RE: ALPHAKAT BIO-MASS/ DIESEL C0NVERSION RATIO
08-06-2011 Dr G Zimmer

To clarify the discussions of the last few days.

(Wood) Cellulose has the formulation $C_6H_{11}O_5$;

This will be changed, during et AlphaKat process into its constituent components: 2,5 CO_2, 3,5 CH_2 and 4 H

The mass balance is as follows:

$C_6H_{11}O_5$ has a Molecular weight of 163

The products:

2,5 CO_2	=	110
3,5 CH_2	=	4
4 H	=	4

This means only 32.5 weight % of the total mass of **dry biologic waste** will be Diesel at the end.

This means from one tone of dry bio-waste will give 325 kg Diesel;

This means 325 kg / 0,833 = 390 Liters.

Correction must be made for "moisture content".

'Green' Sugar Cane tops with 25% H_20 will require 1000/0.75 = 1250 tonne of green feedstock to effect conversion to 390 litres of Syn-Diesel.

The KDV 500 standard plant can produce up to 500 litres/ hour from 1.2 tonne of biomass (dry –basis)

Other types of biomass will respond differently and with the addition of plastic waste for example, the conversion rate may be as high as 80%!

Cheers

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Table 3 Proximate and elemental analyses of biomass feedstock

	Bagasse	Cane trash	Rice husk	Rice straw	Cassava rhizome	Corncob
Proximate analysis (wt% as received)						
Moisture	50.73	9.20	8.20	10.00	59.40	7.00
Volatile	41.98	67.80	58.90	60.70	31.00	70.40
Fixed C	5.86	16.90	19.70	18.90	8.10	21.20
Ash	1.43	6.10	13.20	10.39	1.50	1.40
Elemental analysis (wt% as received)						
C	21.33	41.60	39.10	38.17	18.76	43.70
H	3.06	5.08	4.59	5.02	2.48	5.21
N	0.12	0.40	0.18	0.58	0.32	0.19
O	23.29	37.42	34.70	35.28	17.50	42.50

Table 4 The maximum amount of liquid fuel production via BG-FT from Thai biomass

Type of biomass	Chemical formula	Max. fuel with O_2 as agent (g/kg biomass)	Max. fuel with H_2O as agent (g/kg biomass)
Sugarcane trash	$C_{4.1}H_6O_{2.8}$	210.00	301.00
Bagasse	$C_{3.7}H_{6.4}O_3$	226.80	274.26
Rice husk	$C_{4.1}H_{5.8}O_{2.8}$	203.42	294.56
Rice straw	$C_4H_{6.3}O_{2.8}$	222.60	301.56
Palm oil fibre	$C_{4.2}H_{7.4}O_{2.6}$	260.54	373.24
Empty fruit bunch	$C_{3.4}H_{4.1}O_{3.3}$	146.86	154.14
Palm oil shell	$C_{4.4}H_{5.9}O_{2.6}$	205.94	331.52
Cassava rhizome	$C_4H_{6.4}O_{2.8}$	225.82	310.52
Rubber wood	$C_4H_6O_{2.4}$	227.36	348.46
Eucalyptus	$C_{4.1}H_{5.7}O_{2.8}$	200.20	280.84
Palm oil tree	$C_4H_{6.1}O_{2.9}$	212.52	289.10

Table 6 Amount of diesel product from Thai biomass via CDP

Type of biomass	HHV of biomass (kJ/kg)	Diesel production (g/kg biomass)	Diesel production (l/kg biomass)
Sugarcane trash	16,794	275.22	0.32
Bagasse	9,243	151.47	0.18
Rice husk	15,400	252.38	0.29
Rice straw	13,650	233.70	0.26
Palm oil fibre	13,548	222.03	0.26
Empty fruit bunch	8,969	146.98	0.17
Palm oil shell	18,267	299.36	0.35
Cassava rhizome	7,451	122.11	0.14
Rubber wood	10,365	169.86	0.20
Eucalyptus	8,514	139.53	0.16
Palm oil tree	9,354	153.29	0.18

After the theoretical calculations by using both biomass gasification with integrated Fischer-Tropsch synthesis (BG-FT) and catalytic depolymerisation process (CDP), it can be concluded that, the CDP can provide more diesel output due to its higher energy efficiency (more than 70%), whereas the energy efficiency of BG-FT is only 33-50%. Besides the higher heating value of biomass itself, all the operation parameters and the catalysts will affect the amount and quality of liquid fuel produced from CDP. The effects of these parameters will be investigated in the future. In addition to the higher diesel output, the cost of CDP is also less than the BG-FT which consists of a two step conversion process: biomass gasification and FT-Synthesis.

Advantages of FT-diesel and CDP-diesel are that they are high quality and ultra clean transportation fuel with very low sulphur content and aromatic compounds. The specification of FT-diesel and diesel derived from CDP is illustrated in Table 7, in comparison with petroleum-derived diesel [1, 15]. In addition, the FT-Diesel and diesel derived from CDP can be directly used in the automobiles and existing infrastructure without any adaptations.

Table 7 Specification of FT-diesel and CDP-diesel in comparison to conventional diesel

Fuel specification	FT-Diesel	CDP-Diesel	Conventional diesel
Chemical formula	Paraffin		$C_{12}H_{26}$
Molecular weight (kg/kmol)			170-200
Cetane number	> 74	63	50
Density (kg/l) at 15°C	0.78	0.865	0.84
Lower Heating Value (MJ/kg) at 15°C	44.0	42.7	42.7
Lower Heating Value (MJ/l) at 15°C	34.3		35.7
Stoichiometric air/fuel ratio (kg air/kg fuel)			14.53
Oxygen content (%wt)	~ 0		0-0.6
Kinematic viscosity (mm^2/s) at 20°C	3.57	10.6	4
Flash point (°C)	72	77	77

For the economic point of view, both synthetic diesel fuels can compete with conventional diesel fuel in the near future, because the possible high crude oil price. The production cost of FT-Diesel and CDP-Diesel is 0.31-0.45 €/liter and 0.23-0.40 €/liter, respectively [1, 25] whereas the crude oil price is about 60.77 €/barrel and it is predicted that the crude oil prices can reach 82.89 €/barrel in next year [26].