SRI VIDYA COLLEGE OF ENGINEERING & TECHNOLOGY, VIRUDHUNAGAR
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
SHORT ANSWER QUESTIONS AND ANSWERS
EE 6701 –HIGH VOLTAGE ENGINEERING
UNIT-II ELECTRICAL BREAKDOWN IS GASES, SOLIDS& LIQUIDS
PART – A

1. Name a few gases used as insulation medium
N2, CO2, CC2F2 (Freon), SF6 (Sulphur Hexa Fluoride)

2. Name the theories explaining B.D in gaseous insulation:
1) Town sends Theory 2) Streamer Theory.

3. What are the physical conditions governing ionization mechanism in gases dielectrics?
1) Pressure
2) Temperature
3) Electrode configuration
4) Nature of electrode surface
5) Availability of initial conducting particles

4) What is primary ionization?
Electron produced at the cathode by some external means, during its travel towards the anode due to the field applied, make collisions with neutral atoms/molecules and liberate electrons & positive ions. The liberated ions make future collisions and the process continue. The electrons and the ions constitute current. This process is called primary ionization.

5) What is secondary ionization?
- The librated positive ions, during the primary ionization process migrate towards cathode bombard and emit secondary electrons from the cathode.
- The excited atoms/molecules, got excited during the collision of initial electrons, emit photons which bombard the cathode & emit secondary electrons
- Metastable (excited particles) bombard the cathode metal surface & produce secondary electrons.

The secondary electrons released as above make ionization collisions & produce additional electrons. The electrons again produce ionization collisions & the process repeats. This is called & secondary ionization. The discharge is self sustained because once the secondary electrons are formed. They take care of the situation. Where there are initial electrons at cathode or not ionization proceeds. That is called self sustained discharge.

6. Define primary ionization co-efficient .(Town-sends Ist ionization co-efficient)
The average number of ionizing collisions made by an electron per centimeter travel of the electron in the direction of the field is called Town-sends Ist ionization co-efficient .It depends on the gas pressure and E/P

7. What is Town-sends secondary ionization co-efficient
It is the net number of secondary ions produced per incident positive ion or photon or metastable particle

8) What is Town-sends condition for Breakdown?
Town-sends current growth equation is
Town-sends criterion for BD

9. What is Spark voltage sparking distance

The voltage applied which creates the above breakdown condition is called spark voltage Vs and the corresponding gap d is called sparking distance.

10) Demerits of Town-sends theory:

1. Beyond a p.d > 1000 torr cm, this theory does net explain correctly.
2. Town sends theory says that current growth depends on ionization. But actually it depends on gas pressure and geometry of gap.
3. Town sends mechanism predicts time lag of 10-5 sec. But actually the time lag is 10-8 sec.
4. The discharge form is not as the one predicted by Town-sends theory. It is filamentary & irregular and not "diffused form" as predicted by town-sends.

11) Streamer theory is based on what?

- Streamer theory considers the influence of space charge on the applied field.
- Secondary avalanches are produced from the gap
- Transformation from avalanche to streamer occurs when the length of avalanche exceeds a certain value.
- Streamer theory overcomes the demerits of Town-sends theory.

12. Explain why Electronegative gas has high BD value.

- The molecules of (SF6 gas) electro neg. gases have the property of electron attachment, (i.e., the outermost orbit of the molecules has holes)
- There molecules attach the electrons in the gap to become negative ions
- Negative ions have lesser mobility than electron
- This attachment plays an effective role of removing electrons which otherwise have led to current growth and break down
- Number of attaching electrons made by one electron drifting 1 cm in the direction of the field is called attachment coefficient.

13. Distinguish between BD in uniform field and BD in Non uniform field:

1. In the uniform field, increase in applied voltage produces a Breakdown in the gap in the form of a spark with out any preliminary discharge.
2. In the non uniform field, an increase in applied field, first cause a discharge in the gas around the points where the field is the highest. (Eg. Sharp Points, Curves of electrode). This from of discharge is called corona discharge, which extends finally as the field is increased and bridges the gap between the electrodes ultimately & cause BD.

14. What are the characteristics of corona discharge

1. It has bluish luminescence.
2. It produces hissing noise.
3. Air surrounding the corona becomes converted to ozone.
4. Creates loss of Power.
5. Create radio interference.
6. It causes deterioration of the insulation surface.

15. What is corona inception field?

The voltage gradient required to produce visual ac corona in air at a conductor surface is called corona inception field.

17. What is Paschens Law?

Paschans law explains the relationship between the Break Down voltage and the product of pressure (p) and gap (d), in the case of Breakdown in gas.

It states that, $V = f(p.d)$ The Breakdown voltage is a function of p.d.

18. What is Vaccum

Atmospheric Pressure = 760 torr
High Vacuum = 1 x 10-3 to 1 x 10-6 torr
Very high Vacuum = 1 x 10-6 to 1 x 10-8 torr
Ultra Vacuum = 10 x 10-8 torr & below
For electrical Insulation purposes
Vacuum => High Vacuum=> 1 x 10-3 torr to 1 x 10-6 torr.

19. Basic of BD in Vacuum

- There is no gas molecule in vacuum
- No collision – the initial electron crosses the gap without any collision.
- Hence BD not possible, (theoretically)
- But actually when applied voltage is very high somehow beyond a very high applied voltage due to some or other reasons gases are librated inside the chamber causing BD.

20. What are the various factors affecting B.D. in vacuum medium.

- Gap length
- Geometry & material of electrode.
- Surface uniformity of the electrode
- Treatment of the surface (Surface treatment)
- Presence of extraneous particles & residual gas pressure in the gap.

21. Name the various mechanisms explaining Vacuum Break Down

- Particle Exchange Mechanism
- Field emission Mechanism

  Anode heating Mechanism Cathode heating Mechanism
- Clump theory

22. What is Time lag for Break Down?

The time difference between the instant of applied voltage and the occurrence of breakdown.

23. What are the requirement of gases for insulation purposes?

1) High dielectric strength 2) High thermal stability

24. What property of SF6 gas is not favorable in electrical approach?

It is not environmentally friendly and it causes global warming. Hence SF6 is used along with Air or other suitable gases.

25. Distinguish between the BD in pure liquid & commercial liquid.

Pure liquid

Theoretically only possible (hypothetical). BD is due to Electronic breakdown involving commission of electrons at fields greater than 100 KV/cm. Town-sends type of primary ionization & secretary ionization can be applicable.

Commercial liquid contains suspended particles, bubbles of air or liquid etc. BD Mechanisms are influenced by these impurities. BD depends on several factors

- Nature & condition of electrodes.
- Physical properties of liquid.
- The impurities present in the liquid.
- No single theory can explain the BD.

26. What are the parameters that alter the BD strength of liquid dielectrics
    - Physical properties like pressure, temperature.
    - Dissolved impurities
    - Suspended particles.
    - Nature & conditions of electrodes

27. Name a few liquid dielectrics
    1) Transformer oil
    2) Synthetic hydro carbons – (Polyolefin's)
    3) Chlorinated hydro carbons:P.C.B. (Toxic)
    4) Silicone oils.Alternative to PCB
    5) Esters
        1) Natural Esters : Castor oil
        2) Organic Ester & Phosphate esters (synthetic Esters)
    6) Hydrocarbons tetrachloro ethylene & per fluro poly ether.

28. Qualities of good dielectrics (liquid)
    1. High heat transfer capacity 2. Good dielectric strength
    3. Good chemical satiety

29. BDV of pure liquid depends on what factors
    BDV of pure liquid depends on
    - Field applied Gap separation
    - Cathode work function Temperature
    - Density Viscosity
    - Temperature of liquid Molecular structure

30. What are the various theories of BD of commercial liquids
    - Suspended particle mechanism
    - Cavitations and bubble mechanism
    - Thermal mechanism of breakdown
    - Stressed oil volume theory

31. What is the principle of stressed oil volume Theory in Breakdown liquids.
    The BDV of liquid dielectric depends on the region which is subjected to the highest stress and the volume of liquid contained in the region.

32. What are the characteristics of a good solid dielectric?
    1. low dielectric loss
    2. high mechanical strength
    3. free from gaseous inclusions
    4. free from moisture
    5. resistance to thermal & chemical degradation
    6. High BD Strength.

33. How can solid dielectrics be classified
    1. Organic dielectric
    e.g. Paper, Wood, rubber
    2. In organic dielectric
    e.g. mica, glass, porcelain, p v c, epoxy resins, Perspex.

34. What are the various BD Mechanisms for solid dielectrics?
    1. Assuming no external influences
        1. Intrinsic BD
            Electronic BD
            Avalanche BD
        2. Electro Mechanical Fracture Mechanism
        3. Thermal BD
    2. Considering the External Influence
            1. Chemical BD
            2. BD due to Tracking & Treeing
            3. BD due to internal discharge.

35. The usual Mechanism of BD in solid dielectric?
    The usual Mechanism is Thermal BD.

36. What is the cause for long term deterioration & BD in solid dielectrics
    The long term deterioration & BD in solid dielectrics is due to Internal discharges.

37. What is meant by Intrinsic strength of a solid dielectric
    All extraneous influences have to be isolated and the BD value which depends on the structure of the materials and the temperature is called intrinsic BD strength of solid dielectric.
    eg. Poly vinyl Alcohol
    at – 1960c : 15 MV/cm (Intrinsic)
    & at Normal. Temp : 5 MV/ cm to 10 MV/cm
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38. What is 'TRACKING' and 'TREEING' is solid dielectric B.D
    TRACKING:
    Formation of a continuous conduction path across the surface of the insulation mainly due to surface erosion under voltage application is called 'Tracking'.
    Water -Conduction path-heat -Drying - Conduction film -Carbonization -B.D
    TREEING
    The spreading of spark channels during tracking in the form of the branches of tree is called Treeing.

PART – B

1. Deduce the Townsend's break down criteria. Also define the Townsend's Primary and secondary ionization coefficients.

2. (i) Explain clearly breakdown in non-uniform fields & corona discharges. (ii) Explain breakdown in uniform field (streamer mechanism).

3. Explain the various theories of breakdown mechanism of vacuum.

4. State the criteria for sparking potential and hence obtain the relation between sparking potential and (PD) values (Paschens law). Discuss nature of variation of sparking potential with PD values.

5.Explain the various theories of breakdown mechanism of commercial liquid dielectrics.

6.Explain the various breakdown mechanism involving in solid dielectric breakdown