell and W. F. Libby, *Phys. Rev.* **135**, 1453 A (1964).
6. H. E. Bömmel, A. J. Darnell, W. F. Libby, B. R. Tittman, A. J. Yencha, *Science* **141**, 714 (1963); B. R. Tittman, A. J. Darnell, H. E. Bömmel, W. F. Libby, *Phys. Rev.* **135**, 1460 A (1964).
7. K. C. Brog, W. H. Jones, F. J. Milford, *Bull. Am. Phys. Soc.* **9**, 261 (1964).
8. K. Schubert, E. Dörre, M. Kluge, *Z. Metallkunde* **46**, 216 (1955).
9. Yu. M. Ukrainskii, A. V. Novoselova, Yu. P. Simanov, *Russ. J. Inorg. Chem.* (*English transl.*) **4**, 60 (1959).


25 January 1965

## Electron Yield in the γ-Radiolysis of Water Vapor


Abstract. *Nitrous oxide at low concentrations reduces the high yield of hydrogen from γ-irradiated water vapor containing methanol from 8.9 per 100 electron volts absorbed to a plateau value of 5.9. This indicates that both electrons (yield 3.0) and hydrogen atoms (yield 5.4) are precursors to the hydrogen, the former being scavenged by nitrous oxide.*


The high yield of hydrogen, $G(H_2)$, produced when various additives are present during the γ-irradiation of water vapor has been interpreted (*1*) in terms of reactions of H atoms:

$$H_2O \rightarrow H, OH, H_2$$
$$H + CH_3OH \rightarrow H_2 + \dot{C}H_2OH$$

These H atoms are believed to originate from both the excitation and ionization of $H_2O$, and for the latter the reactions

$$H_2O \rightarrow H_2O^+ + e^- \quad (1)$$
$$H_2O^+ + H_2O \rightarrow H_3O^+ + HO \quad (2)$$
$$H_3O^+ + e^- \rightarrow 2H + OH \text{ or } H_2O + H \quad (3)$$

have been suggested.

Using experimental methods described (*1*) we have made observations which support the idea that two precursors to H atoms are present. The presence of 0.1 percent of nitrous oxide is sufficient to reduce $G(H_2)$ from a mixture of water vapor and methanol from 8.9 to a plateau value of 5.9, which remains constant over a fivefold increase of $N_2O$ (Fig. 1). Nitrogen is also produced with $G(N_2) = 3.8$.

As in the case of aqueous systems (*2*) and gaseous propane (*3*), it seems probable that $N_2O$ acts as an electron scavenger

$$N_2O + e^- \rightarrow N_2 + O^-$$

thus preventing reaction 3. If this is so, then a yield of electrons $G(e) = 3.0$ is produced, and, since the yield of hydrogen as molecules is 0.5, this would leave an H-atom yield $G(H) = 5.4$.

If H atoms arise entirely from excitation, then the extent is about twice that of ionization. However, H atoms may originate partly from the ultimate neutralization process. The following sequence seems feasible:

$$O^- + H_2O \rightarrow OH^- + OH$$
$$H_3O^+ + OH^- \rightarrow H_2O + H + OH$$

If this does occur, then the original neutralization, reaction 3, must produce two H atoms and there are about equal amounts of excitation and ionization.

We also find that in the absence of methanol the same range of $N_2O$ concentration gives $G(N_2) = 3.0 \pm 0.4$ (10 experiments) in water vapor. This is essentially the same as the decrease in $G(H_2)$ when methanol is present, but less than $G(N_2)$ in these conditions. The higher $G(N_2)$ probably originates from the reaction

$$N_2O + \dot{C}H_2OH \rightarrow N_2 + OH + CH_2O \quad (4)$$

In support of this we have confirmed an earlier observation (*4*) that $N_2O$ in pure methanol vapor gives rise to a chain reaction, since values of $G(N_2)$ are as high as 50.

However, with pure methanol $N_2O$ does not affect $G(H_2)$, even though it would appear that the charge-neutralization process analogous to that in water occurs

$$CH_3OH_2^+ + e^- \rightarrow CH_3OH + H$$

and will be prevented by $N_2O$. It would seem that the alternative neutralization also produces a hydrogen atom and might be

$$CH_3OH_2^+ + OH^- \rightarrow CH_3OH + H + OH$$

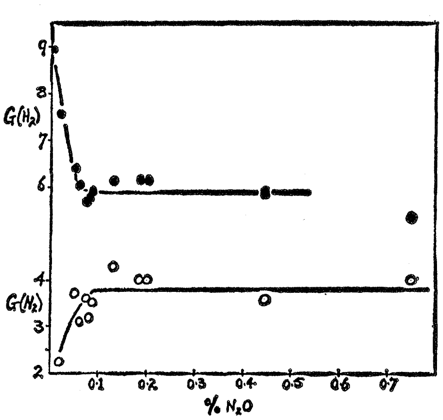


Fig. 1. Hydrogen and nitrogen yields in the γ-radiolysis of water vapor containing 2.35 moles percent methanol at 120°C. Dose: $10^{19}$ ev $g^{-1}$.


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**References**

1. J. H. Baxendale and G. P. Gilbert, *Discussions Faraday Soc.* **1963**, 186 (1963).
2. F. S. Dainton and D. B. Peterson, *Proc. Roy. Soc. London Ser. A* **267**, 443 (1962).
3. G. R. A. Johnson and J. M. Warman, *Nature* **203**, 73 (1964).
4. J. H. Baxendale and R. D. Sedgwick, in preparation.


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## Iron Accumulation in Cockerel Plasma after Estrogen: Relation to Induced Phosphoprotein Synthesis


Abstract. *In cockerels a single injection of estrogen causes a rise of several fold in the plasma iron. At 18 hours this response is proportional to the amount of diethylstilbestrol injected and may be used as a convenient measure of estrogen action. The phenomenon is probably related to the estrogen-induced synthesis of iron-binding phosphoproteins.*


The blood of laying hens contains a phosphoprotein fraction that can also appear in cockerels treated with estrogen (*1, 2*). Most of this phosphoprotein, in both laying hens (*3*) and estrogenized cockerels (*4*), is identical to the egg protein, phosvitin. Phosvitin has a high iron-binding potential (*5*) and such a complex may account for the total iron content of egg yolk (*6*). We now report on the possible correlation between the phosphoprotein and the iron content of plasma.

White Leghorn cockerels (100 to 150 g) and 3-month-old laying hens were used. The method for the estimation of plasma iron was based on that of Tompsett (*7*). This method gave the same values for total inorganic iron as those obtained with ashed samples of hemoglobin-free material. Plasma (0.5 ml) was heated in a boiling water