**Physical properties and chemical structure of fuels**

Physical properties and chemical structure of HCs are need to be understood for an effective operation and safety purposes. These properties are

* Volatility characteristics and associated boiling points -----Whether it is a gas or liquid or solid
* Heating value/energy density
* Ignition temperatures ---- the minimum temperature needed for self-ignition in the presence of an adequate energy source
* Flame speed and propagation
* Chemical stability, explosiveness
* Compatibility with other materials

Apart from the above properties, one key property is the fuel’s H/C ratio, in other words relative number of H atoms to C atoms in a molecule. Below values show you H/C for different hydrocarbon fuels. This ratio is an indicator of the fuel’s energy density and carbon emissions.

Coke --------~ 0.010

Wood --------~0.125

Diesel Fuel --------~0.15

Kerosene --------~0.16

Gasoline --------~0.18

Natural gas as methane -------- 0.33

Propane --------0.22

As the ratio increases, energy density of the HC increases and the CO2 emission levels decrease. For instance, (energy density)natural gas > (energy density)petroleum >energy density)coal

**Refining Petroleum**

**Major refinery products from petroleum**

Below figure is adapted from <https://www.eia.gov/energyexplained/images/charts/products_from_barrel_crude_oil-large.jpg>.

It shows the distribution of major refinery products for 1 barrel of oil. Remember that 1 barrel of oil is equal to 42 Gallons of Crude oil but the major products shown below makes roughly 45 Barrels. This is due to the refinery process gain. Refinery process gain is simply a result of the refinery products having lower specific gravity compared to that of crude oil.

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As shown above, the highest fraction belongs to the motor gasoline. Gasoline is followed by distillate fuel, in other words, diesel fuel and then followed by jet fuel, kerosene.

Once the crude oil is extracted, it is converted into different gaseous, liquid and solid products via fractional distillation.

**Fractional distillation**

Below figure is adapted from <http://www.bbc.co.uk/staticarchive/d1fc03f39806642998b1bd6ea1dda2c8e2e2b674.gif>

Fractional distillation fractionates the crude oil into useful products based on their boiling point differences. So, the ones that are extracted on the top of the column have lower boiling points, volatile, flow and ignite readily. The ones that are obtained from the lower portions of the column have high boiling points such as residue, fuel oil and diesel oil.



Reference: Ghazi A. Karim, Fuels, Energy and the Environment, 1st Edition, CRCPress.