6. Problem on Biological Oxygen Demand

A 2 % solution of sewage sample is kept in incubation for 5 days at 20 Celsius.If dissolved oxygen of day 1 and day 5 are 8.5 mg/lit and 5.5 mg/lit respectively. Calculate BOD
Soln:

Formula:

BOD = (DO1 -DO5) x dilution factor
= (8.5 - 5.5) x Vf/Vi
= 3 x 100/2
= 150 mg /lit

ENERGY

1 K cal= 2.2 C.H.U= 3.968 B.T.U

1. Problem on Dulong-Petit's formula:

Calculate the GCV and NCV of coal sample containing C= 74 % , H= 10%, S = 6%, O= 5% and ash=5%.
Soln:

GCV = 1/100 [8080 x %C + 34500 (H-O/8) +2240 xS]
= 1/100[8080 x 74 + 34500 (10-5/8) + 2240 x 6]
= 9347.97 Kcal /Kg

NCV = GCV - 9/100x % H x 587
= 9347.97 - 0.09 x 10 x 587
= 8819.67 Kcal/Kg

2. _Proximate analysis

i)1.5 gram of coal was subjected for proximate analysis. The weight of coal after heating at 100 ^{o}C for 60 minutes was found to be 1.28 g. This was further heated in muffle furnace at 925 ^{o}C for 7 minutes, the weight after heating was found 1.08 g. Finally, the coal is heated further at 750 ^{o}C for 30 minutes the weight of residue was found as 0.35 g. Calculate % Moisture, % volatile matter, % ash and % fixed carbon.

Soln: Weight of coal taken for analysis = W1 = 1.5 g
Weight of coal after heating 100 ^{o} C fr 60 minutes = W2 = 1.28 g
Weight of coal after heating in furnace at 925 ^{o} C for 7 minute=W3= 1.08 g
Wight of coal after heatng in furnace at 750 ^{o} C for 30 min= W4= 0.35 g

Formula:

$$\% \text{ Moisture} = \frac{W1-W2}{W1} \times 100$$

$$= \frac{1.5 - 1.28}{1.5} \times 100$$

$$= 14.66$$

$$\% \text{ V.M} = \frac{W2 - W3}{W1} \times 100$$

$$= \frac{1.28 - 1.08}{1.5} \times 100$$

$$= 13.33\%$$

$$\% \text{ Ash} = \frac{W4}{W1} \text{ xx}100$$

$$= \frac{0.35}{1.5} \times 100$$

$$= 23.33\%$$

3. Problem on Ultimate analysis

i)Determination of % Carbon and % Hydrogen:

1.8 gram of coal was analyzed for % C and % H in combustion tube experiment. The vapour released during combustion was absorbed in dry CaCl2 tube and KOH bulb. The increase in mass of CaCl2 tube and KOH bulb was found to be 0.35 g and 0.68 g respectively. Calculate % C and % H.

Soln:
Mass of coal = 1.8 g

Increase in mass of CaCl2 tube = 0.35 g
Increase in mass of KOH bulb = 0.68 g

$$\% \text{ Carbon} = \frac{\text{increase in mass of KOH bulb}}{\text{Mass of coal}} \times \frac{12}{44} \times 100$$

$$= \frac{0.35 \times 12 \times 100}{1.8 \times 44}$$

$$= 5.3$$

$$\% \text{ Hydrogen} = \frac{\text{increase in mass of CaCl2 tube}}{\text{Mass of coal}} \times \frac{2}{18} \times 100$$

$$= \frac{0.68 \times 2 \times 100}{1.8 \times 18}$$

$$= 4.19 \%$$

ii) Kjeldahl Method for determination of Nitrogen:

1.35 gram of coal was heated in Kjeldahl flask for nitrogen determination. The liberated ammonia was dissolved in 45 ml of 0.25 N H_2SO_4 solution. The excess acid required 18 ml of 0.25 N KOH solution for neutralization. while the 50 ml of distilled water required 48 ml of o.25 N KOH for neutralization. Calculate % Nitrogen in coal.

$$\% \text{ Nitrogen} = \frac{(V_{blank} - V_{Sample}) \times N_{KOH} \times 1.4}{\text{Mass of coal}}$$

$$= \frac{(48 - 18) \times 0.25 \times 1.4}{1.35}$$

$$= 7.77 \%$$

iii) Problem on Sulphur content:

1.1 gram of coal in bomb calorimeter experiment gave of $BaSO_4$ residue which on heating in furnace and cooling in desiccator gave 0.69 g of residue. Calculate % S in coal sample.

Soln:

$$\% \text{ Sulphur} = \frac{\text{mass of BaSO4 residue}}{\text{Mass of coal}} \times \frac{32}{233} \times 100$$

$$= \frac{0.69 \times 32 \times 100}{1.1 \times 233}$$

$$= 8.61 \%$$

4. Oxygen requirement for combustion for SOLID COAL:

$$\underset{12}{C} + \underset{32}{O_2} \longrightarrow CO_2$$

Therefore,

12 gram of carbon required = 32 gram of oxygen for combustion

Hence multiplication factor for oxygen required = $\frac{12}{32}$

Similarly,

$H_2 + \frac{1}{2} O_2 \longrightarrow H_2O$

2 16

Hence , multiplication factor for oxygen required = $\frac{16}{2}$

$S + O_2 \longrightarrow SO_2$

32 32

Multiplication factor for oxygen required = $\frac{32}{32}$

= 1

Element	Multiplication Factor
Carbon	32/12
Hydrogen	16/2
Nitrogen	- (no reaction with oxygen)
Sulphur	32/32
Oxygen	-1

i) Calculate the amount of oxygen and air required for combustion of 1 Kg coal containing Carbon =80 %, N= 2.5 %H = 3%, S=2.5 % ash = 5 % .

% O = 100 – (80 + 2.5 +3+2.5+5)

= 7 %

Element	Quantity present in **1 Kg**	Multiplication Factor	Amount of O_2 required
Carbon	0.80 Kg	12 /32	= 0.80 x 12/32 = 0.30
Hydrogen	0.03 Kg	16/2	= 0.03 x 16/2 = 0.24
Sulphur	0.025 Kg	32/32	= 0.025 x 32/32 = 0.025
Nitrogen	0.025 kg	- (does not burn)	-
Ash	0.05 kg	- (does not burn)	-
Oxygen	0.07 kg	1	- 0.07 (substract from total)
Total oxygen required for burning 1 Kg Coal			= 0.30 + 0.24 + 0.025 +(-0.07) = 0.495 Kg

Total oxygen required for burning 1 kg coal = o.495 kg

100 Kg of air contains = 23 kg of oxygen

Therefore,

Multiplying factor for converting oxygen to air = 100/23

0.495 kg of oxygen = 0.495 x 100/23

= 2.152 Kg

If in case, oxygen is supplied in excess for combustion of coal then we need to supply extra oxygen than what is calculated for combustion.

For e.g.

Suppose if there is 20% excess air is supplied for combustion

Amount of air required if 20% excess air is supplied = 2.152 x 120/100

= 2.5824 Kg

5. **Oxygen requirement for combustion for Gaseous Fuel:**

i) Calculate volume of oxygen and air required for combustion of 1 m3 gaseous fuel containing following composition:

CH_4 = 20%, C_3H_6 = 15%, H_2=30%, CO=5%, H_2O=8%, C_2H_6=12%, oxygen remaining.

Gaseous Component	Volume present in 1 m3	Combustion reaction	Multiplication Factor	Volume of Oxygen required for
CH_4	0.20 m^3	CH_4 + 2 O2 ------> CO2 + 2 H2O	2	= 0.20 x 2 = 0.40 dm^3
C_3H_6	0.15 m^3	C_3H_6 + 9/2 O2 ------> 3 CO2 + 3H2O	9/2	= 0.15 x 9/2 = 0.675 dm^3
H_2	0.30 m^3	H_2 + ½ O2 ------> H2O	½	=0.30 x ½ = 0.15 dm^3
CO	0.05 m^3	CO + ½ O2 ------> CO2	½	=0.05 x ½ = 0.025 dm^3
H_2O	0.08 m^3	No reaction	-	-
C_2H_6	0.10 m^3	C_2H_6 + 7/2 O2 ------> 2CO2 + 3 H2O	7/2	= 0.10 x 7/2 =o.35 dm^3
O2	0.10 m^3		-1	-0.10 dm^3
Volume of oxygen required for combustion of 1 dm^3 of fuel				= 0.40

	+0.675+0.15+0.025+ 0..35-0.10 = 1.5 dm^3

Therefore,

Volume of oxygen required for combustion of 1 dm^3 of fuel = 1.5 dm^3

Volume of air:

100 dm^3 of air contains = 21 dm^3 of oxygen

Therefore,

1.5 dm^3 of oxygen will be = 1.5 x 100/21

=7.142 dm^3 of air

Volume of oxygen required for combustion of 1 dm^3 of fuel = 7.142 dm^3 of air

UV-Vis SPECTROSCOPY

1. The transmittance of 2 x 10^{-4}M of solution was found to be 76.2% at a wavelength of 530 nm when placed in cuvette of path length 1 cm. Calculate absorbance, molar absorptivity and transmittance of sample when pathlength is 2 cm.
   Solution:
   Formula:

   A = 2- log(%T)

   A = 2 – log(76.2)
   = 2 – 1.8819
   = 0.1181

   $A = \epsilon . b . C$

   $\epsilon = \frac{A}{b. c}$