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An Experiment for Obtaining Hydrogen and Its Mechanism of Burning

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Abstract-An experiment for getting hydrogen is fabricated. The main emphasis of the investigation is based on hydrogen gas because on igniting it in the presence of oxygen for obtaining fire, its molecular bond is broken. By gaining excess amount of kinetic energy, both the electrons leave from the molecular structure. So the covalent bond is dissociated. It becomes now impossible for the electrons to return even in the atomic level. Because the hydrogen atom is a mono electronic atom and the centre of the atom has been shifted due to the force of repulsion applying in between the relative protons. Due to change of positions of protons, the electrons can not come back to respective original state but wonder for finding the positions for revolution permanently else where. Thus the atomic state of both the hydrogen atoms is also lost. The free charge of protons now exert forces on hydrogen and oxygen molecular gases for breaking the respective covalent bonds in bulk. However the molecular bond of oxygen is also destroyed but the atomic state still remains existing. Because the sharing electrons are returned back to original positions in atomic co orbitals. A whirlwind of energetic electrons separated from the hydrogen and relaxing on co orbitals of oxygen atoms is created. It can be manipulated that these electrons are responsible for emitting flame of fire as radiation of thermal energy. The oxygen atoms play the important role to relax electrons by giving place respectively in the partially vacant co orbitals of 2p sub orbit for taking possession. The excess of kinetic energy of electrons required more than orbiting in the captured co orbitals is transformed as radiation emitted. In this procedure, both the electrons of hydrogen molecule are donated to atomic oxygen for increasing the electronic configuration from 2p4 to 2p6. After accepting electrons, the oxygen atom becomes negatively charged ion by two units. One unit of negative charge is neutralized by one proton of hydrogen nuclei to make OH assembly, and the other unit of negative charge makes the assembly as negatively charged $(OH)^-$ radical. The other proton of hydrogen nuclei $(H)^+$ is also used in making electrovalent bonding between charge constituents by $(H)^+ \rightarrow\leftarrow (OH)^-$ interaction resulting H2O molecule in addition during the process of burning of hydrogen gas for liberating energy.

Keywords- Hydrogen gas, zinc metal, sulfuric acid, chemical reaction, oxygen, reagent bottle, fire, pressure difference, thrust, electrovalent and covalent bonds, Coulomb electrostatic force of attraction, water molecule, exothermic, enthalpy.

I. INTRODUCTION

The atoms are composed of a high inertial mass centred at the nucleus and the electrons of comparatively lighter in mass are as revolving around it. Thus the electrons in atoms can not remain in static positions. However the atoms take part in the formation of molecules like H2, O2, H2O, H2SO4 etc. but the composition of atoms is entirely different when the shape of molecules is designed. Several atoms are distinguished from each other by having different numbers of proton and neutron present in the nucleus. These are called the nucleons and are responsible for the mass number of the atom. Protons have positively charged identity while the neutrons have electrically no any charge. Although the number of electrons revolving around the nucleus is the negative charge identity of a particular atom but the atom is electrically neutral due to the similar number of positive and negative charge constituents [1]. This equality of protons and electrons does not remain the same when atoms are found to make molecules. Thus the assembly of atoms is responsible for the change. The change can occur only in the number of electrons associated by revolving within the atom. It means when the electron does not find comfortable for revolution in the presence of assembly of other atoms, its orbit of revolution can change by two means [2].

1) When the electrons leave the revolutionary orbit from one kind of atom to another kind of atom. Therefore the electrons are given from one atom to another. In the other words, the number of electrons revolving around the nucleus of associated atoms is changed. The donor atom becomes as a positively charged ion while the acceptor atom behaves as negatively charged ion member of that assembly. The Coulomb's electrostatic force of attraction acts to bind the positive and negative charge ions in the equilibrium state of existence. The bond is called the electrovalent bond. The chemical formulae for the molecule is decided by the valency of the participating atoms and the valency is estimated by the number of electrons either donated or accepted by the concerned atoms.

2) When the electrons from the outermost orbit of two atoms are shared for revolution around the nucleus of each other, the shape of the co orbitals for revolution of electrons is changed. Closed cyclic type of co orbitals are established for the revolution of the sharing electrons. In the other words, the number of electrons revolving around the nucleus of associated atoms is increased. Thus both the atoms get bound near to each other for the restructuring of a resulting molecule. The bond is said to be a covalent bond. The valency of the atom taking part in this type of binding of two atoms for the formation of the shape of the molecule is decided by the number of shared electrons taking part from each side of the atom for revolution in the co orbitals for motion around each nucleus successively. These types of co orbitals are entirely different in shape from the circular type of atomic co orbitals.

Atoms are characterized by having co orbitals for electrons to revolve in its own orbit, which has been nominated as co orbital for that electron. These electrons have revolving positions as according to the rule of distribution of electrons. Electrons are primarily distributed around the nucleus at different distances by $2n^2$ rule. Then the electrons are redistributed into sub orbits of s, p, d and f [3]. The actual configuration of electrons is obtainable in view of coupling by considering the orbital and spin quantum numbers for the electrons [4]. This concept of interpretation takes the electron to provide its actual position so- called the co orbital around the nucleus [5]. Thus acquiring of the revolutionary co orbital by any of the electron is governed by a certain mechanism. It means to say that the filling of a sub orbit is ruled by a well defined pattern. All the electrons of s type of sub orbit of all the orbits of the atom have a similar type of configuration of finding the co-orbitals while revolving around the nucleus. The other sub orbits p, d and f have also entirely different locations of finding the relative co orbitals. The individuality of a co orbital plays an important role for the stability of the atom. The phenomena of coupling between electrons is considered by giving a place to coupling electrons in co orbitals situated perpendicularly aligned to each other. In s type of sub orbit, there is only one pair of two electrons which couple with each other. In p type of configuration, only six electrons in three pairs of coupling can revolve. Similarly d and f type of configurations will have five pairs of ten electrons, and seven pairs of fourteen electrons respectively. The coupled electrons are designated for pairing by having $\pm$ 1/2 spin quantum numbers and revolving in co orbitals lying mutually in perpendicular directions. The number of such paired electrons can be easily shorted out by knowing the capacity of the concerned sub orbit. The orbital quantum number $l = n-1$ plays the main role of giving place for revolution in order to isolate according to the value of orbital quantum number alloted. The orbital quantum number can have $2l+1$ values total from $+l$ to $- l$. Thus co orbitals are the actual positions of electrons for revolution in atoms based on the theory of atomic quantum numbers.

II. THEORY

This is very interesting to discuss about the popularity of chemical bond during the formation of a molecule. Generally two types of bonding between the two atoms is undertaken for consideration.

The donation of electron by one kind of atom and accepted by the other kind of atom is simply used in electrovalent bonding. Because the electron can not remain with out motion. If it is donated to any other kind of atom then it becomes important to know the transition of electron from one state of one type of atom to another state of other kind of atom. Because it is being ejected from one energy level to another during such electronic transition.

In oxygen atom the outermost p sub orbit consists $2p^4$ electronic configuration. This sub orbit can bear maximum six electrons in three pairs of co orbitals. The $2p^4$ electronic configuration of oxygen atom shows that one pair of co- orbitals is already existing. Only two electrons are uncoupled and need coupling. Suppose two electrons are donated to oxygen by any other type of the atom, then the accepted electrons will go to revolve in two different co orbitals for changing the electronic configuration of oxygen from $2p^4$ to $2p^6$. Three pairs of coupling of electrons would be found in six co orbitals for revolution in fully filled $2p^6$ sub orbit. In a paired set of electrons, the co orbitals for those must be found mutually perpendicular.

In contrast, the sharing of electrons takes place by the two atoms for binding with each other for making covalent bond. Because the electrons can not remain without revolution hence revolve associated with both the nucleuses. Thus the number of electrons revolving around each nucleus is increased by the shared number of electrons. The orbit of revolution for such electrons gets a new shape.

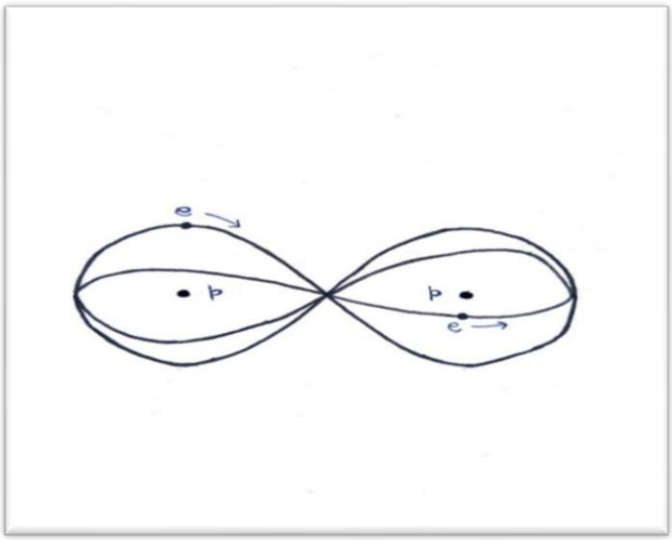

Figure 1. Exhibition of closed cyclic co orbitals responsible for structuring the hydrogen molecule.

In this study, the covalent bonding for the molecules of hydrogen gas is designed. The molecular formation occurs by the combination of two hydrogen atoms. In hydrogen atom, the mono protonic nucleus is surrounded by the single circular co orbital of an electron by revolution. Therefore in atomic hydrogen, only one electron revolves in $1s^1$ electronic configuration around the nucleus Two hydrogen atoms are unitedly to bound for making the molecular form as H2. The formation of H2 molecular gas from two hydrogen atoms can be understood on the basis of covalent bond between two hydrogen atoms by sharing one electron. When two atoms of hydrogen come to near each other, each electron of the atom is also being attracted by the nucleus of other atom. As a result, electrons have no any option to share motion around both nucleuses. The circular co orbital of each electron takes the shape of a closed cyclic type of co orbital. Thus the electronic configuration of each hydrogen atom changes from $1s^1$ to $1s^2$ necessary for binding mutually with each other in the molecular form of hydrogen gas. For affiliation with coupling to take place between this pair, both the electrons follow motion in two separate but mutually perpendicular closed cyclic co-orbitals. Thus due to association of both the electrons with both the nuclei, two atoms are said to be bounded by covalent bond. Figure 1 shows its exhibition of binding for the formation of hydrogen molecule H2 by covalent electrons.

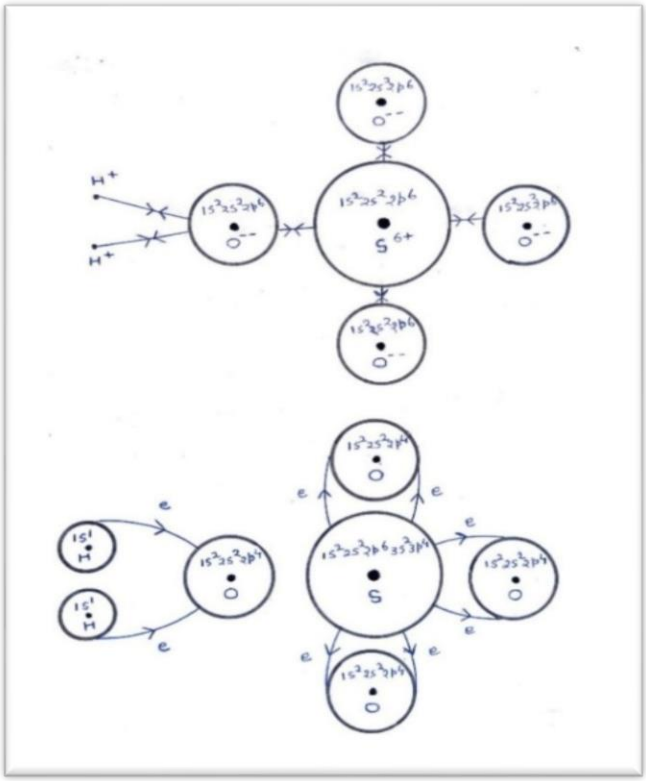

Figure 2. Exhibition of identities of sulfuric acid for the displacement of hydrogen gas from it.

In oxygen atom, four electrons are found in the outermost p type of electronic configuration of co orbitals. During the formation of oxygen molecule from its two atoms, two electrons are shared by each of the atom for common motion around each nucleus of oxygen atom. Due to configuration of $2p^4$, one set of paired electrons already exist in p sub orbit, hence this pair will still remain associated with each atom in co orbitals provided for revolution. But two uncoupled electrons of each oxygen atom take part in sharing co orbitals for common motion around each nucleus of oxygen atom. Hence the shape of circular co orbitals of these four electrons is changed into closed cyclic co orbitals. Four closed cyclic co orbitals are created in view of coupling mechanism. Therefore two sets of paired electrons moving in mutually perpendicular closed cyclic co orbitals will be the uniqueness of motion of electrons while revolving around both the nucleuses. The association of both the atoms as a result of sharing of co orbitals for revolution of electrons around both the nucleuses make a bond for the existence of oxygen in its molecular form as described by O2. The outer most electronic configuration around each nucleus is now changed from 2p4 to 2p6. Out of 6 electrons, two of the electrons revolve by coupling mechanism in the already existing atomic circular co orbitals. And, four electrons in two sets of paired electrons revolve by coupling mechanism in the closed cyclic co orbitals generated for the formation of oxygen molecule by the use of covalent bonding between the two atoms.

III. EXPERIMENTAL

Hydrogen is such an element which has made its first placing number in the periodic table of groups of elements. Hence it is the lightest of all the atoms. It is found in the upper atmosphere due to its less density than air. It is rarely found in earth's surface. It rises towards the upper atmosphere. Hydrogen can be prepared in the laboratory only. Zinc metal is the most popularly used element for obtaining the H2 gas experimentally by its chemical reaction with dilute H2SO4 [6]. It is observed that this chemical reaction is a very fast and so easily reactive. The aim of this investigation is to make hydrogen gas for the sake of knowing its unique property of inflammability. However the chemistry of hydrogen is very common but in this investigation it is studied in view of correlating the various scientific facts associated with the findings. The chemical reaction occurring can be written with the help of following chemical equation.

$$\mathbf{Zn + H2SO4 = ZnSO4 + H2}$$

In sulfuric acid of formulae H2SO4, the acidic radical $SO4^{--}$ is present due to the formation of it in the presence of $2H^+$ ions. For understanding the existence of $(SO4)^{--}$ in H2SO4, the electronic configuration of hydrogen, oxygen and sulfur is compulsorily needed to take into account as following -

$$\mathbf{1\ H = 1s^1}$$
$$\mathbf{8\ O = 1s^2, 2s^2, 2p^4}$$
$$\mathbf{16\ S = 1s^2, 2s^2, 2p^6, 3s^2, 3p^4}$$

The mutual positions and the combination of atoms is exhibited in figure 2. The sulfur atom is surrounded by four oxygen atoms for making $(SO4)^{--}$ sulfate radical. The sulfur atom donates total 6 electrons from its $3s^2$ and $3p^4$ sub orbits to three oxygen atoms positioned at one side of the sulfur atom. Out of these six electrons, two of the electrons are captured by each of the three oxygen atoms. The fourth oxygen atom takes the position towards the two hydrogen atoms. Both the electrons are donated by hydrogen atoms and are captured by the fourth oxygen atom. On donating electron, each hydrogen atom behaves as a positively charged nuclei ion by one unit. Finally each of the oxygen atom, due to change of its electronic configuration from $2p^4$ to $2p^6$ carries a negative charge of two units. Sulfur is ionized positively by six units. Sulphur surrounded by four oxygen atoms makes a sulfate radical $(SO4)^{--}$ due to containing of extra negative charge of two units than of the assembly of SO4 made. Hence the assembly acts as a sulfate radical because of the acceptance of two extra electrons donated by two hydrogen atoms. Thus it is clear that H2SO4 is associated with the following identities [7].

$$\mathbf{H2SO4 = H^{+} + H^{+} + SO4^{--}}$$

When the zinc metal is dropped inside the reagent bottle containing sulfuric acid, the hydrogen gas is displaced by association of atomic zinc ion $(Zn)^{2+}$ with the sulfate radical ion $(SO4)^{2-}$. The electronic configuration of zinc atom dominant in chemical reaction to take part is as according to the need shown by-

$$\mathbf{30\ Zn = 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^{10}}$$

The zinc atom applies its two electrons from $4s^2$ sub orbit to take the position of $2H^{+}$ ions in front of $SO4^{--}$. It gives two electrons for the replacement of 2H atoms and association of itself in the form of Zn^{++} with negatively charged $SO4^{--}$ radical ion. After donation of two negatively charged electrons, doubly positive zinc ion Zn^{++} is attracted by the nearby sulfate radical. The hydrogen ions return to its atomic state by acquiring the two electrons given by Zn. In such a manner, H2 in the molecular form is bonded by covalent bonding mechanism in between the atoms so separated during the chemical reaction by displacement method.

IV. RESULTS AND DISCUSSION

It is well known that the hydrogen gas is inflammable. But it burns only in the presence of occurrence of oxygen. The flame of fire is obtained on ignition only. The hydrogen gas is produced chemically by its traditional chemical reaction between the zinc metal and dilute sulfuric acid. The reagent bottle is used as an appropriate apparatus for this purpose so that the gas may be stored and controlled for firing in open space at the top edge of the containing bottle. A rubber cork having a hole at the centre is fitted as the cap of the bottle. The gas for experimentation is taken by a outlet capillary jet inserted through the hole into the cork. When the gas comes through the capillary tube, it is being ignited. The gas remains burning throughout. Only the threshold igniting fire is needed to start the burning of the gas. For igniting, a little fire is sufficient while a huge amount of fire is released as a result of burning of a bulk of hydrogen gas present. Oxygen gas is necessarily required for almost all type of burning material. It is noticeable that both hydrogen and oxygen are consumed during burning and obtaining the fire. The hydrogen gas produced by the chemical reaction can be stored inside the bottle by closing the capillary hole by paper sealing. A bit of hydrogen is leaked from the paper seal at the upper side of capillary tube. On giving fire to this leaking hydrogen, a controlled flame of fire can be obtained very easily due to the burning of the hydrogen gas continuously. It is an evidence for obtaining hydrogen gas in fact is being a burnable gas. The burning of gas in deed occurs only in the presence of oxygen. Of course, it consumes oxygen together for burning. This can be verified based on the evidence obtained when the pressure of gas produced inside the bottle is high enough and the paper sealing is removed at the time of giving fire, the capillary tube gets a thrust to move towards upward direction as a rocket all of a sudden. The development of thrust for movement of the capillary tube against the gravitation towards upward direction in space can be understood on the basis of creation of vacuum at the point of firing due to consumption of oxygen and by burning of hydrogen. The pressure difference produced in the air makes a sound of blast due to the generation of longitudinal sound waves of high amplitude of disturbance. The hydrogen gas pressure inside the bottle at the lower end of the capillary tube is assumed to be greater in magnitude than the vacuum pressure almost to zero magnitude due to consumption of mixture of hydrogen and oxygen at the upper top end of the jet on firing. The pressure difference is the cause of application of thrust acting on capillary tube for moving towards the upward direction against gravitational force.

It is noticed that both hydrogen and oxygen are consumed during burning and obtaining fire. Hydrogen acts as a fuel and oxygen assist it to burn. The oxygen gas helps hydrogen in burning due to the fact that the oxygen provides such a change in its own state of existence as hydrogen requires for burning. The gaseous state of each must be changed for burning cause. This change is provided by the role of igniting the mixture for burning. Both the gases get lost the original state of existence for fire to generate. The new state of presence is achieved as the constituents of water only. It means a chemical change will also occur now after burning. These constituents originate from the mixture of hydrogen and oxygen gas as a result of burning of hydrogen in the presence of oxygen. Thus even after preparation of hydrogen and owing to the presence of oxygen surrounding It, a further need to supply H and OH ions is necessary to obtain from the mixture of H2 and O2 gas. It means to say that now it is equally important to dissociate the presence of both the molecular gases H2 and O2. It is supposed that it can only be possibly done by igniting. But ignition consists a little

fire and will break only few molecules of H2 and O2. While it can be observed that most of all molecules of hydrogen and oxygen get consumed due to burning of fuel and the changes occurring for that. Therefore the whole change is related with the suddenly developed process. Because the solution of problem of generation of huge amount of energy is yet to be explained, hence the matter is very complicated. Experimentally, it is well known that hydrogen burns on igniting in the presence of oxygen. Thermal radiation is released and water is produced as the main product during the burning process. The mechanism of the process is tried to explain theoretically supported by the correlation of various scientific facts. However the trend goes towards surprising results but the phenomenological approach is very close to apply in view of spectroscopic analysis.

When the hydrogen gas is ignited, both the covalent electrons of hydrogen molecular gas get out from the orbits. After dissociation of covalent bond by the external energy, both the electrons associated in making the covalent bond leave from the molecular level. Due to gaining of excess kinetic energy, it becomes now impossible for electrons to return in the atomic state. Because the hydrogen atom is a mono electronic atom, and the centre of atom has been shifted due to repulsive force applying in between the relative protons. Thus the atomic state of diatomic hydrogen gas is lost due to ejection of electrons. The Other molecules of hydrogen and oxygen having a property to move freely due to nature of gassy state, when pass through the protonic bridge are also dissociated in bulk due to interaction involved by charge distribution. However the molecular structure of oxygen is also destroyed but the atomic state even now remains existing. Due to change of positions of protons (centre of atoms), the electrons of hydrogen molecule do not come back to respective original ground state but wonder for finding positions for revolution permanently else where. Electrons from the molecular hydrogen are ejected out for relaxing through oxygen atoms provided by the molecular oxygen. Thus the presence of oxygen atoms play the important role to relax wondering electrons by giving place in the respective vacant co orbitals of p sub orbit. The excess of energy of electrons required more than orbiting in the captured orbit is transformed as radiation produced [8]. Because the electron can not go towards the nucleus of oxygen atom below a certain level of p sub orbit due to prohibition, hence the extra kinetic energy of electron is transformed into radiative energy before probing into the orbit for revolution. This is the main cause of emission of light by any of the substance in accordance to the basics of luminescence. Only the kinetic energy required in the captured orbit remains with the electron for revolution. This necessary condition is adapted by the electron for equalizing the centripetal and electrostatic forces responsible for revolutionary motion around the nucleus. The rest of the kinetic energy is transformed by the emission of radiation consisting of fire. The flame is a whirlwind of rising and expanding fire produced due to the quantitative breaking of molecular hydrogen and oxygen necessary for electronic transition to take place for generating the fire.

After accepting electrons, the electronic configuration of oxygen changes from $2p^4$ to $2p^6$. Therefore the co orbitals of p sub orbit of oxygen atom are fully occupied by the presence of maximum number of six electrons. The oxygen atom gets negatively charged by two extra electrons revolving in p type of co orbitals. Now the protons have no any option except to associate with this negatively charged oxygen ion. Protons so- called the hydrogen nuclei are attracted by the oxygen for taking part to make the constituents of water respectively. For this task, one unit of negative charge of electron of oxygen ion is neutralized by the positive charge of one proton in making OH assembly. And, the other second unit of negative charge of electron possessed by the oxygen makes the OH assembly as negatively charged ion as $(OH)^-$ radical. Now this radical ion attracts the second proton (H^+) for electrovalent bonding to make up water molecule [9]. Hence these constituents H^+ and $(OH)^-$ are responsible for the formation of electrovalent bonding for the chemistry of water molecule. Therefore the bonding can be understood based on electrostatic force of attraction acting between charge constituents of water obtained from the mixture of hydrogen and oxygen after ignition for burning by the following type of interaction-

$$H^+ \rightarrow\leftarrow (OH)^- = H2O$$

The finding of flame of hydrogen on burning in the presence of oxygen and the mechanism developed for obtaining the fire on ignition clearly shows that hydrogen and oxygen do not automatically combine. An initial input of activation energy is required to overcome from the metastable molecular states. Molecular forms of both the gases are destabilized during for the formation of constituent of water. The process tends to release energy in addition before formation and combining of constituents into more efficient form of water vapors gas. Due to release of energy during its formation, the chemical reaction involved can be expressed by an analogous exothermic chemical equation.

$$2H2\ (g) + O2\ (g) = 2H2O\ (g) + energy$$

The equation shows that the chemical energy of H2 (g) & O2 (g) is more than that of water. Hence during such reaction, heat energy is liberated.

Thus a reaction of hydrogen with oxygen is an exothermic reaction because it liberates more energy than it absorbs. Hence in such an exothermic reaction, the enthalpy change is negative because the enthalpy of reactants is higher than the enthalpy of products.

$$\Delta H = \sum HP - \sum HR = - Ve$$

$$\sum HR > \sum HP$$

V. CONCLUSION

In view of chemical bonding, it is concluded from this investigation that whether the electrons are donated from one type of atom and are accepted by the another type of atom for electrovalent bonding, the transition of electrons from the co orbitals of donator to the co orbitals of acceptor atom can not take place with out the involvement of attractive force acted by the acceptor's nuclei on coming electrons. Because the attractive force of the acceptor nucleus can only regulate the revolutionary motion of electron around on entering into the accepted co orbitals. Similarly when the electrons are shared between two atoms for covalent bonding, the change in shape of co orbital for such shared electrons can not be possible with out the effect of attractive force on electrons acted by each of the nucleus. As a result of such force provided by the nucleus, each electron is forced to revolve around the both nucleuses successively by following a path of closed cyclic in design. The mechanism of burning of hydrogen is deduced in this connection. The formation of water constituents is the clue for that. Because due to ignition of hydrogen in the presence of oxygen, its electrons become free hence move towards the acceptor so are transferred into the atomic co orbitals of oxygen. Therefore in such transitions, one can predict the transformation of excess of kinetic energy of electrons into radiative energy before entering for revolution. The transition of electrons from the molecule of hydrogen to oxygen atom is necessary for creation of oxygen to behave as doubly ionized. This process is done by destabilizing both hydrogen and oxygen molecular gases through igniting. The oxygen ion uses two hydrogen ions already situated in the vicinity. One ion is used in making $(OH)^-$ radical while the other H^+ ion is used in making water molecule. Thus the energy is found to be liberated only during transition process of electrons for the task of building water constituents.

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