MEASURING THE INFLUENCE OF THE PRESSURE CHANGES ON THE GAS FLOW OF PLASMA STATISTICALLY

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ABSTRACT

We studied the influence of the change in pressure on the flow of gas plasma statistically, using chi-square distribution method. Through the theoretical calculations of this method we concluded that any change in the apply pressure causes a change in the flow of gas plasma. It was a forward change, as the diagram of (pressure-the flow of the seen gas, pressure-the expected flow of the gas) relations shows.

قياس تفاوت الضغط في مجرى غاز البلازما أحصائيا

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خلاصة

قمنا بدراسة لقياس تفاوت الضغط في مجرى غاز البلازما أحصائيا بأستخدام طريقة توزيع كاي. ومن خلال الحسابات النظرية لهذه الطريقة توصلنا الى ملاحظة انه عند حصول اي تغير في الضغط المسلط يؤدي الى حصول تغير في مجرى غاز البلازما. وكان نوع التغير الحاصل طردي كما توضح لنا من خلال الرسوم البيانية للعلاقات (الضغط- مجرى الغاز المشاهد)، (ضغط- مجرى الغاز المتوقع).

WHAT IS PLASMA?

A useful definition of plasma is aquasineutral gas of charged and neutral particles which exhibits collective behavior. This statement highlights the transition between a "weakly ionized gas" (where the ionized a toms are influenced in the main by short- range collisions) and a plasma.

In plasma, charge separation between ions and electrons gives rise to electric fields, and charged particle flows give rise to currents and magnetic fields. These fields result in action at a distance, and arrange of phenomena. (1)

INTRODECTION

In recent years, glow discharge techniques have found increasing application in fabrication of semiconductor devices (e.g. photo resist removal, plasma etching, and deposition). (3)

A plasma containing a variety of high reactive particles, ions, free electrons and free radical. The range of electron energies are between 1-20 e V and ion densities are normally between $10^{9} - 10^{12}\,cm^{-3}$.

More than 90% of the particles in such plasma can be free radicals which constitute the main source of the plasma's intense reactivity. (2)

PLASMA PARAMETERS

In this section we describe the salient properties of a group of charged particles. Some of these properties are so general, e.g., temperature and pressure, that they apply to all states of matter. (4)

A. TEMPERATURE PARAMETER

The concept of temperature is a very precise one. Only if a collection of particles exists and only if that collection has a certain distribution of particle energies, may a temperature be defined. That distribution is called a Maxwellian.

It is not necessary – in fact it is a rarity – for plasmas to be exactly Maxwellian. Even the average energy of particles may dramatically vary between different locations in the containment vessel.

In spite of all this, the concept of temperature, or at least of an average energy, is useful in a local description of plasma.

B. DENSITY PARAMETER

A second important parameter describing a plasma is its density. This too is of critical importance in determining reaction rates. As stated earlier, the densities of positive and negative charges are locally balanced, usually to better than 1%. Across a plasma device, though, the densities can vary a hundred- fold or more.

One usually aims at keeping the density high near the work surface if it is desired to have plasma, bombardment of that surface. But there are applications where plasma bombardment is undesirable, such as when lattice damage or arcing might occur.

C. PRESSURE PARAMETER

The product of plasma density time's temperature gives the plasma pressure. This quantity is a measure of how well used is the energy provided to form the plasma.

The energy confinement time is the ratio of the stored energy (plasma pressure times the plasma volume) to the input power.

As will be seen later by an application of this concept, different methods of plasma formation and confinement place quite different requirements on the power supplies used to generate and to maintain the plasma and also affect where the input power is ultimately deposited.

CHI-SQUARE DISRTIBUTION

It is from the continuous probability distributions the important in statistics. Who first decryption chi –square distribution was Kral pearsor in 1900. (5)

To chi – square distribution wide applications such as:-

1. Test of goodness of fit.
2. Test of independence.
3. Test of binomial distribution.
4. Test of multinomial probability distribution.
5. Test concerning the equality of several variances.

APPLICATION DISCUSION

The gas flow of plasma changes at the pressure change, to prove this hypothesis we measured the pressure change in the gas flow of plasma statistically, by using chi – square distribution.

The application was as following:-

1. Formulation of the null and alternative hypothesis

   H_0: Find change in plasma when the pressure changes.

   H_1: Find no change in plasma when the pressure changes.

2. Test – statistic

P $mTorr$	$Q \ \frac{mT.liter}{\sec}$	$P+Q$	$E=\frac{(P+Q)+\sum Q}{\sum(P+Q)}$	$\frac{(Q-E)^2}{E}\times 10^{-7}$
10	2032710.4	2032720.4	2032710.2	0.19
20	4065420.8	4065440.8	4065420.5	0.22
30	6098131.2	6098161.2	6098130.7	0.4
40	8130841.6	8130881.6	8130840.9	0.6
50	10163552	10163602	10163551.2	0.62
60	12196262.4	12196322.4	12196261.4	0.81
70	14228972.8	14229042.8	14228971.7	0.85
80	16261683.2	16261763.2	16261681.9	1.03
90	18294393.6	18294483.6	18294392.1	1.22
1000	203271040	203272040	203271023.6	13.23
2000	406542080	406544080	406542047.3	26.3
3450	701285088	701288538		$\chi^2 = 45.47\times 10^{-7}$

$$V = \pi r^2 h$$

$$= 3.14 * (510)^2 * 448 = 36587872$$

$$t = 30 * 60 = 1800 \sec$$

That: **P**- Pressure of plasma.

V- Volume of chamber.

t - time of gas flow.

Q- Gas flow of plasma **(Seen Value)**.

E- Gas flow of plasma **(Expected Value)**.

3. Selection of the level of significance

We find χ^2 from the distribution tables when $\alpha = 0.95$

Level of significance to $\chi^2 = 1 - \alpha$

= 1-0.95= **0.05**

We find χ^2 (sechdualized) = 2.60321

And

χ^2 (arithmetical) =45.47× 10^{-7}

4. Decision

From through comparison we find:-

χ^2 **(arithmetical) <** χ^2 **(sechdualized)**

To that we accept null hypothesis (H_0)

We find that: - the change in pressure causes a change in the gas flow of plasma.

Through the theatrical calculations we discovered the occurrence of a change in the flow gas of plasma when there is a change in the apply pressure.

To know the kind of this change we draw the graphic relations between Q&P, E&P, as in Fig (1, 2), respectively.

We noticed that when we increase pressure the expected values of the flow gas (E) and the seen values of the flow gas (Q) increase as well. This leads to the increase in the plasma density in side the reaction chamber.

As a result, new types of generated ions appear in addition to free radicals, electrons, variety of neutral species, and so forth from the plasma contents. These new types generated abundantly in the plasma zone gave us a chance to use the plasma technique in many applications to the manufactures as (etching, deposition, photo resist removal).

CONCLUSION:-

1. The change in pressure causes a change in the gas flow plasma.
2. In crease the pressure leads to increase in plasma density.
3. Occurrence in crease in the generated abundantly in the plasma.

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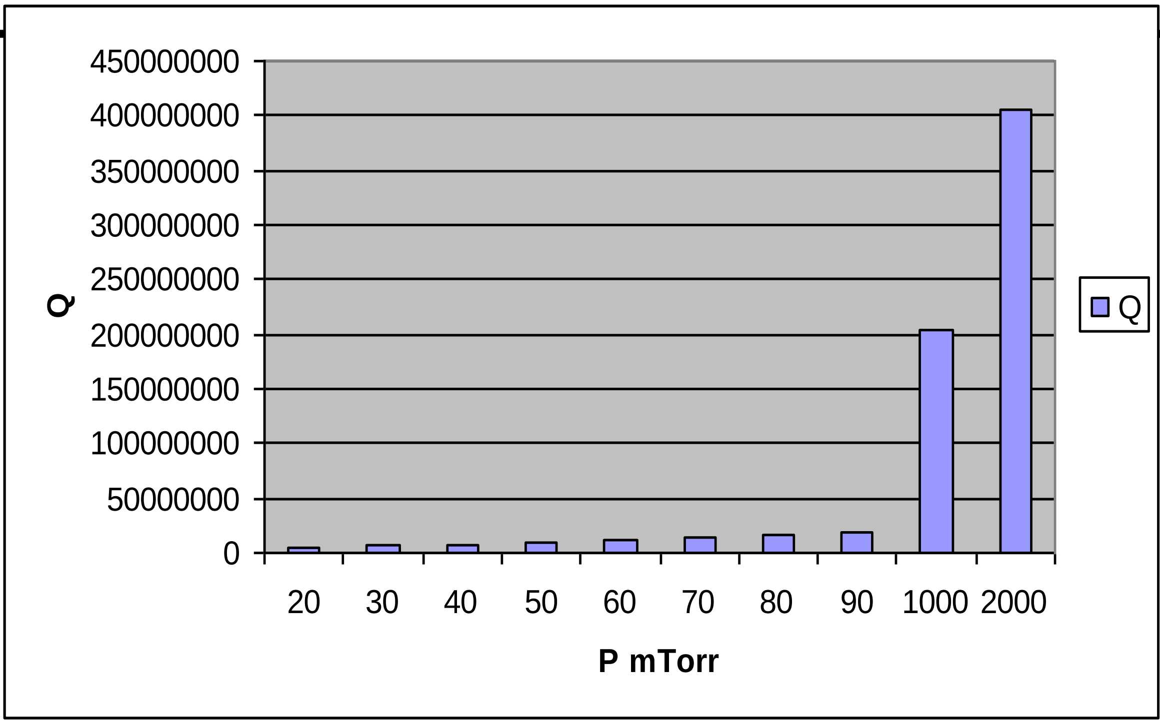

Fig (1) pressure Vs the flow of the seen gas.

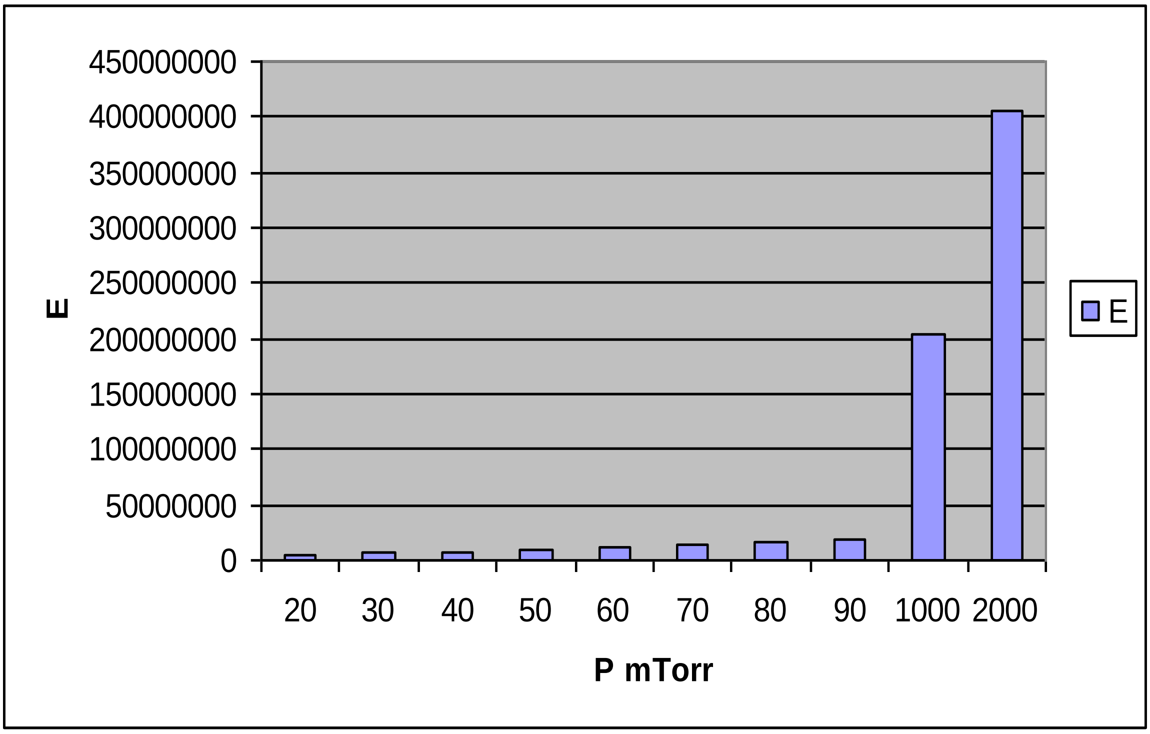

Fig (2) pressure Vs the expected flow of the gas.