Ignition point or ignition temperature

- It is the minimum temperature to which a portion of the mixture must be raised in order to initiate or cause a rapidly accelerating reaction in the whole of the accumulation with the accompaniment of flame.
- It does not refer to the temperature of the ignition source which must obviously be at a higher temperature.
- Ignition point of pure methane in oxygen is 550°C.
- Ignition point of flammable firedamp – air mixtures is 650°C to 750°C.

It is not a definite temperature but depends upon the following factors:

- Nature of the source of ignition whether flame, spark, etc
- Shape and size of the space where ignition occurs
- Methane content
- Temperature of surroundings
- Pressure
- Oxygen concentration
- Presence of other gases
- Turbulence

Ignition lag: When fire damp comes into contact with an igniting source, the temperature of which is comparatively a little above its ignition point, a certain time must elapse before it is ignited. This period is known as ignition lag.

It has been estimated that a 6.5% methane –air mixture and a source of heat at a temperature of 700°C, the lag was 11 s and at 1175°C only 0.1 s.

Explosion characteristics

- Flame temperature
- Explosion pressure
- Flame length
- Velocity of propagation of flame or flame velocity
- Direct blast and backlash
- Explosion gases.

(a) Flame temperature

It is the flame temperature of the firedamp-air mixture just at the moment of its explosion. It depends on:

-concentration of firedamp

-uniformity of the mixture

-turbulence

-confinement

-heat losses

It is maximum at the stoichiometric concentration and is less at the lower and upper flammable units. The temperature does not remain constant. The adiabatic flame temperature for a stoichiometric methane-air mixture is 2200K.

(b) Explosion pressure

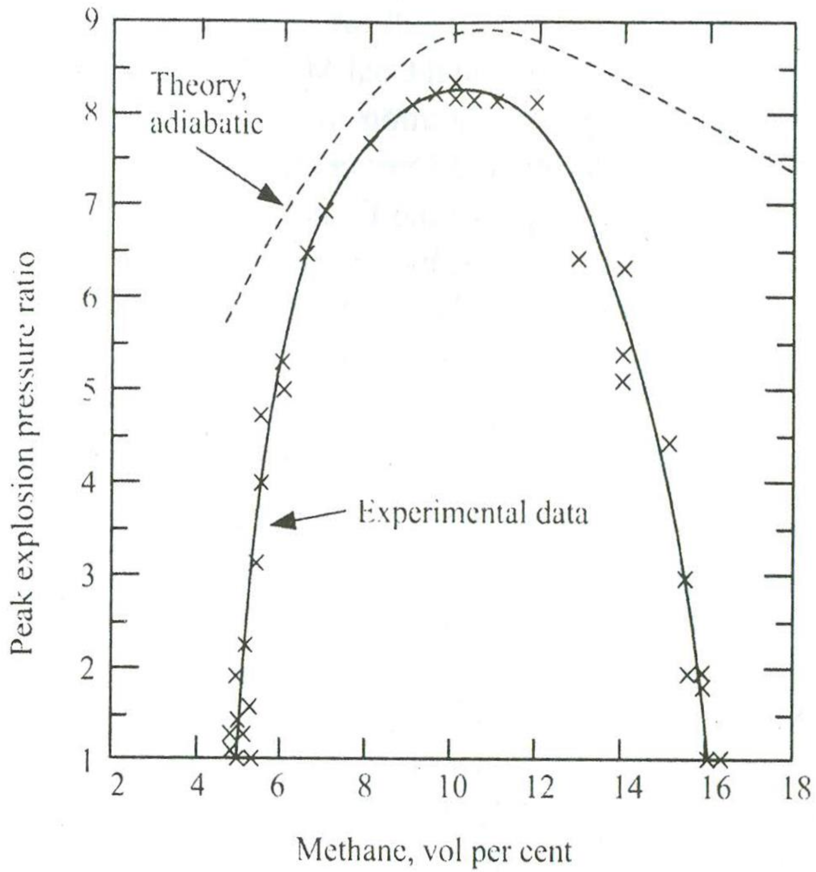
depends on:

-flame temperature

-confinement

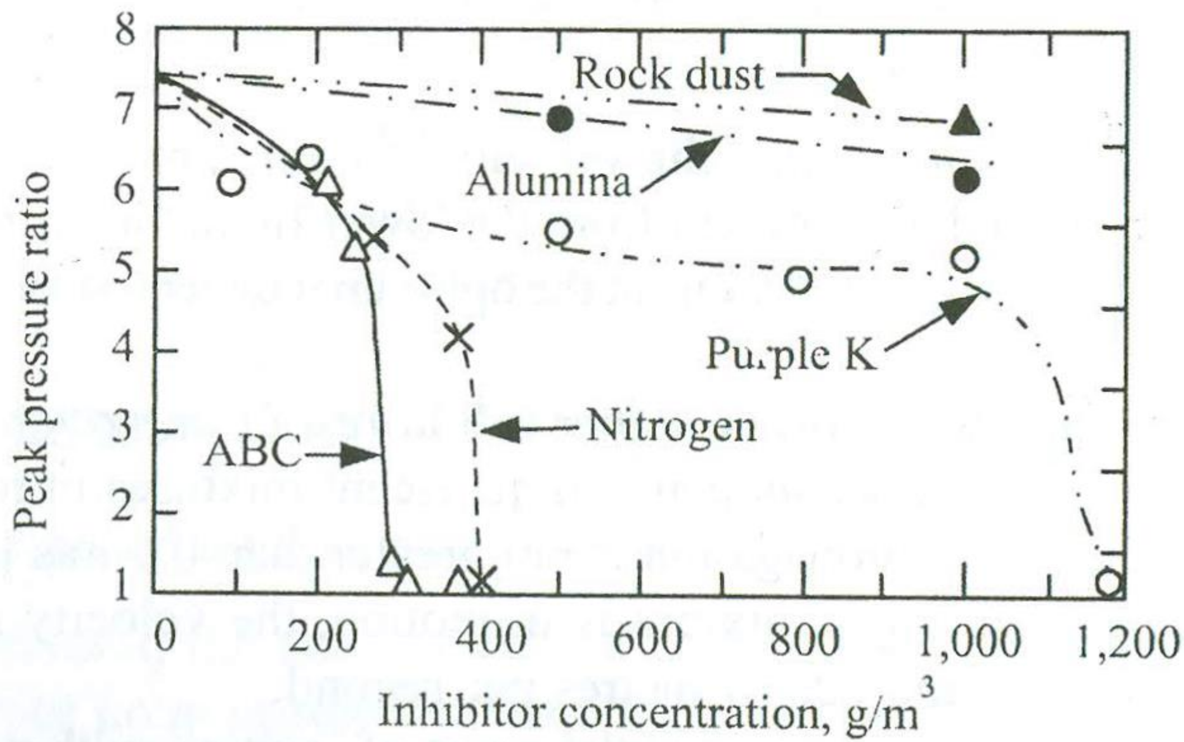
The maximum explosion pressure of a methane-air mixture (760 mm Hg, 20°C) when ignited in a closed vessel is 7.2 bar. But in mine workings, explosion pressure may exceed this value.

A shock wave travels ahead of the explosion flame which compresses any firedamp accumulation encountered on its way to a pressure greater than 1 bar. This accumulated further and can become more than 7.2 bar.



Explosion pressure for quiescent methane–air mixtures

Using some inhibitors the peak ratio can come down:



Effect of inhibitors on explosion pressure

(c) Flame length

Based on experiments, the length of flame increases as the gas concentration in a gas zone increases from the lower limit of flammability to about 12%, after which it decreases.

The length of the flame is directly proportional to the volume of the zone and, for a given roadway cross-section, the total flame length is four-and-a-half times the length of the gas zone for 9.5% mixtures and five times the length for 12% mixtures.

(d) Velocity of propagation of flame

It is very small and depends on the following factors:

(1)Methane content of mine air

The velocity of flame propagation increases with increasing firedamp content from the lower flammable limit upwards. After reaching the maximum value at the optimum concentration, the velocity decreases.

(2)Condition of the gas mixture, whether it is at rest or in motion

In quiescent mixtures in tubes, the maximum velocity of propagation is not greater than 0.6 m/s. On the other hand, when the gas mixture is in motion, the velocity may quickly increase to a few hundreds of metres per second.

(3)Point of ignition

effects velocity of propagation

at the close end of a roadway----maximum damage

at the outbye end of the roadway----rapid burning, less damage

(4)Length of gas zone

Experiments shows that the velocity of flame propagation of a gas explosion increases from zero at the point of ignition to a maximum distance of about twice that of the original length of the gas body.

The maximum flame velocity for the 7.5 m zone is about 99 m/s and that for the 15 m zone is 533 m/s.

(5)Presence of obstacles in the path or change in area of roadway cross-section

roadway with obstacles if reducing the cross-sectional area of the surrounding, the velocity of

Direct blast and backlash

Firedamp explosion characterised by two distinct operations: direct blast & indirect blast or backlash.

In case of direct blast, a pressure wave of great force and speed travels ahead of the explosion flame.

Whereas backlash is caused by the vacuum arising out of the cooling of explosion gases and condensation of water vapour and is of less intensity than the direct blast but traverse the same path backwards.

If Methane concentration >9.5%, then there are two types of explosion flame occur, primary flame and secondary flame.

The primary flame propagates at a greater velocity and consumes the entire available oxygen.

The secondary flame propagates in the opposite direction and it is produced by the burning of the unburnt gases with the help of oxygen supplied by the backlash.

Explosion gases

The chemical composition of the products of a firedamp explosion depends greatly upon the whether it is pure firedamp explosion or a mixed explosion of firedamp and coaldust.

With the pure firedamp explosion, carbon dioxide is always formed and carbon monoxide is frequently found. A certain amount of oxygen is also found due to fresh air supplied by backlash where as in mixed explosion carbon dioxide is frequently found.

Causes of firedamp explosions

Mostly firedamp explosion occurs in an active mine in face areas and headings. The various causes may be grouped under the following headings:

I. Negligence of miners
II. Use of damaged safety lamps and their improper handling
III. Blasting
IV. Mine fires
V. Friction
VI. Electric sparks
VII. Other special causes