EFFECT OF A PULSE MAGNETIC FIELD ON A HIGH PRESSURE PLASMA

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ABSTRACT:
An r.f.. induction plasma torch is a convenient source for the production of high temperature, and steady dense plasma to study the ionic processes in the plasma. The temperature of the torch, supplied with organ, remains around 10,000 K for a wide range of gas flow rates and r.f. power, though the size of the plasma varies with gas flow rate and r.f. power. The application of a pulse magnetic field, however, has been shown to increase the plasma temperature by several thousand K
The application of the pulsed field has been found to produce oscillation on the surface of the plasma. Because of the increased temperature and conductivity the skin depth of the pulse applied field is found less than 1.4 cm, which is the radius of the plasma.

***INTRODUCTION*:**
The induction plasma torch, essentially consist of a quartz tube 3.7 cm in diameter held vertically in a water pool r.f. coil, near the upper end of the tube as shown in fig 1a and 1b. The coil is energized by an r.f. generator working at 13.0 kw at a frequency of 6 MHZ The torch was stabilized by feeding organ tangentially at the lower end of the tube.

***EXPERIMENTAL TECHNIQUE*:**
A pulsed magnetic field is applied to the steady torch by discharging a 5.0µF capacitor through a theta coil, coaxial and surrounding the r.f. coil .The theta coil was 10.7 cm in diameter, 30 cm long and produced damped oscillatory magnetic field with a period of 2.7 µ S.
Radial temperature distribution was obtained spectroscopically (1) by viewing the plasma through a narrow slit in the theta coil. The intensities I_λ of 415.9, 418.2, 425.9, 426.6 and 427.2 nm lines of Ar. 1 were measured with a calibrated photomultiplier. The intensity of a spectral line rose to a maximum in about 10 µ S.

***RESULTS AND DISCUSSION*:**
When self absorption is negligible, a plot of log $[I_\lambda /(A \times g)]$ against the upper level, excited energy gives the straight line plot, called the Maxwell – Blotzman plot, indicating thermal equilibrium in the plasma. The slope of this plot gives temperature (2, 3) of the plasma. Due to plasma surface oscillations difficulties were experienced in temperature measurement. The radial temperature distribution at peak line intensity, after the application of the pulse magnetic field of intensity 1.25 T, is compared with that of the steady torch in fig 2.
The temperature distribution attains a maximum value at about 7 cm from the axis of the

discharge tube. For the pulse magnetic field the skin depth is nearly equal to discharge radius. An attempt was made to measure the intensity of the pulse magnetic field with a water pool inductive probe, but the field was too small to be measured.
During scanning of the plasma for spectroscopic measurement of temperature, after the application of the magnetic pulse, large amplitude plasma oscillations were found which were mainly confined to the boundary layers of the plasma. These oscillations eventually dissipated there energy to the boundary region and thus contributed to an off axis temperature distribution of the plasma.
Fig.3 shows large oscillations on the plasma surface. The frequency of these oscillations increase and the amplitude decreases with the passage of time, showing change of oscillation energy into heat. This contributes to the off-axis peak temperature distribution in the plasma.

High speed photography of the plasma does not show any significant change in the plasma size. This suggests a heating mechanism consisting of joule heating of the plasma. In an atmospheric pressure plasma the particles collision frequency is high (10^{11} S^{-1}), the plasma is near thermal equilibrium, this enables the electron density n_e to be calculated by means of Saha equation. This leads to the calculation of electric conductivity of the plasma, following the method used in reference (2). At the temperature distribution of fig. 2 immediately above r.f. coil, at r=0 $n_e = 4.6 \times 10^{13}$ cm^{-3}

While at r= 0.7 cm

$$n_e = 1.25 \times 10^{15} \, cm^{-3}$$

Sometimes magnetic pulse excite oscillations of a frequency which changes with time as shown in fig 3. In addition to these oscillation with persist even after the magnetic pulse large amplitude oscillation of higher frequency are always excited during the first 10 μ S. as can be seen in fig.3.
In another experiment r.f input was modulated by human voice, the same voice, though poor in quality, was reproduced by the plasma torch

***CONCLUSION*:**
The temperature of induction plasma torch (using organ) remains around 10,000 K. The application of a pulsed magnetic field of maximum 1.25 T increases the plasma temperature by 3,000 K. High speed photography shows no change in the size of the plasma, however oscillation are observed on the plasma surface.

***REFERENCES*:**

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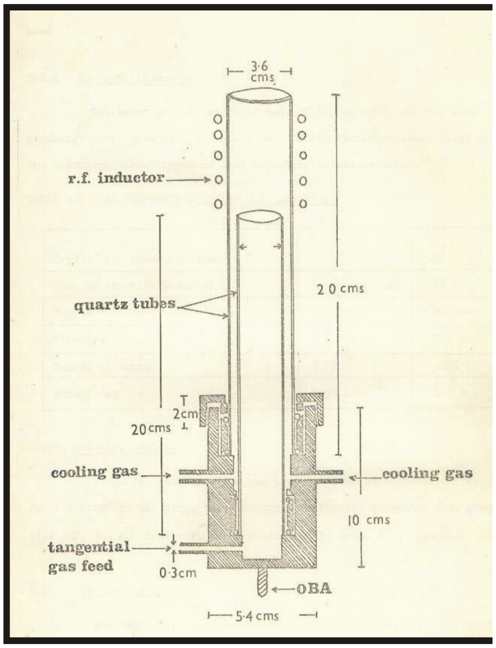

Fig 1 a: Plasma torch

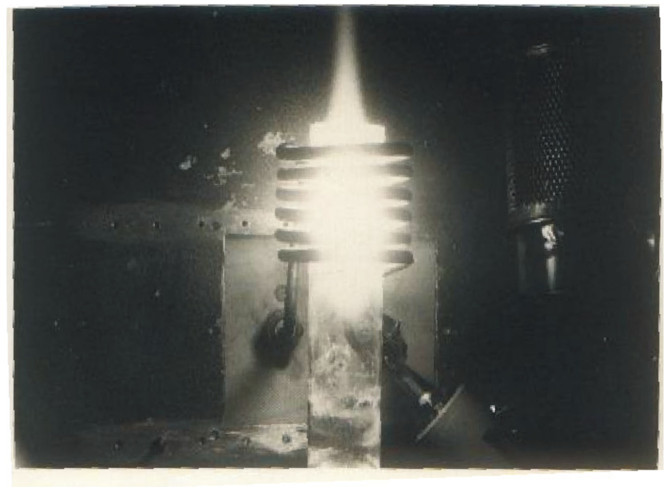

Fig 1 b: The rf Induction Plasma torch

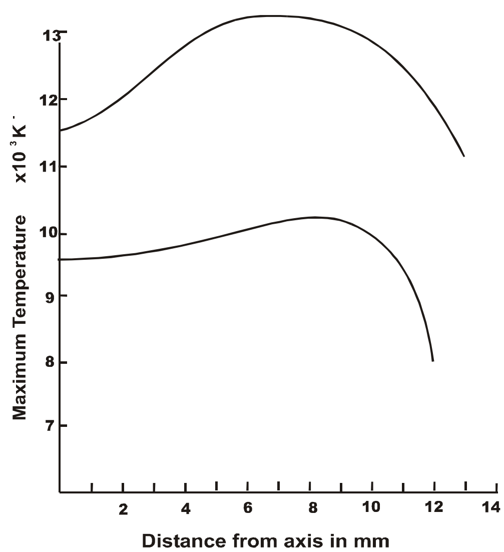

Fig. 2: Temperature distribution in the plasma o.3 cm above the top of the rf coil. a. No. magnetic field

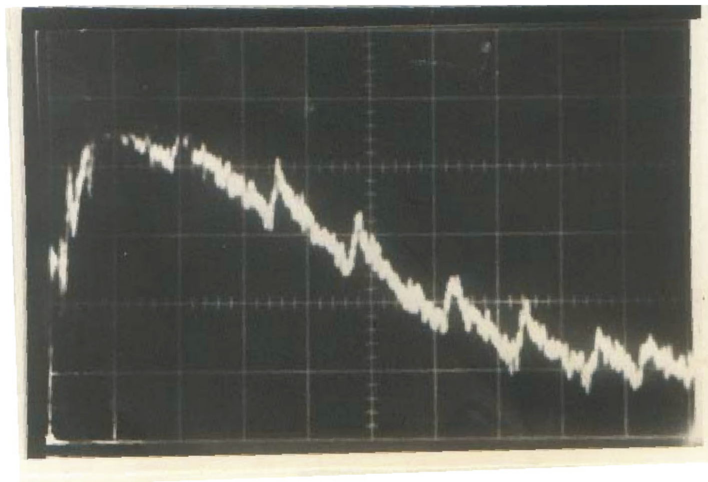

Fig 3: Oscillogram showing the plasma instabilities after the appliation of a 1.25 T pulsed magnetic field.