Closed-loop biomass/coal cofiring project at Hawaii Commercial and Sugar

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This paper summarizes a collaborative research effort involving Sandia National Laboratories (SNL), Hawaii Commercial and Sugar (HC&S), the University of California at Davis (UC Davis) and the Hawaii Natural Energy Institute (HNEI). The objective of this work was to determine the suitability of four biomass fuels and blends of these biomass fuels with Australian coal for use in the HC&S sugar factory boilers in Puunene, Maui for steam and power generation.

HC&S and HNEI used four treatments to prepare biomass fuels from the same parent material, a cane variety designated B52298. The biomass treatments represent a range of preparation from minimal processing (WC-U) to commercial bagasse processing. The two remaining treatments (WC-M and WC-MLM) represent intermediate levels of processing. The Australian coal was pulverized similarly to that used for entrained flow (pulverized coal) facilities. Table 1 summarizes the feeds used in the testing.

Table 1 Summary of fuel names for coal and cane variety B52298 fuel lots for pilot scale testing.

Fuel ID	Material	Forage Chopped	Initial Cuba Milling – (4 passes)	Leaching	Second Cuba Milling – (4 passes)
AC	Australian Coal				
WC-U	Whole Cane	X			
WC-M	Whole Cane	X	X		
WC-MLM	Whole Cane	X	X	X	X
SC-MLM	Whole Cane	X	X	X	X
CB	Commercial Bagasse	NA	NA	NA	NA

WC – whole cane U – unprocessed
SC – stripped cane M – milled four times through Cuba mill
L – leached using tap water at 10:1 wt ratio of water to fiber

All tests in this study were conducted in the Multi-Fuel Combustor (MFC) at Sandia National Laboratories, a pilot-scale, down-fired, turbulent flow reactor that simulates temperature, gas composition, and residence time existing in commercial combustion systems[1]. Products exiting the MFC pass through an open, optical-access test section before entering an exhaust ventilation duct. Temperature-controlled deposit collection probes simulating superheater tubes in commercial boilers were used in this open test section to collect data on ash deposition rates at 400 and 500° C (see Figure 1). Extracted gas samples were monitored for CO, CO_2, O_2, NO_X, and SO_2 concentrations using continuous emission monitors. Flyash samples (non-size-classified, total particulate) were collected from the exhaust product gas stream onto filters for compositional analysis.

Table 1 shows test data of flyash composition and NOx in the exit gas. These data indicate that NO_x concentration in the exit gas of sugar cane feeds appears to be quantitatively lower than that of coal. Additionally, the level of processing also appears to decrease the concentration of NO_x. The flyash composition and the ash deposition analyses (in-progress) will provide information on the effect of flyash

on boiler heat-exchange tube performance. We will interpret these and the balance of the data as well as provide recommendations for an upcoming demonstration at the HC&S facility.

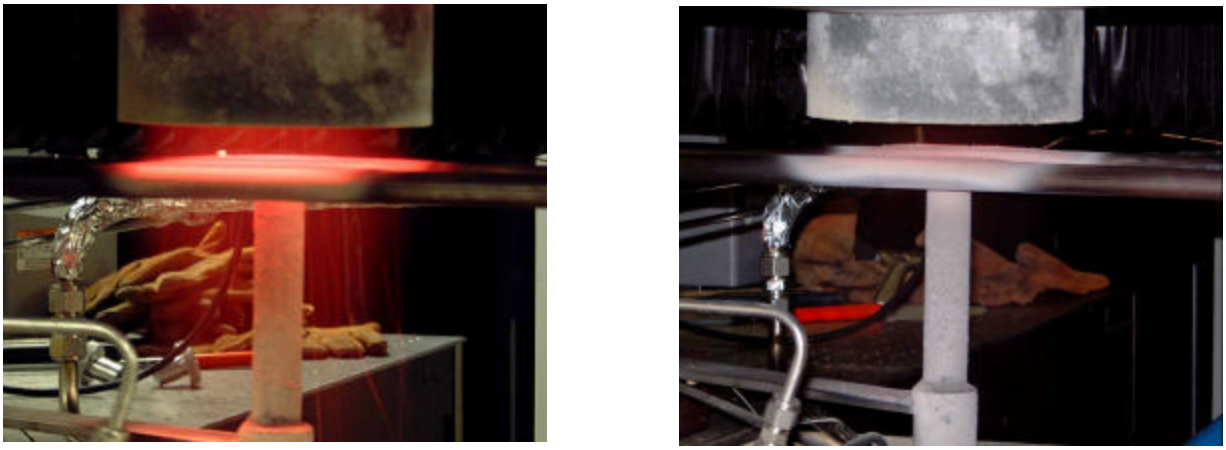

Figure 1 – Ash deposition on temperature-controlled deposit collection probes during and after the co-firing of coal and bagasse.

Table 2 – Flyash and NOx analysis from MFC tests

Fuel Blends	Flyash Analysis											Gas
	SiO_2	**Al_2O_3**	**TiO_2**	**Fe_2O_3**	**CaO**	**MgO**	**Na_2O**	**K_2O**	**P_2O_5**	**SO_3**	**Cl**	**NOx (ppm)**
100% coal	54.2	34.8	2.1	3.2	1.2	0.8	1.2	1.0	1.1	0.4	0.1	490
100% WC-U	35.7	13.7	1.1	2.4	1.4	1.4	1.0	24.4	2.8	1.4	14.5	390
100% WC-M	52.5	5.9	0.5	1.9	1.7	1.4	0.8	29.4	4.6	1.3	-	370
100% WC-MLM	73.5	5.2	0.5	2.4	2.1	1.3	0.5	11.3	2.6	0.7	-	330
100% SC-MLM	59.7	15.5	1.2	2.8	1.6	1.3	0.9	10.4	2.9	0.3	3.5	210
30% WC-U 70% Coal	in progress											
30% WC-M 70% Coal	53.1	31.5	1.9	3.1	1.6	0.9	1.2	3.3	1.9	1.4	0.2	470
30% WC-MLM 70% Coal	55.9	24.9	1.6	3.6	1.7	1.5	0.9	6.9	1.7	0.6	0.7	530
30% SC-MLM 70% Coal	52.9	32.1	3.3	3.2	1.1	0.8	1.2	2.2	2.4	0.7	0.1	520
70% WC-U 30% Coal	42.3	19.7	1.4	2.4	1.2	1.0	1.2	18.6	2.6	1.1	8.5	500
70% WC-M 30% Coal	56.1	25.8	1.6	2.8	1.4	1.0	1..0	7.3	1.6	0.7	0.8	500
70% WC-MLM 30% Coal	58.7	28.2	1.7	3.1	1.3	0.9	1.0	3.5	1.1	0.5	0.1	440
70% SC-MLM 30% Coal	57.9	27.4	1.9	3.0	1.2	1.0	1.1	4.3	1.4	0.4	0.4	360
30% CB 70% Coal	53.4	33.5	2.4	3.9	1.1	0.8	1.1	1.5	1.9	0.2	0.1	520
70% CB 30% Coal	48.9	35.1	2.5	5.8	1.3	0.9	1.1	2.6	1.4	0.4	0.2	550
100% CB	in progress											

[1] Baxter, L. L., Char Fragmentation and Fly-Ash Formation During Pulverized-Coal Combustion. *Combustion and Flame* 90[2], 174-184. Aug 1992