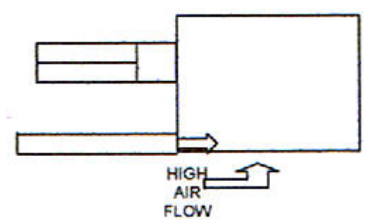
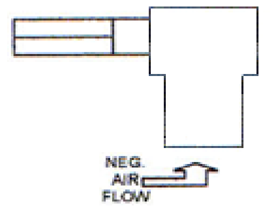
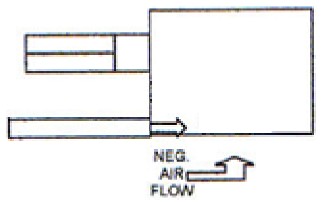
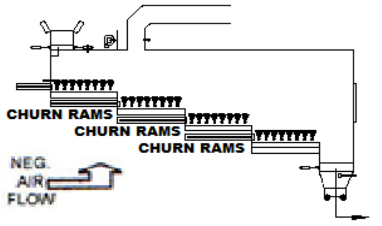
Appendix 2
Comparison of Waste to Energy Technologies

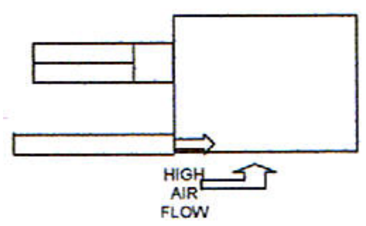


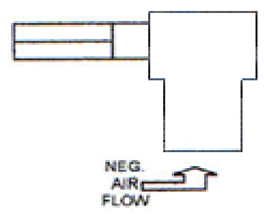


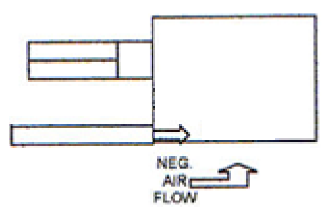


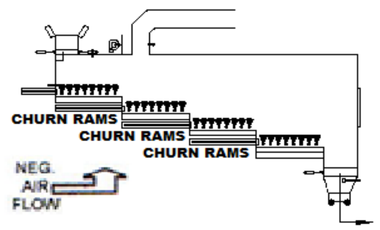


ITEM	DESCRIPTION	MASS BURN INCINERATION	FLUID BED GASIFICATION	STATIC HEARTH GASIFICATION	ENTECH STEPPED HEARTH GASIFICATION	COMMENTS
A	**SUMMARY OF TYPICAL PROCESS PARAMETERS:**					
	a. Process Temperature	850 - 950 C	1150 - 1250 C	1150 - 1250 C	650 - 850 C	SUMMARY OF THE DETAILED ANALYSIS HEREIN: The Entech stepped hearth gasification process is unique in that it provides for high surface area exposure + very long retention + very high agitation of the process matter. These process factors results in a very high degree of capability to process extremities in waste variation (e.g. CV, density, humidity, ash content, etc).
	b. Process Stoichiometric Air	200%	50%	50%	15%	
	c. Surface Area Exposure of Process Matter to Heat & Air (Hearth Loading)	230 kg/m²/hr	830 kg/m²/hr	370 kg/m²/hr	80 kg/m²/hr	
	d. Description of Agitation of Process Matter	Typically Grate Stoker	Pneumatic	Typically Mechanical Stoker	Multi Churn + Stoker System	
	e. Degree of Agitation of Process Matter	Minimal	Very High	Minimal	Very High	
	f. Retention Time of Process Matter Before Ejection as Ash	1 - 2 hr	¾ - ½ hr	1½ - 2 hr	16 - 24 hr	
	g. Volumetric Loading	115 kg/m³/hr	280 kg/m³/hr	120 kg/m³/hr	40 kg/m³/hr	Additionally, the Entech low velocity process conditions results in ultra-low entrainment of PM & HM into downstream equipment.
	h. Process Velocity	3.08 m/sec	1.44 m/sec	0.65 m/sec	0.17 m/sec	
	i. Entrainment of Pollution Concerns (PM & HM)	High	Very High	Low	Very Low	
B	**PROCESS CONDITIONS REQUIRED TO MAXIMIZE THERMAL DEGREDATION**	**A. Maximise surface area exposure of process matter to heat and air (hearth loading)** **B. Maximise agitation of process matter (to loosen high density and high moisture waste and expose it to the process)** **C. Maximise retention to increase time of exposure of process matter to heat and air + increase time of agitation.**				Though combustion doesn't occur, thermal degradation efficiency for gasification processes is commonly referred to as "combustion efficiency".
C	**PROCESS EFFICIENCY COMPARISON:**					
	a. Surface Area Exposure of Process Matter to Heat & Air (Hearth Loading)	Low	Very Low	Low	High	- Higher is superior for combustion efficiency.
	b. Process Matter Trapped from Exposure to Heat & Air (Volume Loading)	High	Very High	High	Very Low	- Lower is superior for combustion efficiency.
	c. Pneumatic Agitation	High	Very High	Low	Very Low	- Higher is superior for combustion efficiency.
	d. Mechanical Agitation	Low	Nil	Low	High	- Higher is superior for combustion efficiency.
	e. Time of Process Matter Exposure to Agitation		Low		High	- Higher is superior for combustion efficiency.
	f. Time of Process Matter Exposure to ALL Process Conditions Above		Low		High	- Higher is superior for combustion efficiency.
	g. Retention Time of Solid Residue / Ash Prior to Ejection		1-2 Hrs		16-24 Hrs	- Higher is superior for combustion efficiency.
	h. Overall thermal degradation / combustion efficiency	Moderate		Low	High	- Higher is superior.









ITEM	DESCRIPTION	MASS BURN INCINERATION	FLUID BED GASIFICATION	STATIC HEARTH GASIFICATION	ENTECH STEPPED HEARTH GASIFICATION	COMMENTS
D	**PROCESS EFFICIENCY IMPLICATION TO CAPABILITY:**					- NOTE: Low combustion efficiency of the static hearth gasification process is why these systems can handle easy feed-stocks (e.g. biomass), but have failed to commercialise for difficult feed-stocks such as MSW, C&I, RDF.
	a. Overall Thermal Degradation / Combustion Efficiency (per above)	Moderate	Moderate	Low	High	
	b. Efficiency → Capability for Homogenous / “Easy” Feed-Stock	High	High	High	High	
	c. Efficiency → Capability for Heterogeneous & Dense Feed-Stock	Moderate	Low	Very Low	High	Efficiency is relative to agitation + time exposure of process matter.
	d. Efficiency → Capability for High Humidity Feed-Stock	Low	High	Low	High	Efficiency is relative to agitation + surface area exposure + time exposure of process matter.
	e. Efficiency → Capability for Subliming Feed-Stock (e.g. some plastics, rubber, etc that “pool” upon heating)	Low	Low	Very Low	High	Efficiency is relative to agitation + exposure time of process matter.
	f. Efficiency → Capability for High CV Feed-Stock	Moderate	High	High	High	
	g. Efficiency → Capability for Low CV Feed-Stock	Very Low	High	Very Low	High	Efficiency is relative to agitation + surface area exposure + time exposure of process matter.
E	**CALCULATION ENTRAINMENT OF POLLUTION CONCERNS:**					- NOTE: Due to limited availability of data for commercialised fluid bed and static hearth gasification for MSW; the comparison is based upon 1.2-t wet and 1.0-t dry feed.
	a. Typical Dimensions	3.5mL x 1.5mW x 2.0mD	3.5mD x 1.2mL x 1.2mW	4.5mD x 1.8mL x 1.8mW	8.0mL x 1.6mW x 2.4mD	
	b. Hearth Loading	228 kg/m^2/hr	833 kg/m2/hr	370 kg/m^2/hr	80 kg/m^2/hr	
	c. Volumetric Loading	114 kg/m^3/hr	278 kg/m^3/hr	119 kg/m^3/hr	40 kg/m^3/hr	
	d. Volume Occupied by Process Matter	0.5m Deep	0.75m Deep	0.75m Deep	0.5m Deep	
	e. Cross-Section of Unoccupied Area	1.5m x 1.5m = 2.25m^2	1.2m x 1.2m = 1.44m^2	1.8m x 1.8m = 3.24m^2	1.6m x 1.9m = 3.04m^2	
	f. Typical Gas Flow Rate	@ 200% Stio = 200/15 x 0.52 = 6.93 Am^3/sec	@ 50% Stio = 200/50 x 0.52 = 2.08 Am^3/sec	@ 50% Stio = 200/50 x 0.52 = 2.08 Am^3/sec	@15% Stio = 0.52 Am^3/sec	Reference is the Entech M&HB for Boodarie Pj. At 15% stoichiometric = 0.52Am3/sec
	g. Typical Gas Flow Velocity (V = Q / A)	V =6.93 Am^3/sec ÷ 2.25 m^2 = 3.08 m/sec	V = 2.08 Am^3/sec ÷ 1.44 m^2 = 1.44 m/sec	V = 2.08 Am^3/sec ÷ 3.24 m^2 = 0.65 m/sec	V = 0.52 Am^3/sec ÷ 3.04 m^2 = 0.17 m/sec	
	h. Velocity Comparison	(x) 18	(x) 9	(x) 4	Datum (x) 1	
	i. Entrainment of Pollution Concerns (PM & HM)	Very High	High	Low	Low	PM & HM refers to solid matter, namely particulate matter and heavy metals