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15/04/2021

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Engineering Chemistry

Phase Rule - Tutorial 2

1.) Explain Reduced Phase Rule.

Ans 1) In a two component system, when P = 2, degree of freedom has the highest value i.e. 3. Three variables temperature, pressure and concenterations of one of the two components must be specified in order to describe the system completely.

2) Since the maximum number of degrees of freedom in a two component system is 3, the phase behaviour of a binary system may be represented by a three-dimensional diagram of pressure, temperature and composition.

3) Solid - liquid equilibrium of an alloy has practically no gas phase and the effect of pressure is small on this type of equibrium. Usually the experiments are conducted under atmospheric pressure.

4) Thus keeping the pressure constant of a system, in which vapour phase is not considered, is known as condensed system. It will reduce the degrees of freedom of the system by one.

5) For such a system the phase rule becomes $F = C - P + 1$. This is known as the reduced or condensed phase rule, having only two variables, temperature and concenteration (composition) of the constituents.

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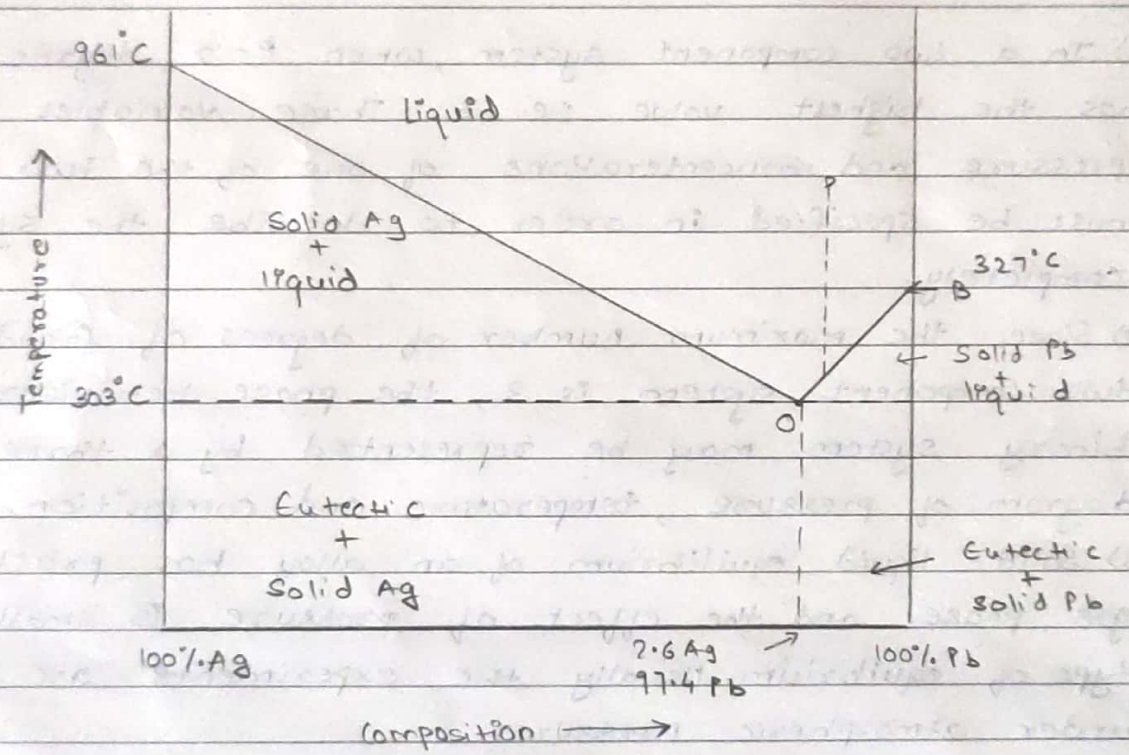
2) Draw neat and labelled phase diagram of Lead - Silver system and explain eutectic ~~phase~~ point.

Ans.



T-C diagram of Pb-Ag system.

Eutectic point (Point O) :

1) The two curves AO and BO meet at O, where three phases (solid Ag, solid Pb and their solution) co-exists and according to condensed phase rule, the system will be invariant ($F = 3 - P = 3 - 3 = 0$).

2) The point O (303°C) represents a fixed composition (Ag = 2·6%, Pb = 97·4%) and is called eutectic temperature). At this point, the temperature remains constant, until the whole of the melt solidified en-block to become solid of eutectic composition.

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3) However, further cooling results in the simultaneous crystallization of a mixture of Ag and Pb in relative amounts corresponding to eutectic point O.

4) Below the temperature line of eutectic temperature, we have two regions in the diagram viz.,

(1) The region marked eutectic + solid Ag, in which crystalline silver and solid eutectic are stable.

(2) The region marked eutectic + solid Pb, in which crystalline lead and solid eutectic are stable.

3) Give limitations of phase rule.

Ans. Limitations of the Phase rule are as follows:

1) Phase rule can be applied only for systems in equilibrium. It is not of much help in case of system which attain the equilibrium state very slowly.

2) All the planes of the system must be present under the same conditions of temperature, pressure and gravitational force.

3) It applies only to a single equilibrium state. It does not indicate the other possible equilibria in the system.

4) Phase rule considers only the number of phases but not their quantities. Even a minute quantity of the phase, when present, account towards the number of phases. Hence much care has to be taken in deciding the number of phases existing in the equilibrium state.

5) The solid and liquid phases should not be so finely subdivided as to bring about deviation from their normal values of vapour pressure.