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STRUCTURE OF LIQUID AND COMPARISON OF ADHESIVE FORCE WITH COHESION FORCE

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ABSTRACT

This paper shows the structure of a liquid based on the degrees of freedom that the molecules have for motion is determined by the number of coordinates that are occupied by cohesion. It gives the structure of liquid- surface model, string model and ring model. Various important properties of cohesion and adhesive forces are also discussed briefly. Also cohesion force is compared with adhesive force and the results are tabulated in this paper.

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INTRODUCTION

We know that the structure of matter depends upon degrees of freedom for free molecular motion. Molecules in the solid state do not have the degrees of freedom for free molecular motion, while in the liquid state, the molecules have two coordinates of free space for molecular motion and the molecules in the gas phase have three coordinates of free space for molecular motion. This paper will examine cohesion as fundamental force and show the structure of liquid.

Fluid dynamics is a sub discipline of fluid mechanics that deals with fluid flow-the natural science of fluids (liquids and gases) in motion. It has several sub disciplines in itself, including aerodynamics (the study of air and other gases in motion) and hydrodynamics (the study of liquids in motion). Fluid dynamics has a wide range of applications, including calculating the forces and moments on the aircraft and also determining the mass flow rate of petroleum through the pipelines, predicting weather patterns, understanding nebulae in interstellar space and modelling fission weapon detonation. The solution to a fluid dynamics problem typically involves calculating various properties of the fluid, such as velocity, pressure, density, and temperature, as functions of space and time.

Before the twentieth century, hydrodynamics was synonymous with fluid dynamics. This is still reflected in names of some fluid dynamics topics, like magneto hydrodynamics and hydrodynamic stability, both of which can also be applied to gases.

A common characteristic of all fluids, whether Newtonian or not, is that they do not slip at a solid boundary. No matter how fast they flow away from the boundary, fluid particles at a solid surface become entrapped by the surface structure. The macroscopic effect is that the fluid velocity equals the solid velocity at a boundary. This is called the no-slip condition where the solid is fixed, so that the fluid velocity drops to zero there. No-slip sets up a slow-moving shear layer or boundary layer when fluid flows near a solid surface. The theory of boundary-layer flow is well developed and explains many effects involving viscous flow past immersed bodies or within passages.

A matter is based on its physical and chemical structure which is made up of atoms and molecules. Molecules as components of matter are common in organic substances. Solid is one of the others existing in liquid, gas and plasma. It is characterized by structural rigidity and

resistance to change of shape or volume. Unlike a liquid, a solid object does not flow to take the shape of the container, nor does it expand to fill the entire volume available to it like a gas does. Force is the external agency applied on a body to change its state of rest and motion. Pressure is the amount of force acting per unit area. A surface is two dimensional which means that at each point there is a coordinating patch on which a two dimensional coordinate system is defined.

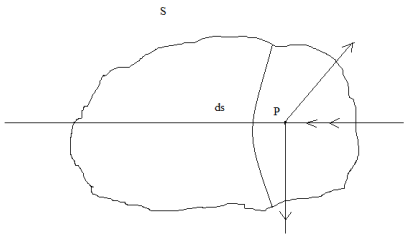
If molecule is in liquid state, it has two coordinates of free space for molecular motion, in solid phase do not have degrees of freedom for molecular motion and in gas state it has three coordinates for free molecular motion. In this article we conclude that the cohesion is considered to be fundamental force and also the structure of liquid- surface model, string model and ring model.

VISCOUS AND INVISCID FLOW

Suppose that the fluid element is enclosed by the surface S. Let ds be the surface element around a point P. Then asurface force acting on the surface may be resolved into normal direction and tangential direction. Normal forces per unit area is said to be normal stress (pressure). The tangential forces per unit area is called shearing stress.

A fluid is said to be viscous (real fluid) when normal stress as well as shearing stress exists.A fluid is said to be inviscid (ideal fluid), if there is no friction and no tangential or shearing stress eg: oil- viscous fluid, dam water- inviscid fluid.

Existence of Normal and Shearing stresses



COHESION FORCE

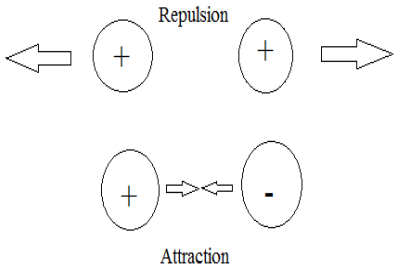
Cohesion or cohesive force is the action in which the molecular force acts between the particles within a body or substances to unite them. In other words, cohesion allows for surface tension that creates a solid like state upon which low density materials can be placed.

Let us consider cohesion in water; it has the properties of water molecules that make them stick together. For an example take a teaspoon of water, it has more than fifty drops of water. There we can find one millions of water molecules in each drop of water. There are one atom of oxygen and two atoms of hydrogen in a molecule of water. We know that, H_2O is the molecular formula of water. Here the oxygen and hydrogen both are fixed tightly together by bonds.

Condensation force present between the molecules is mentioned above. Now we define that cohesion and condensation force are one and the same.The gas state have no coordinates, and there is one coordinate space occupied by liquid state and three coordinates spaces by solid state, since cohesion is considered to be fundamental force.

Cohesion force and the size of molecules are proportional to each other. In liquid state or in solid state of matter, the intermolecular distance depends upon the size of molecules. The molecules are brought together by cohesion force, but by the action of natural force of the repulsive electromagnetic effect between the pair of electrons, the molecules wag about equilibrium state. Electro-magnetic force is the force between charged particles such as the force between two electrons. It is attractive for unlike charges and repulsive for like charges.

Forces existing between molecules

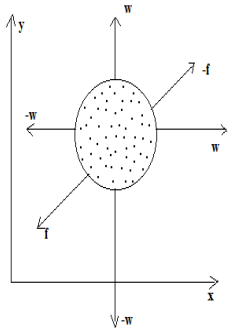


Molecules are wag under the influence of cohesion causes electro-magnetic repulsion and attraction of molecules.

STRUCTURE OF LIQUID

Let us define the structure of the liquid by using a diagram.

Molecule in liquid state

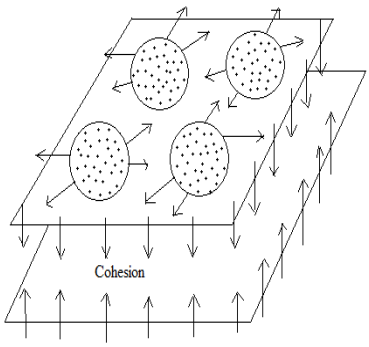


It represents a molecule in the liquid state. There are two coordinates for the motion and one coordinate is taken by cohesion. These arrangements of molecules in the space have the possibilities of developing three models for a liquid. They are surface model, ring model and string model.

SURFACE MODEL OF LIQUID

It is formed on the basis of hypothesis that translation is only made up of molecular motion. On this type, molecules are in free motion on the surface. The cohesion force is displaced. Thus, the force does not act between two molecules but somewhat between two surfaces.

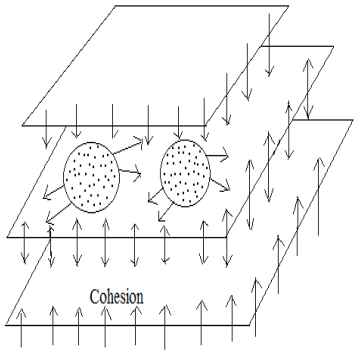
Diagrammatic representation of surface model



THREE SURFACE MODEL OF LIQUID

It is formed on the basis of hypothesis that translation is only made up of molecular motion. On this type, molecules are in free motion on the surface. The cohesion force is displaced. Thus, the force does not act between two molecules but somewhat between the surfaces.

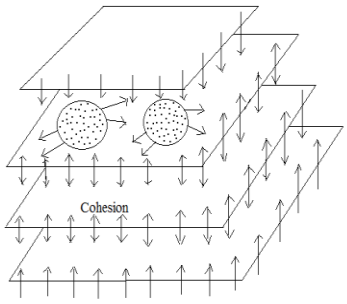
Diagram of Three surface model of liquid



FOUR SURFACE MODEL OF LIQUID

It is formed on the basis of hypothesis that translation is only made up of molecular motion. On this type, molecules are in free motion on the surface. The cohesion force is displaced. Thus, the force does not act between two molecules but somewhat between the surfaces.

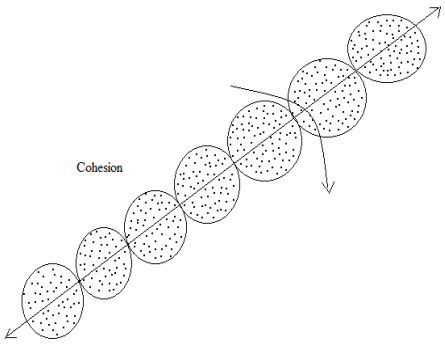
Diagram of Four surface model of liquid



STRING MODEL OF LIQUID

It is formed on the basis of hypothesis rotation which is the one and only form of molecular motion which occurs in a liquid. On this type, the molecules are connected under the influence of cohesion force and subsequently gives a string structure.

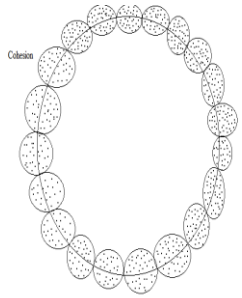
String model of liquid due to cohesion force



RING MODEL OF LIQUID

It is formed on the basis of hypothesis circular which is the one and only form of molecular motion which occurs in a liquid. On this type, the molecules are connected under the influence of cohesion force and subsequently gives a ring structure.

Ring structure of due to molecular motion:



There are four factors which determine the cohesional force between the molecules. They are norming, storming, performing and forming.These factors are responsible to make the molecules to attain the required shape. Even though storming makes some changes in the molecules, performing and norming binds the required factors together and help the molecules to move along a definite path.

Cohesive forces act in liquids to make them inseparable and to resist the external force. These type of forces are possible only in molecules of same substance. For example when considering rainfall, we see the rain in the form of droplets rather in the form of mist, due to the cohesion force acting in the molecules. Thus the united molecules form a large cluster which is relatively

larger in size. Thus cohesion force is considered as a intermolecular force between the molecules.

ADHESIVE FORCE AND ITS PROPERTIES

Adhesive forces are attractive forces existing between unlike molecules. These forces are mainly caused due to the mechanical forces acting between the molecules. For example in the case of glass and water, the adhesive force acting between the molecules avoids the repulsive force between the two molecules.

EFFECTS OF COHESIVE AND ADHESIVE FORCES

If we take any liquid on a smooth surface, the adhesive force acting in the molecules pulls the liquid particles down if it is stronger and the cohesive forces make the liquid molecules to maintain its original shape if it is stronger. However cohesive forces are stronger than adhesive forces in real part. The adhesive forces are stronger in water molecules, while the cohesion forces depends on the surface tension.

The shape of the liquid in any container changes when extra drops are added. The surface tension before adding the extra drops will be less and it gradually increases as the quantity of liquid increases.

CONCLUSION

Thus the various liquid molecular structures can be derived using the number of degrees of freedom. In general from the above datas we conclude that a relationship occurs between cohesion and adhesive molecules based on different factors like surface tension, area occupied by the molecules etc. This paper gives a brief study on the forces existing between the molecules in any kind of a liquid and the various diagrammatic structures like ring, string models,etc.

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