ME-2

(#) properties of Methane (CH_4)

CH_4 is odourless, tasteless, non-toxic gas, molecular weight = 16

density = 0.716 Kg/m³

Sp. gr = 0.559

(#) Slightly soluble in water (3% by Vol.) at 1 bar at 293 K.

→ It diffuse 1.6 times as fast as air.

→ It is combustable and burns with pale blue flame in air. but it not a supporter of combustion and produces CO_2 and vapour.

$$CH_4 + 2(O_2 + 4N_2) \xrightarrow{\text{air}} CO_2 + 2H_2O + 8N_2$$

1 10

(#) proper oxygen balance occur when CH_4 contain of air is 1/11 or 9.5% by volume that is why this gas burns with more explosive under this condition

(#) It forms explosive mixture with air under suitable condition. The rxn gets self accelerated leading to explosion, this is most hazardous character of methane. particularly all coal mines emit methane more or less. CH_4 is responsible for several explosion inside mine.

(#) CH_4 is lighter than air. So, it accumulates in the roofs cavity and rises to workings.

(#) Although CH_4 is odourless, sometimes in some mines, it is emitted with impurities and has characteristics odour like H_2S and SO_2.

(#) Ignition temparature - (650°C - 750°C). This may be higher or lower than these limits depending upon the type of igniter i.e. source and method of ignition. CH_4 content of air, presence of other impurities, surrounding temp. and pres. e.g. hot surface like iron wire gauge used in a safety lamp, ignite CH_4 at much higher temp. about 1200°C. This fact with quick heat dissipation by wire gauge, because of surface area does not allow the temp. to rise to the distance needed to cause explosion of the CH_4 outside of a safety lamp.

(#) Methane air Mixture ignites at 510°C when adiabatically compressed to 60-70 atm. In confined space, explosion pressure can reach upto 7-10 atm and 7-8% CH_4 mixture is most easily ignited.

(#) Methane coming in contact with hard source ignites with a delay. Thus at 650°C the delay is about 10sec and at 1000°C it is 1sec. Delay time diminishes with increase of pressure. The delay b/w ignition and application of the heat source termed as Lag on the Ignition.

This is because of the fact that CH_4 starts dissociating and burning only after a certain quantity of heat i.e. 92-53KJ/mole. This property is utilised in dispensing safe exposal which produce very short duration flame. On presence of H_2 and other combustable gases reduces the lag so much so that in presence of 30% H_2 in the CH_4 completely eliminates the lag on ignition.

Sources of CH_4

→ CH_4 is commonly absorbed on the surface of microfissures and pores while the small proportions are filled with Coal.

→ Absorbed gas is not released from pores when the Coal is heated to 150°C. With increased pressure of the Coal at depth the volume of free gases increases and

absorbed gases decreases. CH_4 gas liberates from ~~coal~~ ore face. ~~rock~~ broken pores nearby scene from surrounding rocks.

→ The probability of encountering CH_4 is more when working approach dyke, Silt and fault are any geological disturbed stressed area. or splitting of ~~seam~~ seams. Outcrust of gas is followed by sudden emission of very large volume of CH_4/CO_2 from strata with Coal and Coaldust.

→ From pores and cracks continious emission of CH_4 is absorbed.

→ As per indian regulation % inflammable gas (CH_4) should not be ~~shiefed~~ exceed (0.75%.) in the general body of air and 1.25% in any place in mine. If CH_4 content exceed 1.25% and working face electricity should be cut off short firing is prohibited, loco running discontinue, man involved in mine other than safety lamp miners.

Depending on gas conc. and liberation of CH_4 from the seams, the collieries ~~coal mines~~ are divided into 3 ~~type~~ categories as per coal mine regulation, 1972.

(1) 1st degree gassy seam: CH_4 % in general body not exceed 0.1%. ~~at~~ at the emission rates does not exceed $1 m^3$/Ton of coal.

(2) 2nd degree gassy seam: CH_4 content exceeds 0.1%. Gas in general body emitted is more than $1 m^3$/Ton of coal (i.e. (1-10) m^3/Ton).

(3) 3rd degree gassy seam: In case of 3rd degree gassy seam, where the emission is more than $10 m^3$/ton of coal.

presence of CH_4 in coal seams:

CH_4 present in coal seam in 2 form:
(1) absorbed
(ii) Free
Free gas is present in pores and open cracks and forms only a very small portion upto 10% or less of total gas present in coal seam.

Most of the gas is in absorbed state on the internal surface of the pore in a monomolecular layer due to very large internal surface area of coal.

(upto 200m²/gm)

The Internal surface area of coal bearing strata such as Sandstones and shells is much smaller and as such the amount of absorbed gas in those rocks is small.

Amount of free gas present in coal is denoted by Q_F

$$Q_F = \frac{273 n p}{T P_0} \quad \text{—(i)}$$

where

Q_F = free gas, m^3/Ton

n = Total porosity, m^3/ton

p = absolute gas pressure (in KPa)

P_0 = atmospheric pressure (in KPa)

T = absolute Strata temp (in K)

Amount of Absorbed CH_4

$$Q_a = \frac{abp}{1+bp} \quad \text{—(ii)}$$

Q_a = quantity of CH_4 absorbed at given pressure p, m^3/ton

10 266
+ 204

(-10?)

a = Langmuir Constant
b = Langmuir Constant with dimension 1/p

The constant a and b are very much dependent on moisture content, temp. and rank of coal.

Types of Damps Commonly present in Mines:

The occurrance of some ~~Gaseous~~ the gaseous impurities in mine atmosphere is known as damps to the miners. The word 'damp' originated from the German word 'Dampf'. 'Dampf' means Vapor or fume or smoke. The common types of Damp made within mine are:

(i) Fire Damp: A mixture of CH_4 and air, it may be explosive depending on the composition (5.42 - 14.8%) methane in air. Though CH_4 is not toxic its presence reduces the oxygen percentage of air. Normal human being can survive in 15% oxygen i.e. in a atmosphere containing 28% CH_4 any further increase in CH_4 content will endanger life.

(ii) Black damp: It is mixture of extinctive gases namely excessive nitrogen and CO_2. It is also known as choke damp. Like fire damp, the ill effect on health by black damp is mainly caused due to lack of O_2.

(iii) After damp: The mixture of gases left After an explosion of fire damp are coal dust, explosion, CO (most toxic element) is after damp and the death occurs mainly due to presence of CO in the event of mine explosion.

(iv) White Damp: A mixture of CO and air where the source of CO is other than explosion such as strata emission, diesel engine exhaust.

(v) Stink Damp: A mixture of air and H_2S is known as stink damp. It is more poisonous than even CO.

O_2

Properties:

It is odourless, colourless and tasteless gas of specific gravity = 1.105 i.e. slightly heavier than air. It is slightly soluble in water. 5% by volume at 0°C. It is highly active element. It readily combines with large no. of gases and compounds. It is essential for all forms of life and combustion.

Reasons of O_2 deficiency in mine:

→ By gradual oxidation of combustible substances like timbers, rocks, minerals like coal, pyrite.

→ mine fires and explosions of CH_4 air mixtures, coal dust explosions.

→ The addition of mine gases such as CH_4, CO_2 in mines. Due to release of such gases from strata of core. This is primary causes.

✓ SECONDARY REASONS

→ Burning of flame safety lamps, Human breathing, exhaust gases,

physiological effect of O_2 deficiency:

→ small deficiency: no serious effect

→ upto 17%. O_2: breathing becomes faster and deeper.

→ upto 15%. O_2: Dizziness, buzzing in ears and Rapid heart bit

→ upto 13%. O_2: ~~Un~~ Unconsciousness after prolonged exposure

→ upto 10%. O_2: Unconsciousness for ½ hour, serious headache.

→ upto 7%. O_2: Heavy ~~bending~~ vomiting and ~~respiration~~ ~~babbitation~~, face turns red and blue cells get dulled and confused. Rapidly leading to Unconsciousness and finally death.

Low O_2 level can cause ~~death~~ shortness of breath, mental retardation and death. Sudden O_2 loss can cause complete failure of critical ~~fun~~ of the brain in normal person. In people who are chemically hypogic, brain cells ~~dege~~ die after even shorter period of complete oxygen lack.

Decreased level of inspired O_2, a lung disease occurs which decreases blood uptake of oxygen from alveolies. Causes low O_2 delivery to the tissues. This O_2 deficiency result in increased

anaerobic metabolism instead of O_2 and water, the end product of anaerobic metabolism are lactic and pyric acid. Significant accumulation of these acid causes intracellular pH to drop resulting in inactivation of enzymes and death of cells.

The ~~Defect~~ explosibility of O_2 in limits of ~~possibility~~ is shown in fig. Known as ~~power~~ coward diagram. Also known as CH_4 and air explosion