FUEL OIL QUALITY & OPTIMUM FUEL SELECTION

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FUEL SELECTION

How do we select a fuel for our application?

- Lowest cost
- "Best" quality
- Cleanest fuel
- Lowest sulphur
- Easiest to use
- Prior experience

FUEL SELECTION

The overriding principle of fuel selection should always be:

The Most Economic Fuel Suitable for the Application

“Fit for Purpose”

INTRODUCTION

- Fuels can vary significantly in cost
  - State (solid, liquid, gas)
  - Properties
  - Ease of use
  - Availability
  - Dependent on competition
- Fuel can account for over 70% of the total cost depending on application
- Fuel selection is a critical aspect to minimise costs

INTRODUCTION

- The combustion process is affected by the fuel used, in that fuels have different:
  - Energy values (Gross & Net)
  - Densities
  - Contaminants
  - Emissivities
  - Viscosities
  - Ease of use (operator interface)

FUEL CHARACTERISATION

- Liquid heating fuels are generally characterised by properties relevant to their application
- Marine fuel oil qualities are often specified for industrial use
  - Not totally relevant
  - Results in "over specification" & higher costs
  - Could exclude more suitable fuels

Fuel Specifications - relevancy

PARAMETER	UNITS	MARINE	INDUSTRIAL
Density @ 15°C	kg/l	Y	N
Viscosity @ 50°C	cSt	Y	Y
Water	% V/V	Y	Y
Micro Carbon Residue	% M/M	Y	N
Sulphur	% M/M	Y	Y
Ash	% M/M	Y	Y
Vanadium	mg/kg	Y	N
Flash Point	°C	Y	Y
Pour Point (winter / summer)	°C	Y	Y
Aluminium + Silicon	mg/kg	Y	N
Total Sediment Potential	% M/M	Y	N
Zinc	mg/kg	Y	N
Phosphorous	mg/kg	Y	N
Calcium	mg/kg	Y	N
Calorific / Heating value	MJ/kg	N	Y

TYPICAL ENERGY VALUES

DESCRIPTION	UNITS	GROSS ENERGY (MJ/kg)	NET ENERGY (MJ/kg)
LPG	MJ/kg	50	46,3
Paraffin	MJ/kg	46,5	43,3
Diesel	MJ/kg	46	43,0
Light Oil	MJ/kg	45,5	42,7
Heavy Oil	MJ/kg	43,5	41,7
Coal Tar	MJ/kg	37	37,2
Natural Gas	MJ/kg	29	
Coal – A grade	MJ/kg	28	27
Electricity	MJ/kWh	3,6	N/A

TYPICAL ENERGY COSTS

DESCRIPTION	UNIT	JUNE 08		OCTOBER 08	
		COST	FACTOR	COST	FACTOR
Brent Crude	($/bbl)	140		55	
Diesel	**R/GJ**	282	100%	242	100%
Coal	**R/GJ**	31	11%	41	17%
Coal Tar	**R/GJ**	72	25%	72	30%
Heavy Oil	**R/GJ**	121	43%	136	56%
Low Sulphur Heavy Oil	**R/GJ**	132	47%	142	59%
Light Oil	**R/GJ**	155	55%	167	69%
Paraffin	**R/GJ**	235	83%	194	80%
LPG	**R/GJ**	187	66%	168	69%

DENSITY

- Liquid fuel densities vary from 0,79 kg/l @ 20 °C for paraffin to 1,05 for coal tar
- Density is temperature dependent
- Once burners are set for a specific fuel, the industrial relevance of density is purely to convert a cents per litre cost into Rand per megajoule
- In marine applications for centrifugal separation

VISCOSITY

- TWO MAIN CATEGORIES BY VISCOSITY:
  - Heavy Fuel Oil (>90 cSt @ $50^{o}C$)
  - Light Fuel Oil (<10 cSt @ $40^{o}C$)
- The relevance of this is in the ease of use, as the more viscous fuel oils require heated reticulation systems
- Rule of thumb :
  viscosity @ burner tip <20 cSt

WATER

- Excess inclusion can lead to slugs and flame-outs
- In moderate inclusion (emulsions) can assist vaporisation & better combustion
- Negative energy value
- Extreme cases of very high viscosity fuel oil / water emulsions to render them pumpable (Orimulsion 70% bitumen, 30% H_2O)

ASH

- Four main categories by ash content:
  - High ash (0,5 – 3%)
  - Medium ash (~0,3%)
  - Low ash (<0,1%)
  - Clean fuel (<0,01%)
- Ash consists of:
  - Sand, metals (Ni, V, Al, Fe, Pb, etc)
  - Catalyst fines (Al + Si)
  - Any incombustible

ASH

- Different applications have different sensitivities to ash.
- Typically - Higher ash, lower cost
- Note: abrasive wear, particulate emissions, fouling, product contamination
- High ash suitable for some applications

SULPHUR

- Three main categories by sulphur content:
  - High Sulphur (>3,0%)
  - Medium Sulphur (1~2%)
  - Low Sulphur (<0,2%)
- SO_2 emissions
- Product contamination
- Legislation (availability vs. scrubbing)

POUR POINT

- Three main categories of pour point:
  - High pour (>30^{o}C)
  - Medium pour (0 - 30^{o}C)
  - Low pour (<0^{o}C)
- Transport & storage limitations

FLASH POINT

- Flash Point is often confused with Auto Ignition Point
- Flash Point is the temperature at which the vapour above a liquid will combust in the presence of a spark
- It is normal to operate a reticulation system above the product's flash point
- Storage is governed by legislation

FLASH POINT

There are four categories of flash point:

- Very High Flash (Non Dangerous: >100ºC)
- High Flash (group IV: 60,5-100ºC)
- Medium Flash (group III: >23-60,5ºC)
- Low Flash (group II: <23ºC)

SANS 10228:2006 - The identification and classification of dangerous goods for transport

ENERGY RELEASE

Energy is released:

- Infrared emission
  - Light
  - High radiance transfer
  - High heat
  - High carbon ratio
- Ultra violet
  - Low light
  - Convection transfer
  - Low carbon ratio

ENERGY RELEASE

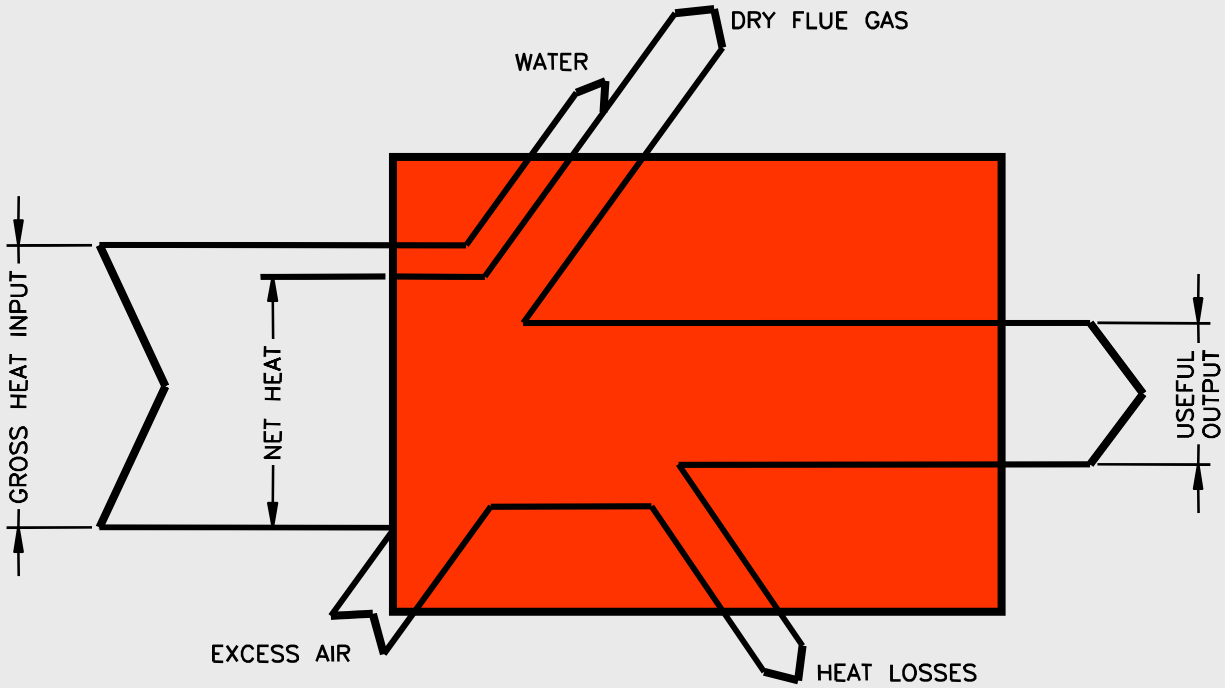
- High Radiance (coal tar)
  - Smelting, large boilers, sintering
- Average Radiance (black fuels)
  - Medium boilers, clay brick,
- Low Radiance (paraffin and gas)
  - Small boilers, space heating

The relevance of the fuel's emissivity is in the appliance efficiency

USABLE ENERGY

- Not all the energy is available for use
- The hydrogen content of the fuel on combustion forms water, which in most combustion applications, is lost up the flue or stack as water vapour and thus the latent heat is lost
- The difference is the **Net Energy Value** of the fuel
- Of the remaining heat, some is lost up the flue, some to heating the appliance on start-up and some through the walls and openings
- What remains is the **Useful Energy**

SANKEY DIAGRAM



FUEL COSTS

As a generalisation:

- Fuels decrease in cost with an increase in impurities
- Fuels increase in cost with a decrease in viscosity
- Fuels increase in cost with a decrease in sulphur content
- Distillates cost more than residual fuels

ASSOCIATED COSTS

- High viscosity liquid fuels require more costly fuel reticulation systems to heat the product (electrical, steam or thermal oil heaters)
- This however is an insignificant cost at around **0,5 – 0,75%** of the total energy bill, which is usually very much less than the difference in the cost of the fuels
- Maintenance costs generally increase with higher contaminants and higher viscosities
- Emissions generally increase with lower cost fuels

FUEL SELECTION

Fuel Oil selection is dependent on:

- The relative cost of the available heating fuels
- The applications' tolerance to impurities (ash, water, metals etc)
- The design of the appliance (radiance/convection, size)
- The environmental sensitivity of the area (sulphur, particulates, smutting)
- For existing installations:
  - The type of burner installed (wear, turn-down)
  - The type of fuel reticulation system installed, although the change over cost is usually quickly recovered

FUEL VALUATION

Before a cost comparison of fuels can be done, the price in **Rand per ton** or **Cent per litre** must be converted to a common energy value base.

- Energy is measured in joules
- So the true measure of energy value for money is **Rand per joule** or for convenience Rand per megajoule (R/MJ)
- In order to do this, the energy value and density of the fuel is required

COST OF CONTAMINANTS

- The acceptable level of ash in a combustion appliance is dependent on:
  - The cost saving of the lower specification fuel
  - Contamination of product (non-boiler applications)
  - The cost of cleaning (frequency, time available and cost of down-time)
  - The amount of spare capacity available
  - Burner and pump wear cost

EMISSIVITY

- The radiance of the flame produced by the fuel has a profound effect on the heat transfer rate
  - High radiance fuels such as coal tar produce a high radiance flame (suitable for melting applications but not smaller boiler applications)
  - Medium radiance fuels such as black oils produce good heat transfer rates and give efficiencies of ~82% in boiler applications
  - Low radiance fuels such as paraffin and gas only achieve efficiencies of around 78% in boiler applications and less in melting applications

OPTIMAL FUEL SELECTION

- A balanced view is required to prevent costly bias
- An understanding of the applications' requirements and sensitivities is required
- It is then possible to put a cost to all of the factors that affect the combustion application and arrive at the most cost effective fuel.

THE END