

P.G.SEMESTER-II
CC- V
Advances in Chemistry

Unit-I Nuclear Chemistry
Topic- Liquid Drop Model of Nucleus (PART - 1)

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LIQUID DROP MODEL OF NUCLEUS

How Does the Liquid Drop Model Describe Atomic Nuclei?

The aim is to explain nuclei's masses and binding energies. The Liquid Drop Model is named after the fact that nuclei are thought to behave similarly to liquids (at least to first order). A liquid's molecules are kept together by the Van der Waals force, which exists only between close neighbours.

Liquid Drop Model of the Nucleus

The liquid drop model of the nucleus explains forces in atomic nuclei as if they were created by a tiny liquid drop in nuclear physics. On a nuclear scale, however, the **fluid** is made up of nucleons (protons and neutrons). The liquid drop model accounts for the fact that the forces acting on nucleons on the surface vary from those acting on nucleons on the inside, where they are absolutely surrounded by attracting nucleons. This is analogous to considering surface **tension** as a factor in calculating the energy of a tiny liquid drop.

Key Facts of Nuclear Liquid Drop Model

1. Nuclei seem to have a constant density, according to scattering studies.
2. Nuclei have their own volume and surface, where various forces **work**.
3. The nucleus is spherical in its ground state.
4. This spherical nucleus can be twisted into a dumbbell shape and then broken into two fragments if enough kinetic or **binding energy** is applied.
5. For the binding energy of nuclei, the Weizsaecker formula is an empirically refined variant of the liquid drop model. The terms are as follows:
 - a. Volume term
 - b. Surface term
 - c. Asymmetry term
 - d. Pairing term
 - e. Coulomb term.
6. Binding energies and masses of atomic nuclei can be calculated using the Weizsaecker formula. As a result, we can calculate the energy released per fission.

Semi-Empirical Formula

The von Weizsäcker mass formula (also known as the semi-empirical mass formula – SEMF) was published in 1935 by German physicist Carl Friedrich von Weizsäcker and was one of the first models that could accurately explain the action of nuclear binding energies and thus nuclear masses. The liquid drop model proposed by George Gamow is the basis for this theory.

The atomic nucleus, according to this model, behaves like the molecules in a drop of liquid. The fluid, on the other hand, is made up of nucleons (protons and neutrons) held together by a strong nuclear force. The nucleus' liquid drop model takes into account the fact that nuclear forces on nucleons on the surface vary from those on nucleons in the nucleus' interior. Other attracting nucleons completely surround the interior nucleons. The forces that shape a drop of liquid can be compared to this.

The nucleus is spherical in its ground state. This spherical nucleus can be distorted into a dumbbell shape and then broken into two fragments if enough kinetic or binding energy is applied. The splitting of such heavy nuclei must be followed by energy release since these fragments have a more stable configuration. This model does not account for all of the atomic nucleus's properties, but it does account for the expected nuclear binding energies.

The Liquid Drop Model

George Gamow suggested the liquid drop model, which was further developed by Niels Bohr and John Archibald Wheeler. It treats the nucleus as an incompressible fluid drop with a very high density that is kept together by the nuclear force (a residual effect of the strong force), with a structure that resembles that of a spherical liquid drop. The liquid drop model, though crude, accounts for most nuclei's spherical shape and allows a rough prediction of binding energy.

The mass formula is solely determined in terms of the number of protons and neutrons it includes. Five terms are described in the original Weizsäcker formula:

- Interior nucleon has a certain number of other nucleons in contact with it when an arrangement of nucleons of the same size is packed together into the smallest volume. As a result, the amount of nuclear energy emitted is proportional to the volume.
- The presumption that each nucleon interacts with the same number of other nucleons is corrected by surface energy. Since this definition is negative and proportional to the surface area, it is approximately equal to liquid surface tension.
- The potential energy of each pair of protons is known as Coulomb energy. The binding energy is diminished since this is a repulsive force.
- The Pauli exclusion theory is explained by asymmetry energy (also known as Pauli Energy). Uneven numbers of neutrons and protons mean that one form of the particle will fill higher energy levels while the other will leave lower energy levels empty.
- The propensity for proton and neutron pairs to form is explained by pairing energy. Due to spin coupling, an even number of particles is more stable than an odd number.

.....**TO BE CONTINUED**

