

EFFECT OF HUMIDITY AND TEMPERATURE
ON THE RELATIVE EFFICIENCY OF STR-
REAMER COUNTER

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ABSTRACT

Investigations were made on the counting characteristics in relation to their dependence on the temperature and humidity. Curves connecting the fundamental parameters are given which are very useful for the design of any required streamer counter.

INTRODUCTION

The efficiency of a corona counter depends on the composition of the air filling. The water vapour concentration has the largest effect on the efficiency of the air filling spark counter⁽¹⁾. Recently more work⁽²⁾ has been done on its effect on the efficiency of streamer counters.

None of the earlier works⁽³⁻⁵⁾ have tried to study the temperature dependence of spark counters in detail. Counce⁽⁶⁾ has expressed the view that it is likely to be slight, but no considerable data on the temperature effect exist until now^(1,7).

The present work is intended to give a clear picture of the effect of both humidity and temperature on the operating characteristics of streamer counters.

APPARATUS

The streamer counter has been described elsewhere⁽⁸⁾ so that only a brief account may be given.

A highly polished stainless steel plate serves as cathode. Anode wire of diameter 0.29 mm is held tightly parallel to the cathode at a distance of 7 mm. The effective length of the cathode is 72 mm and 10 M Ω total resistance connecting anode to H.V.

EXPERIMENTAL RESULTS

(A) Effect of Humidity On the Relative Efficiency of Streamer Counters :

In The present work the dependence of the efficiency of the wire plane streamer counter on the concentration of the water-vapour in the filling air has been measured in the streamer region.

The counting characteristics are shown in ^{Fig.(1)} for various relative humidity extending from 30% to 100%.

The start of the corona streamer pulses V_{ac} increases with the increase of the amount of the water vapour in the counter, while the limiting voltage V_{as} remains nearly the same whatever may be the value of the relative humidity,

except for R.H. = 100%.

The observed dependence of the efficiency of counting on the moisture is a deficiency of the streamer counter, and in carrying out a number of measurements the counter must be placed in a closed enclosure, inside which the relative humidity has to be kept always constant during the running time of the experiments.

Fig. (2) represented the curve of the relative efficiency E_r $\left[E_r = N(x\%) / N(30\%) \right]$ i.e. the plateau counting rate relative to the counting rate of relative humidity 30% as function of the relative humidity.

From Fig. (2) we see that there is a rapid fall in the efficiency of counting on decreasing the humidity until R.H. is $\sim 40\%$ beyond which it decrease somewhat slowly with further decrease of the R.H. The increase in the efficiency of the streamer counter by increasing the humidity, apparently is linked with the formation of heavy negative ions. Increasing the humidity increases the probability of forming heavy negative ions and so as a result of this diffusion is decreased. This fact may bring about the development of streamer counter to operate under more favourable conditions and consequently counting alpha particles with greater efficiency. It is clearly seen from the current curve that the variation of humidity does not affect the corona current. But when V_a

increases the corona current I increases in a good agreement with the following empirical formula determined from the present experimental results applying the least - squares fits.

$$I = 1.5334 \times 10^{-12} V_a^2 + 0.0082 \times 10^{-6} V_a - 126.38 \quad (1)$$

Fig. (3) shows I vs. V_a given by equation (1). On the same figure are represented experimental values which show good agreement with the computed values.

This phenomenon is different from previous observed experimental results⁽²⁾, while in good agreement with that observed by Andreeschchev et al.⁽¹⁾, who had detected no change in the corona current for spark counters.

The internal resistance r_d of the anode-to-cathode discharge space has been determined as function of V_e which is determined by the relation

$$r_d = \frac{V_e}{I} \quad (2)$$

Fig. (4) shows the results. It is obvious that there is a gradual increase of r_d with decrease of V_e coming at the plateau threshold to a very steep rise.

Fig. (5) represents the a.c. resistance r_a vs. V_e which is given from the equation :

$$r_a = \frac{dV_e}{dI} \quad (3)$$

It is clear that r_a decreases with increasing V_e .

(B) Effect of Temperature On the Relative Efficiency of Streamer Counters.

To study the temperature dependence it is essential to allow for the apparent change in the range of particles caused by the change in the density of surrounding air as the temperature is changed.

This experimental work has investigated the effect of the variation of temperature on the streamer counter characteristics. For this purpose a counter with electrode separation 7 mm & anode wire of diameter $\phi = 0.29$ mm with 10 M-external resistance connecting anode to E.H.V. were used. The counting characteristics are shown in Fig. (6) for various temperature extending from 30°C to 80°C. The results indicate that the sensitivity of streamer counter is somewhat dependant on the temperature. Also it shows that the start of the corona streamer pulses increases with the increase of the temperature, in the same time a decrease in the length of the plateau is evident. However, a small positive plateau slope is noticed at 80°C.

Applying the least-square fits to experimental results of corona current which are represented in Fig. (7) by circles empirical formulas of the second order have been determined for I in terms of V_a corresponding to various values of temperature. These have been represented by the continuous curves in Fig. (7).

Fig. (8) indicates that the relative efficiency of the streamer detector increases gradually slow with the increase of temperature coming to a sharp rise at about 80°C.

The internal resistance r_d can be determined as function of V_e for different values of temperature by equation (2)

Fig. (9) shows the results • It is obvious that there is a gradual decrease in r_d with the increase of the temperature while at large values of V_e a very small variation in r_d is noticed.

Fig. (10) represents the a.c. resistance r_a given by eq. (3) vs. V_e for different values of temperature i.e. $T = 30, 40, 50, 60, 70, 80^\circ\text{C}$. It is clear that r_a decrease with the increase of the temperature and that a small variation in r_a is observed at high values of V_e .

Thus we conclude that the efficiency of streamer counter depends on the composition of the gas filling as well as its temperature. The water vapour concentration was the largest effect on the efficiency of the air filling streamer counter.

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تأثير الرطوبة ودرجة الكفاءة النسبية للعداد الحراري

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ملخص البحث

درس تأثير كل من درجة الحرارة والرطوبة على خصائص العداد الفيزي
 ودرست المنحنيات التي تربط متغيرات العداد المختلفة . وقد وجد ان تأثير
 الرطوبة على كفاءة العداد النسبية كبيرا اذا قورن بتأثير درجة الحرارة عليها .

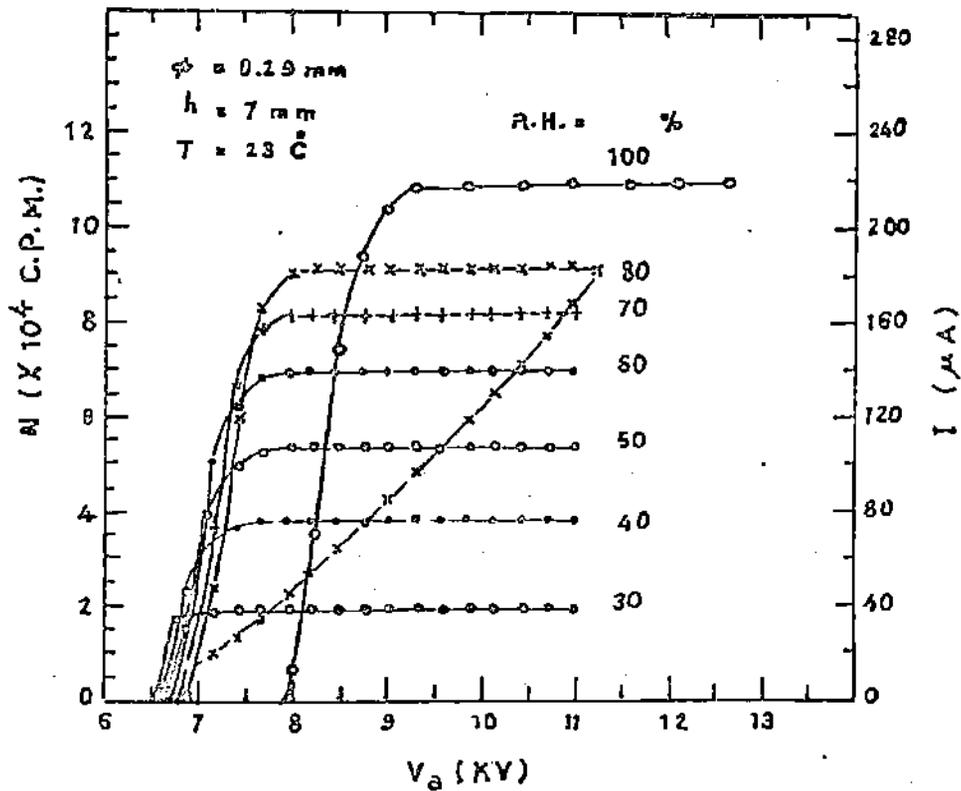


Fig. 1 Counting characteristics for different values of relative humidity.

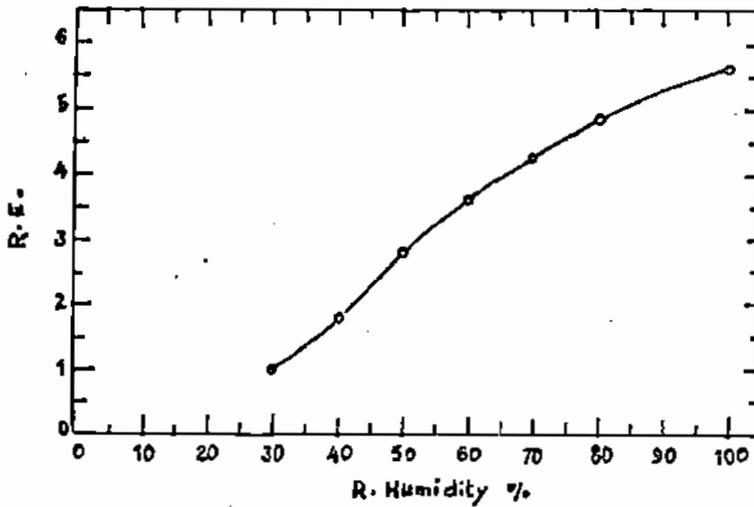


Fig. 2 Relative efficiency E_r VS relative humidity .

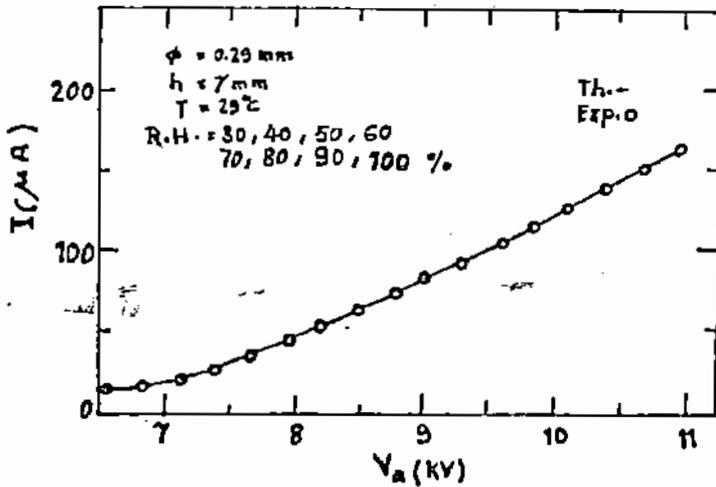


Fig. 3 Corona current for different values of R.H. full curve represented I VS. V_a from empirical formula , ooo , represent experimental results .

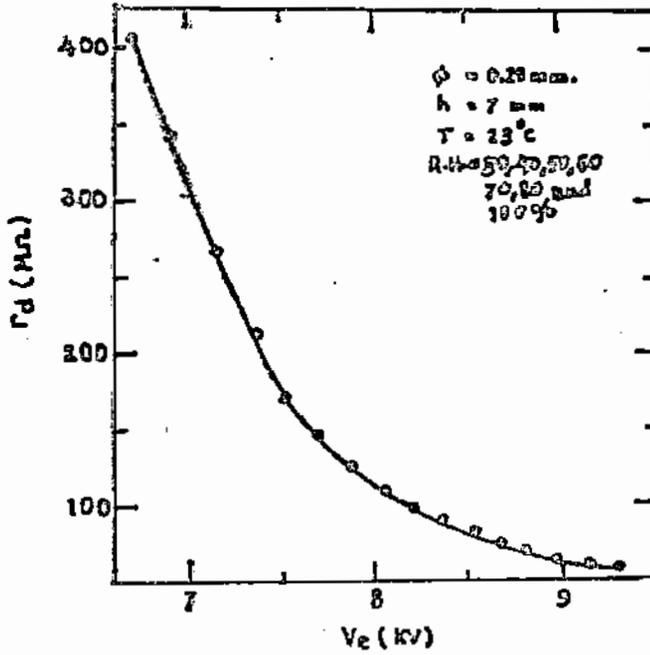


Fig. 4 r_d VS V_e for different values of R.H.

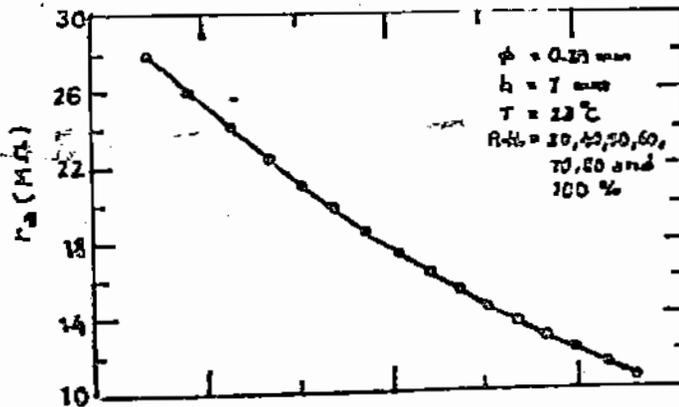


Fig. 5 r_a VS V_e for different values of R.H.

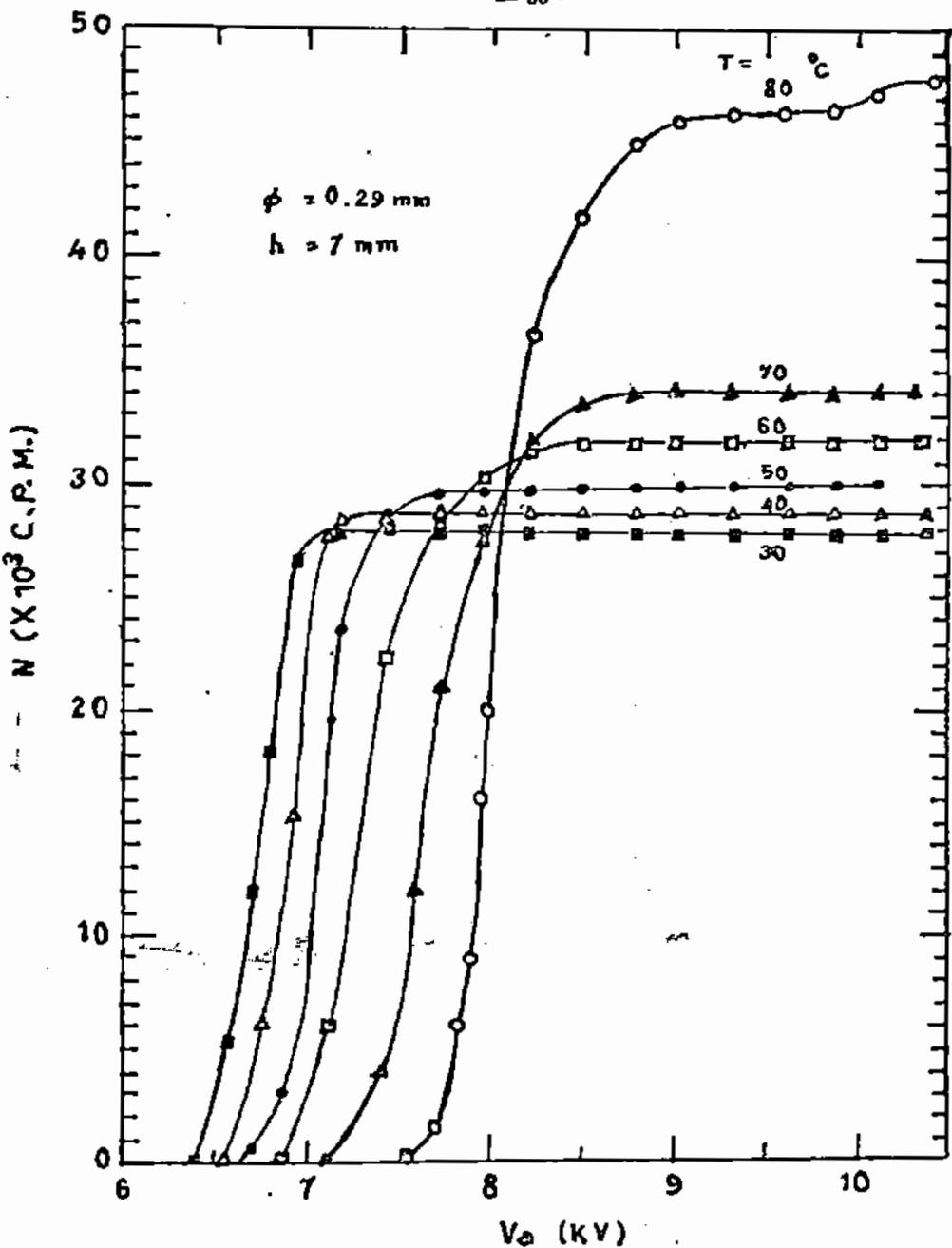


Fig. 6 The counting characteristics for different values of temperature.

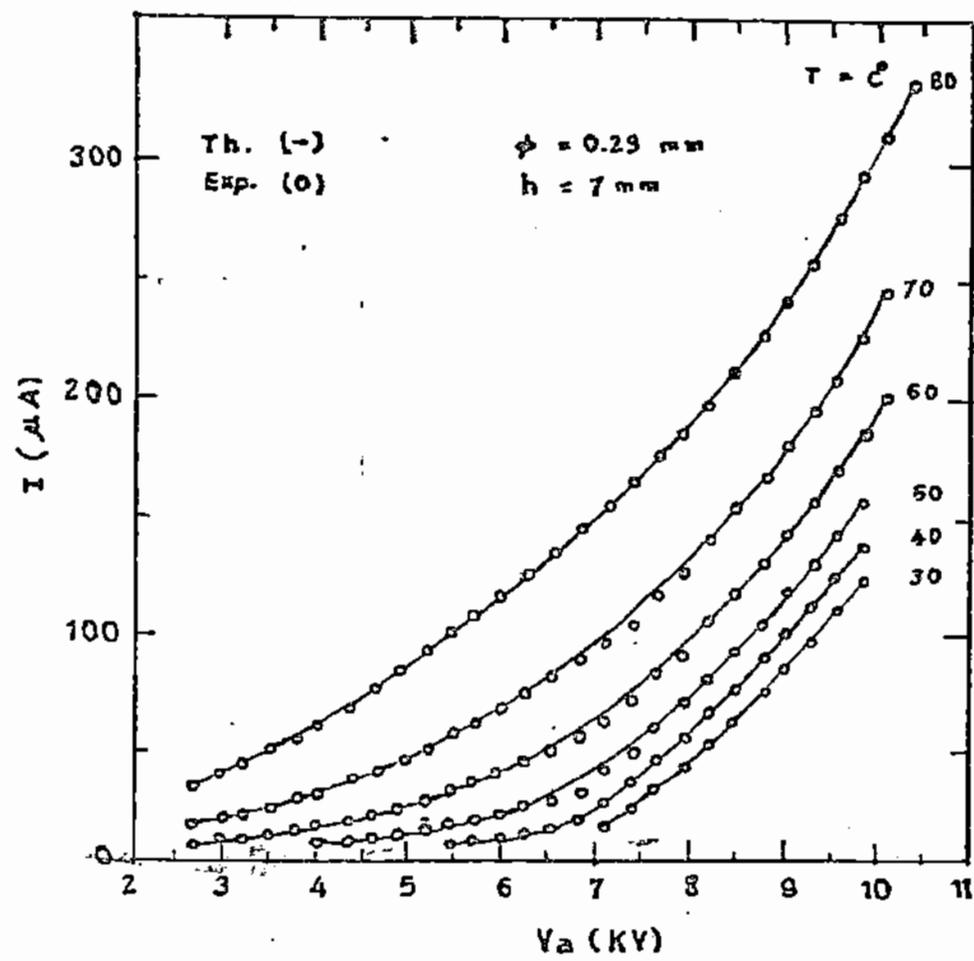


Fig. 7 Full curves represent I VS V_a from empirical formulas $\circ\circ\circ$ represent experimental results, for various values of temperature.

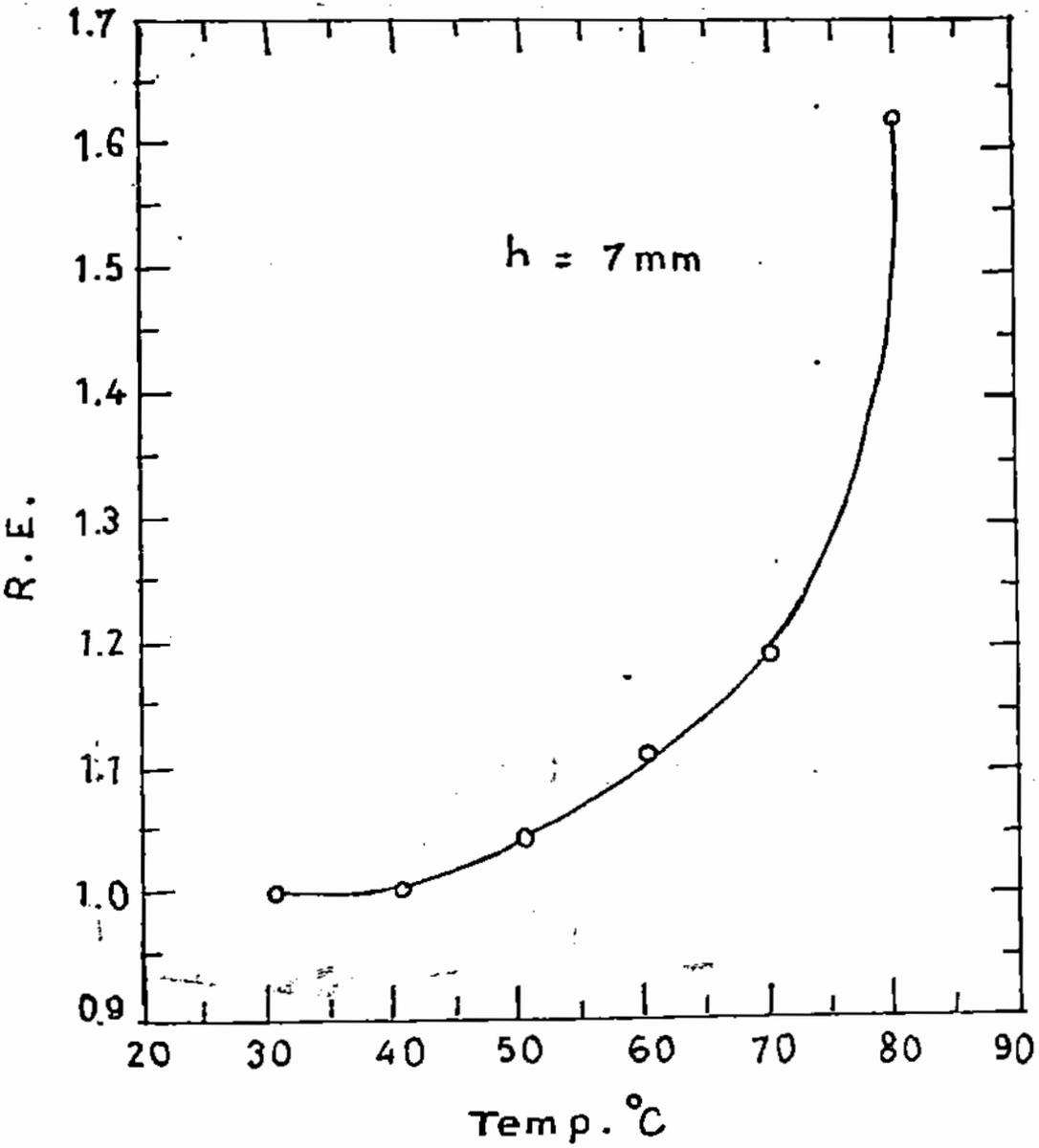


Fig. 8 Relative efficiency (R.E.) VS. temp,

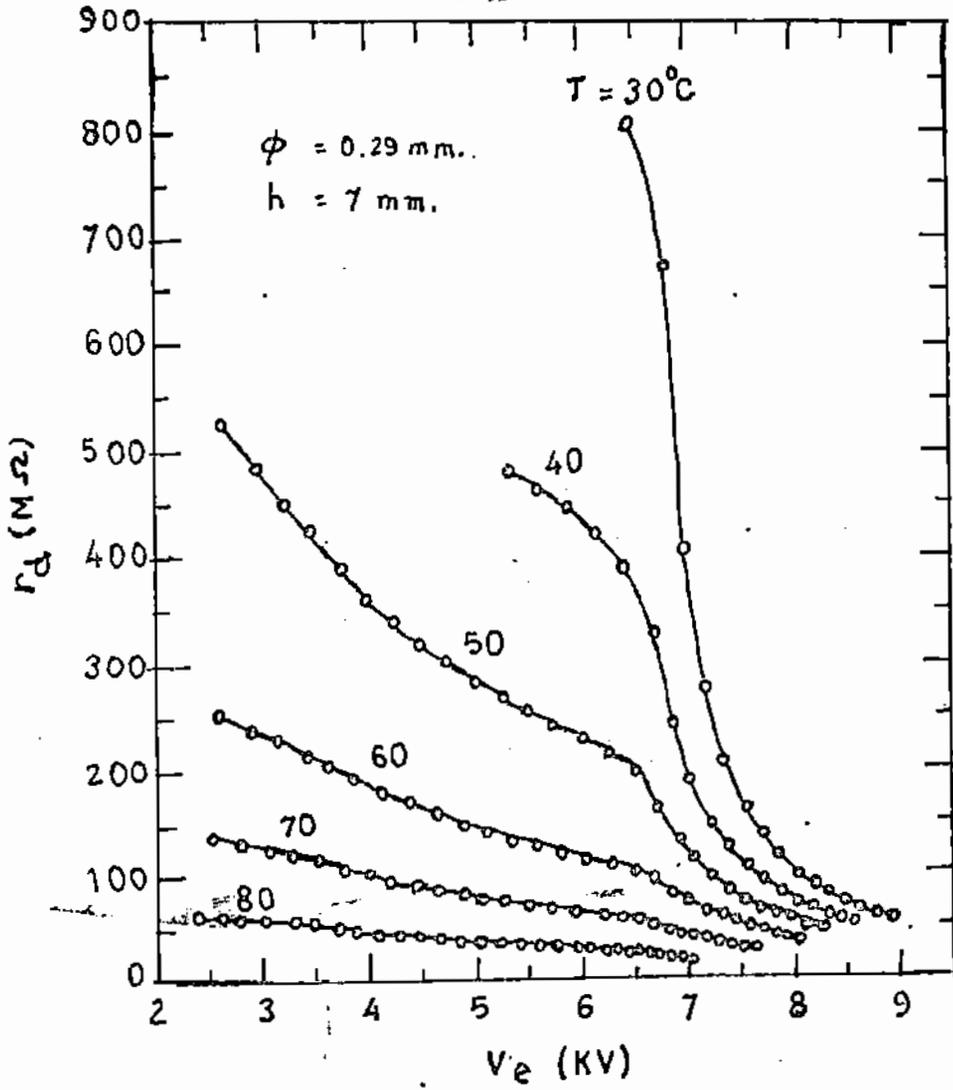


Fig. 9 r_d VS V_e for various values of temperature.

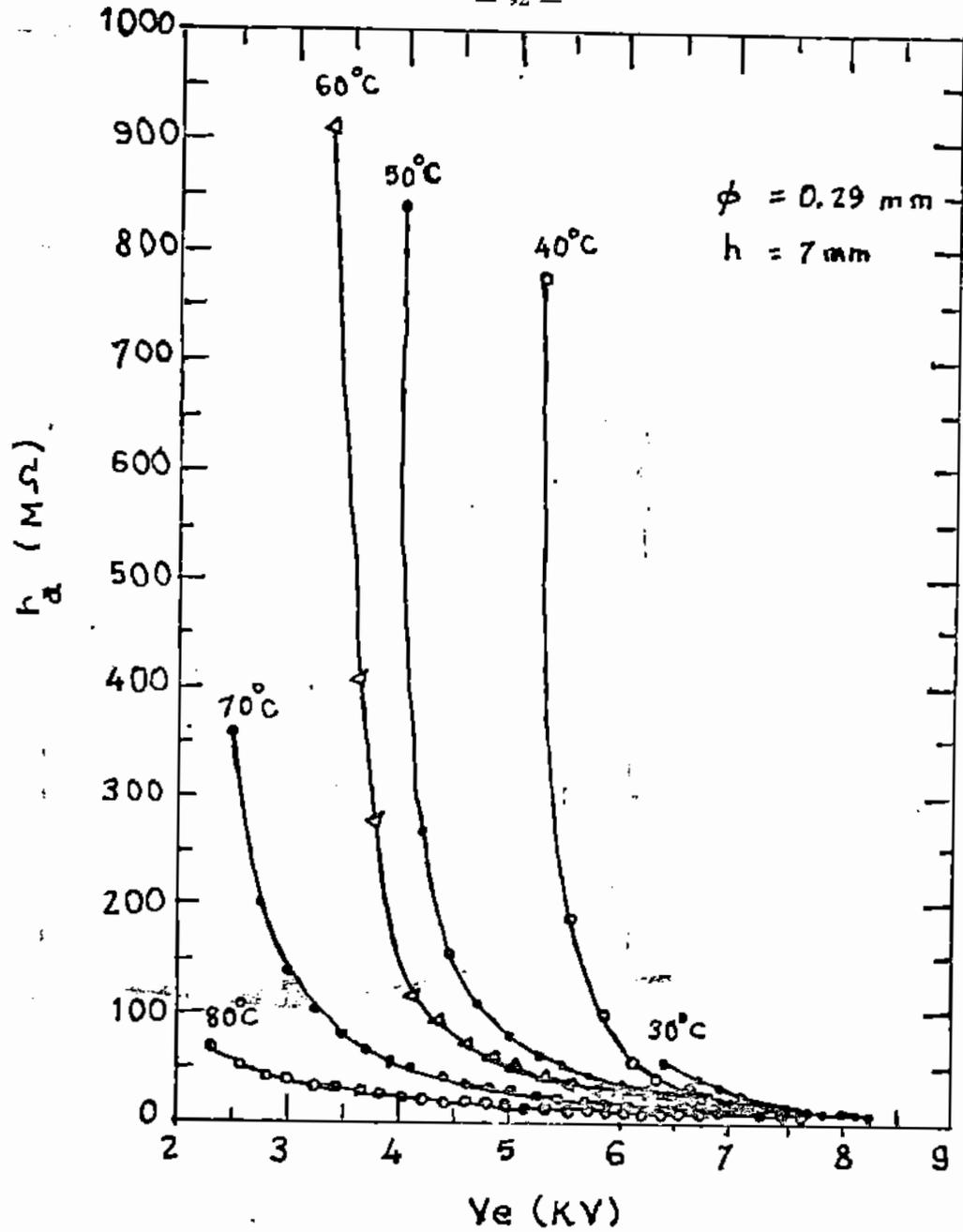


Fig. 10 r_a VS V_e for different values of temperature.

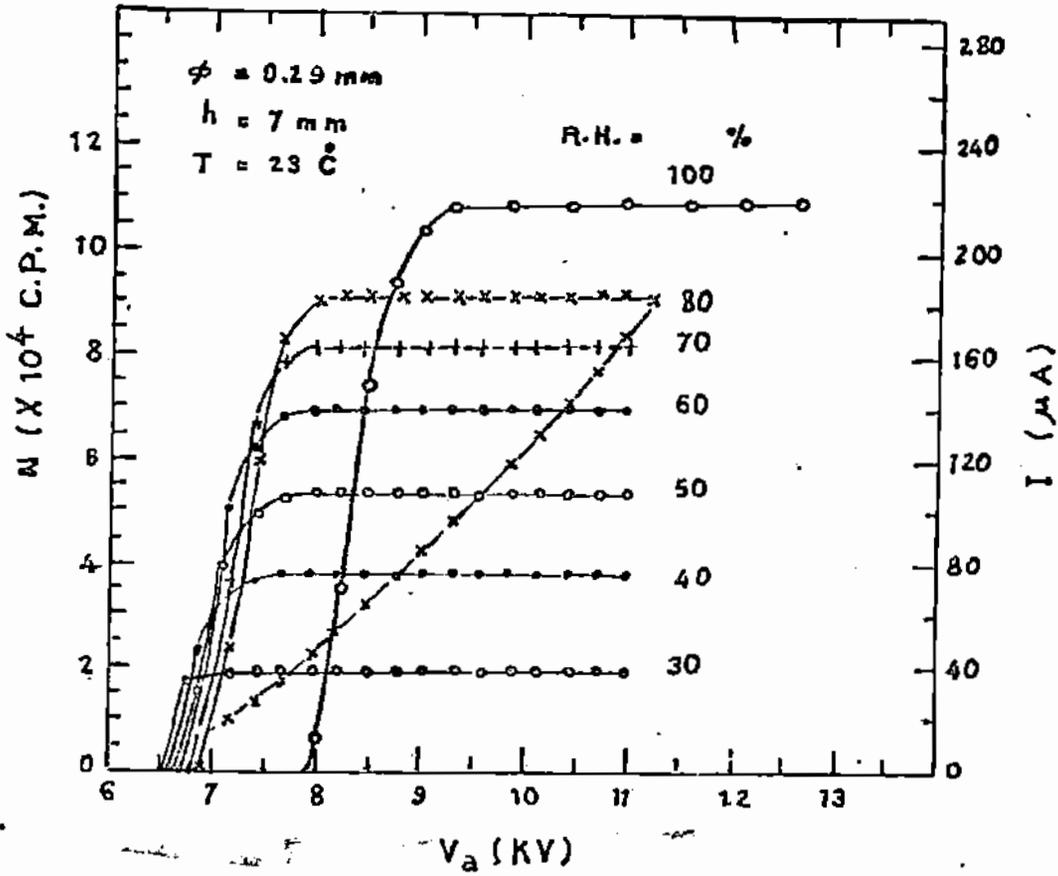


Fig. 1 Counting characteristics for different values of relative humidity.

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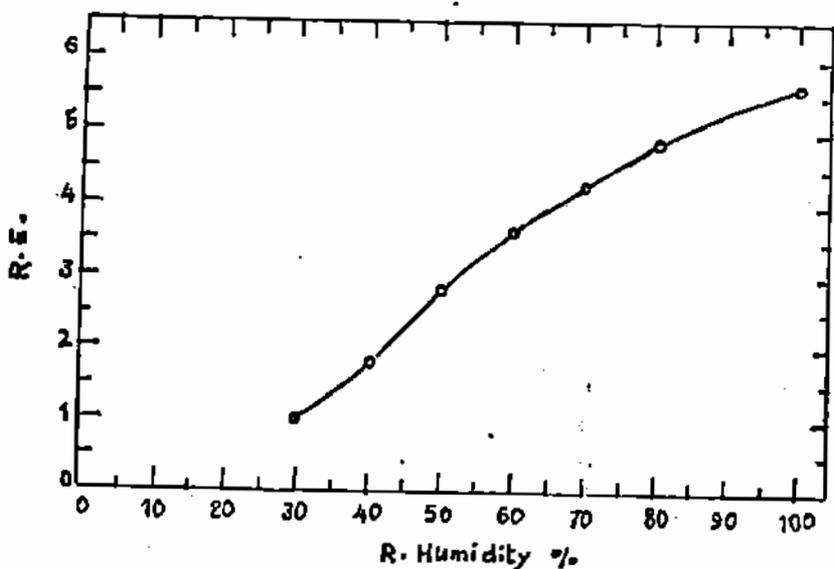


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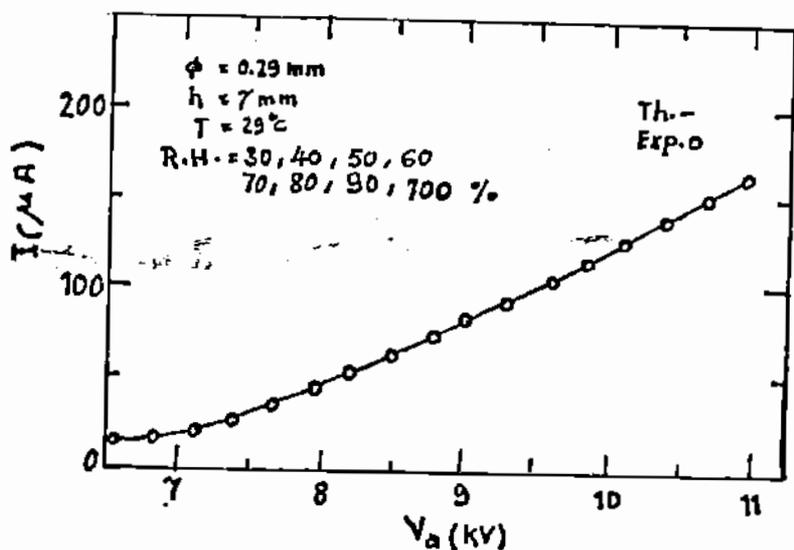


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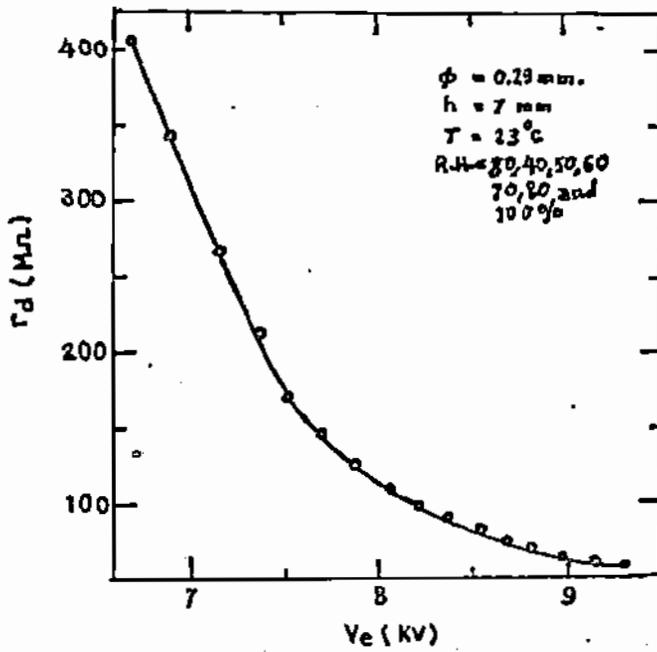


Fig. 4 r_d VS V_e for different values of R.H.

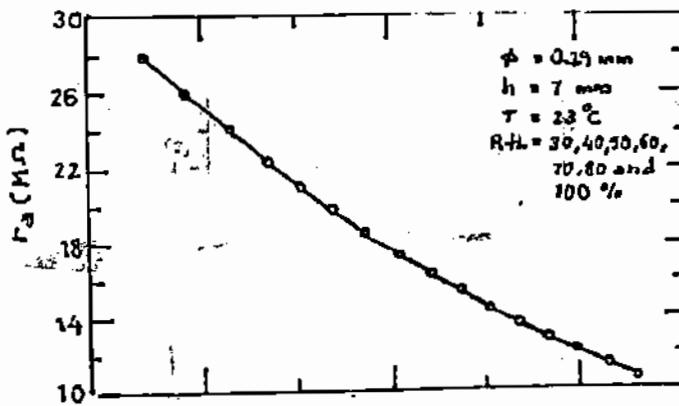


Fig. 5 r_a VS V_e for different values of R.H.

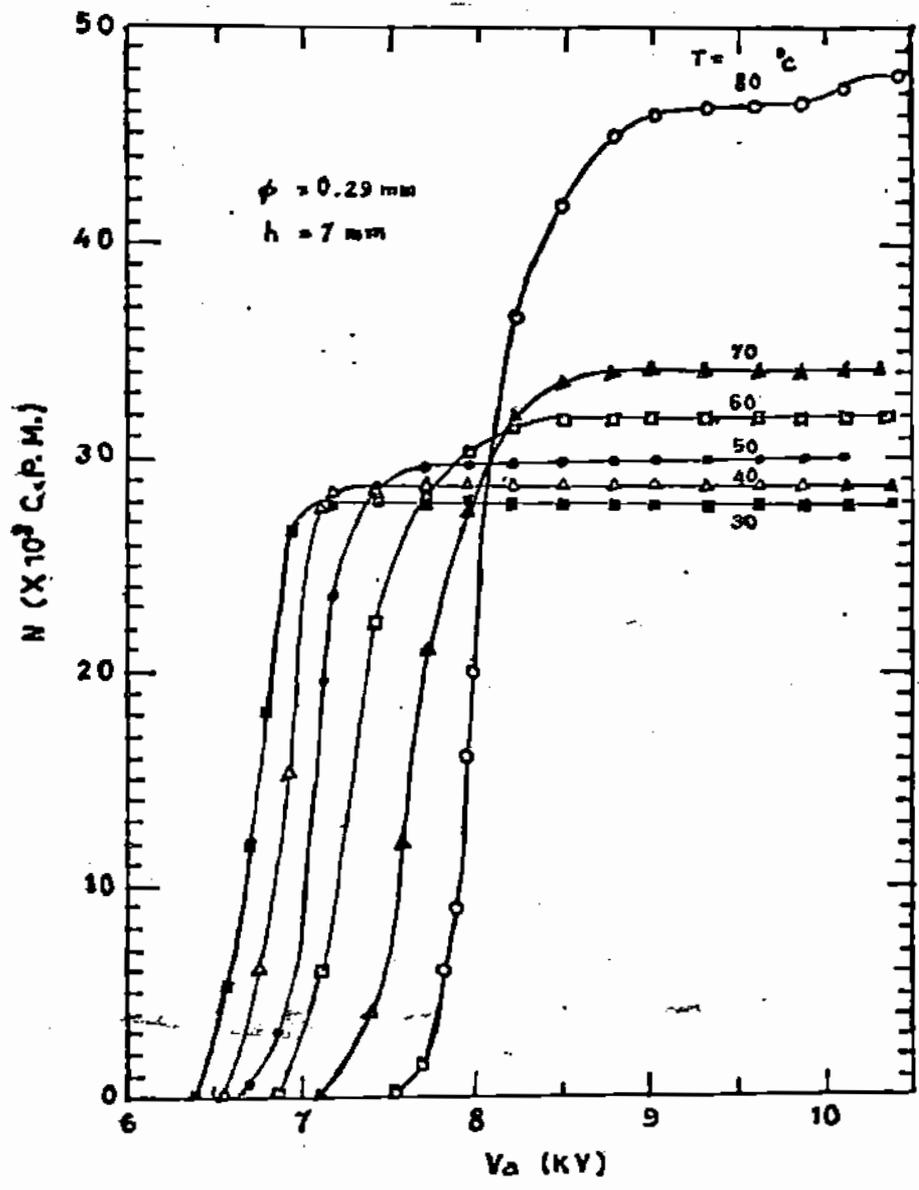


Fig. 6 The counting characteristics for different values of temperature.

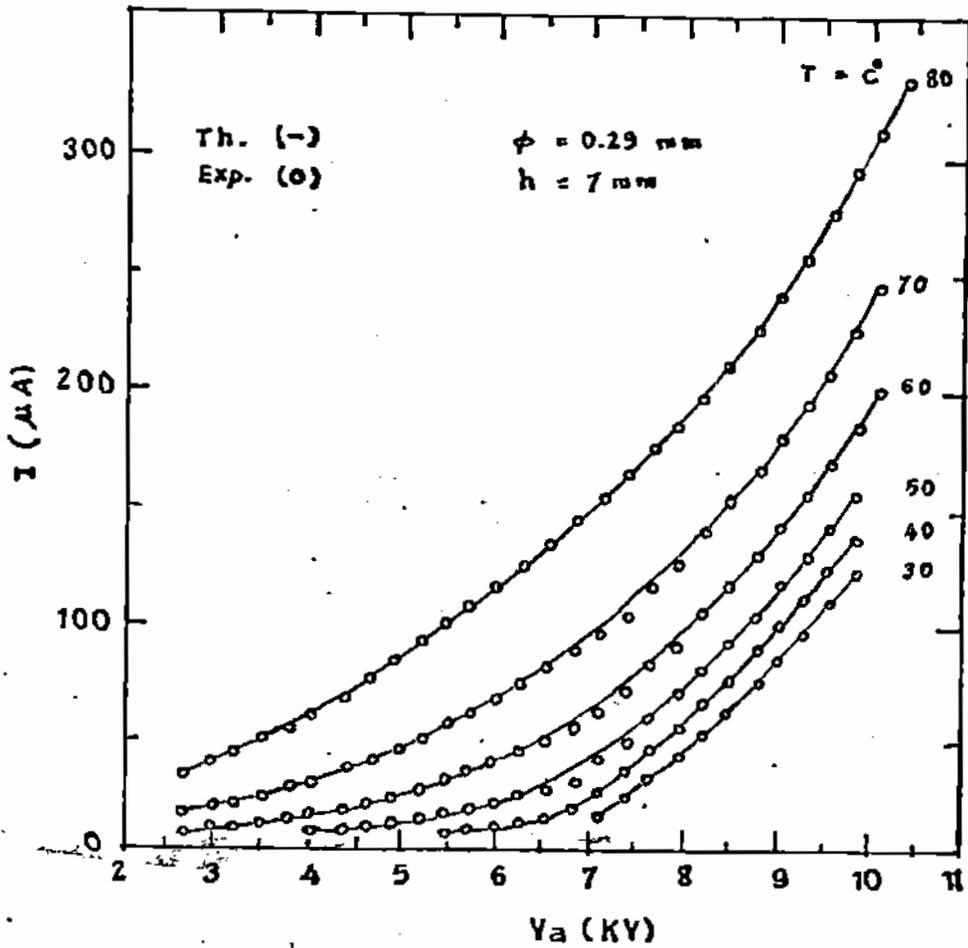


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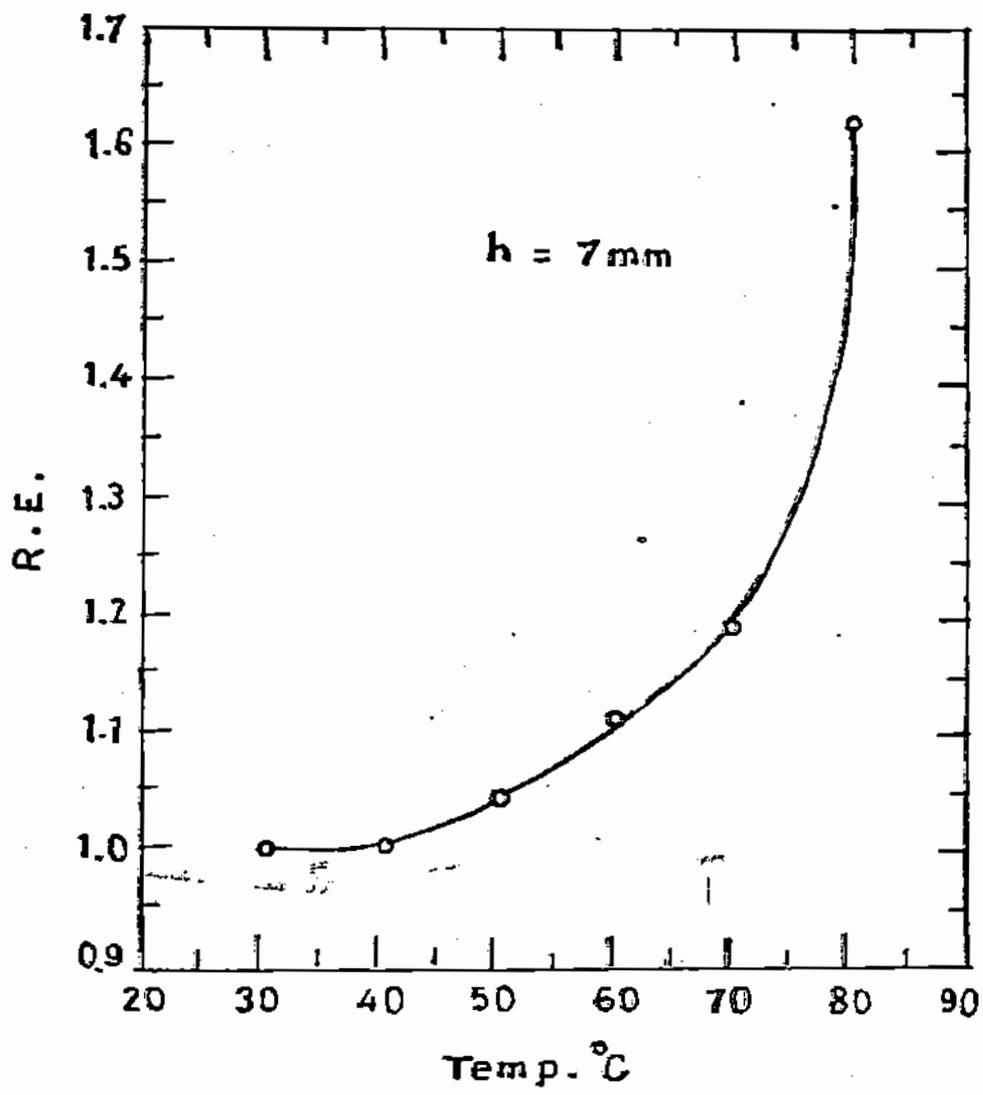


Fig. 8 Relative efficiency (R.E.) VS. temp.

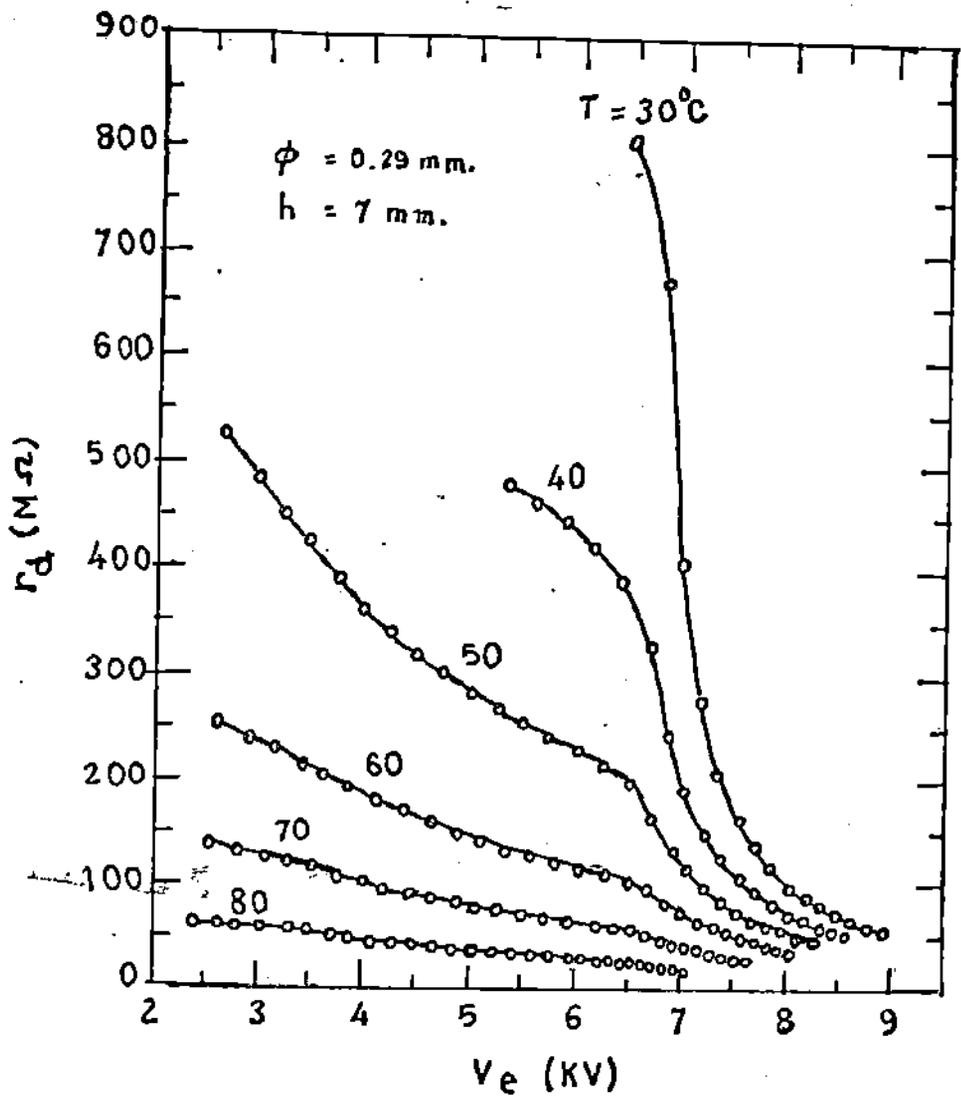


Fig. 9 r_d VS V_e for various values of temperature.

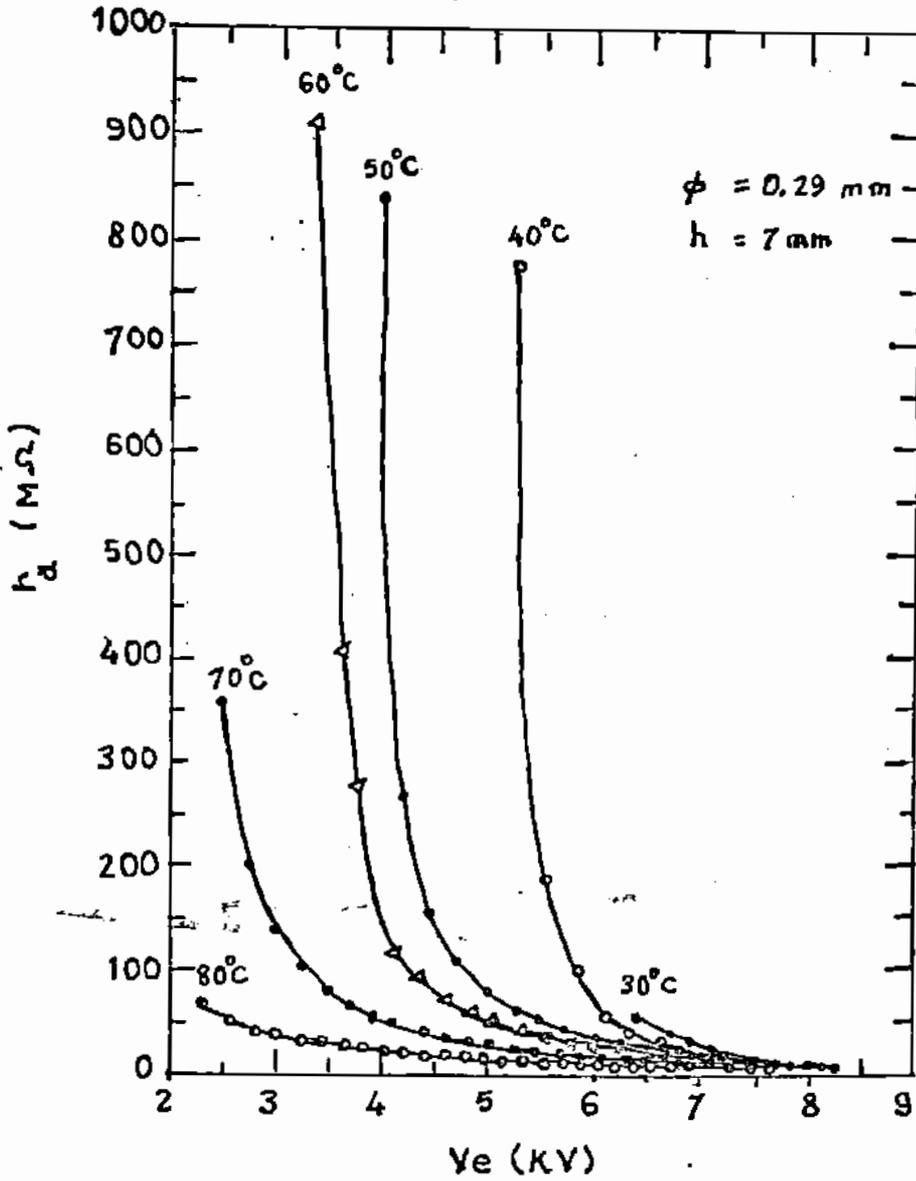


Fig-10 r_d VS V_e for different values of temperature.