# A NOTE ON SPECTRAL INTENSITY CHANGES IN HIGH-FREQUENCY GLOW DISCHARGE IN AIR

BY N. R. TAWDE, F.A.SC., AND G. K. MEHTA

(*Physics Laboratories, Royal Institute of Science, Bombay*)

Received September 20, 1945

ASUNDI AND J. SINGH[1] have recently drawn some important conclusions about the relative strengths of the first positive and second positive band systems of nitrogen excited by h.f. discharge in rarefied air. They observed a change in the colour of the glow when the frequency of oscillation was changed. This happened abruptly at a critical frequency of 735 k.c. below which the first positive system is stronger than the second positive system and above which the reverse is true. The change in colour is attributed by them to the change in intensities of these two band systems.

The authors have referred to the work of Brasefield[2] who has investigated the variations in the electron velocity in the h.f. discharge. He extrapolated the velocity of the exciting electrons in the h.f. discharge from the curves (got from independent experiments) representing the variation in the ratio of the intensities of two neighbouring lines with the uniform velocities of the electrons employed for excitation. This method will be correct if the discharge gives rise to uniform electron velocities. This is not true as the electrons undergo a velocity distribution in the h.f. discharge. Thus it is not possible to draw any quantitative conclusion regarding the mean electron velocity from the above method. The deviations of Brasefield's results from the actual values of the electron velocities, occurring in the h.f. discharge, cannot be estimated unless some new method is tried which takes into consideration the distribution of electron velocities. The general conclusions about (1) the increase in electron velocity with the decrease in the frequency of oscillation; (2) the increase in electron velocity with the increase in excitation voltage; (3) the decrease in electron velocity with the increase in pressure, may be true but no qualtitative conclusions are possible.

Asundi and J. Singh have assumed that the output voltage of the oscillator was constant for all the frequencies. This is contrary to our experience of Hartley circuits. The output voltage varies considerably with the change in frequency. At the same time the conductivity of the discharge being different at different frequencies, the load on the oscillator will vary at different frequencies and may cause a change in the output voltage. It is known that unless the Hartley circuit is meant to deliver a considerably high power the output voltage changes with the load. Data with regard to the modified Hartley circuit used by Asundi and J. Singh giving a constant voltage output at different frequencies and loads would have facilitated the correctness of the above assumption. It would have been better if the constancy of voltage was checked and its absolute value noted. These conditions being not defined, it is quite likely that the change in the electron velocity which is responsible for the change in the relative intensities of the two band systems may be due partly to the change in voltage and partly to the change in frequency or to the change in voltage only.

Again there is no mention of the pressure at which the investigations were made and this is a very significant factor. According to Brasefield's simplified mechanism of the h.f. discharge, a decrease in frequency will increase the electron velocity, because the time for which electric force will act on the electron will be longer at lower frequency. If this is correct, then with a known change in frequency the resulting change in the electron velocity will depend on the mean free path of the electron and thus on the pressure. This change in electron velocity with a known change in frequency will also depend on the voltage of excitation as the velocity will depend on the electric force acting on it. Thus for a particular applied voltage, there will be a pressure above which a change in frequency will not change the electron velocity. This will be when the m.f.p. for the electron will be smaller than the distance travelled by it in the time of half a cycle at the highest frequency. Asundi and Pant[3] have also observed that the phenomena get complicated at high pressures. This is due to the small m.f.p. of the electrons at high pressures.

A phenomenon of the colour change in the glow of the h.f. discharge in air was lately observed by us while doing probe study of the h.f. discharge. The frequency range was higher than that used by Asundi and J. Singh (4 to 15 m.c.). A sudden change in colour was observed when the pressure in the discharge tube was being lowered. The change was abrupt at a certain pressure. The value of this critical pressure was found to vary with excitation voltage as well as the frequency. In view of this, it appears that the change in colour is a complicated phenomenon associated with several parameters like pressure, frequency, excitation voltage, etc. As an example, the following Tables I and II will give an idea as to how either of these parameters is susceptible to change with variation in the other. The observations given here were taken with a cylindrical tube having external sleeve electrodes.

TABLE I

| Frequency in megacycles sec. | Critical Pressure in mm. at | |
|---|---|---|
| | 1000 V | 1300 V |
| 12 | 0·24 | 0·54 |
| 9 | 0·34 | 0·69 |
| 7 | 0·40 | 0·76 |
| 4 | 0·51 | 0·89 |

TABLE II

| Voltage | Critical Pressure in mm. at Frequency | |
|---|---|---|
| | 4 mc./sec. | 9 mc./sec. |
| 800 | 0·20 | .. |
| 1000 | 0·51 | 0·34 |
| 1250 | 0·73 | 0·56 |
| 1400 | 0·85 | 0·68 |

The tube was connected through drying system and oil manometer to a Cenco Hyvac pump. The discharge was excited by h.f. oscillations from a Hartley circuit, the frequency of which was changeable from 4 to 15 megacycles. The h.f. voltages were measured by a thermionic voltmeter specially designed for the purpose. The frequency was measured by a General Radio absorption type of wavemeter. Table I gives the variation of critical pressure with frequency of oscillation at two excitation voltages; while Table II shows its variation with the voltage at two different frequencies.

We agree that the relative changes in the two band systems as observed by Asundi and J. Singh may have been brought about by a change in electron velocity, but whether the critical velocity can be attributed to a change in frequency alone is a doubtful point in the absence of data about the other variables. For some time we have been investigating several other aspects of h.f. discharge quantitatively, the results of which will be communicated in due course.

## REFERENCES


1. Asundi and J. Singh .. *Proc. Ind. Acad. Sci.*, 1945, **22**, 60.
2. C. J. Brasefield .. *Phys. Rev.*, 1929, **33**, 925 ; 1930, 35, 92 and 1073.
3. Asundi and Pant .. *M.Sc. Thesis, Benares Hindu University.*