FUELS AND COMBUSTION

QUESTION

Calculate the stoichiometric (kg) amount of air required for the complete combustion of 1 kg pf liquid fuel with the following properties:

Constituents	% By weight
Carbon (C)	85.9
Hydrogen (H)	12
Oxygen (O_2)	0.7
Nitrogen (N)	0.5
Sulphur (S)	0.5
Moisture (H_2O)	0.35
Ash	0.05
Total	100

The gross calorific value (GCV) of the liquid fuel is 10200 kCal/kg.

SOLUTION

1. Write down what you already know and assumptions

- Air = 23% O_2 (gravimetric)
- H2O does not react during combustion to form O_2
- N2 remains inert and does not form NO_x

2. Write the combustion reactions based on 100 kg of fuel

C	+	O_2	=	CO_2	(1)
12 kg		32 kg		44 kg	
H_2	+	½ O_2	=	H_2O	(2)
2 kg		16 kg		18 kg	
S	+	O_2	=	SO_2	(3)
32 kg		32 kg		64 kg	

3. Calculate the O_2 required for complete combustion of 100 kg of fuel using combustion reactions (1), (2) and (3)

Note: for example, if 85.9% of the fuel is C, then 100 kg of fuel will contain 85.9 kg C

Consituent	**Calculation using equations**	**O2 formed**
85.9 kg C =	85.9 kg C x (32 kg O_2 ÷ 12 kg C)	= 229.07 kg O_2
0.5 kg S =	(0.5 kg S x 32 kg O_2) ÷32 kg S	= 0.5 kg O_2
12 kg H_2 =	(12 kg H_2 x 16 kg O_2) ÷ 2 kg H_2	= 96.0 kg O_2

Total amount of oxygen required for stoichiometric combustion:
= 229.07 kg + 0.5 kg + 96.0 kg
= **325.57 kg O_2**

But oxygen is present in Fuel = **0.7 kg**

Therefore the additional oxygen required = 325.57 kg O_2 – 0.7 kg O_2 = **324.87 kg O_2**

4. Calculate the air required to provide the additional O2 for complete combustion of 1 kg fuel:

Stoichiometric amount of air required
= 324.87 kg O_2 / 0.23
= 1412.48 kg air per 100 kg fuel
= **14.1248 kg air per 1 kg fuel**