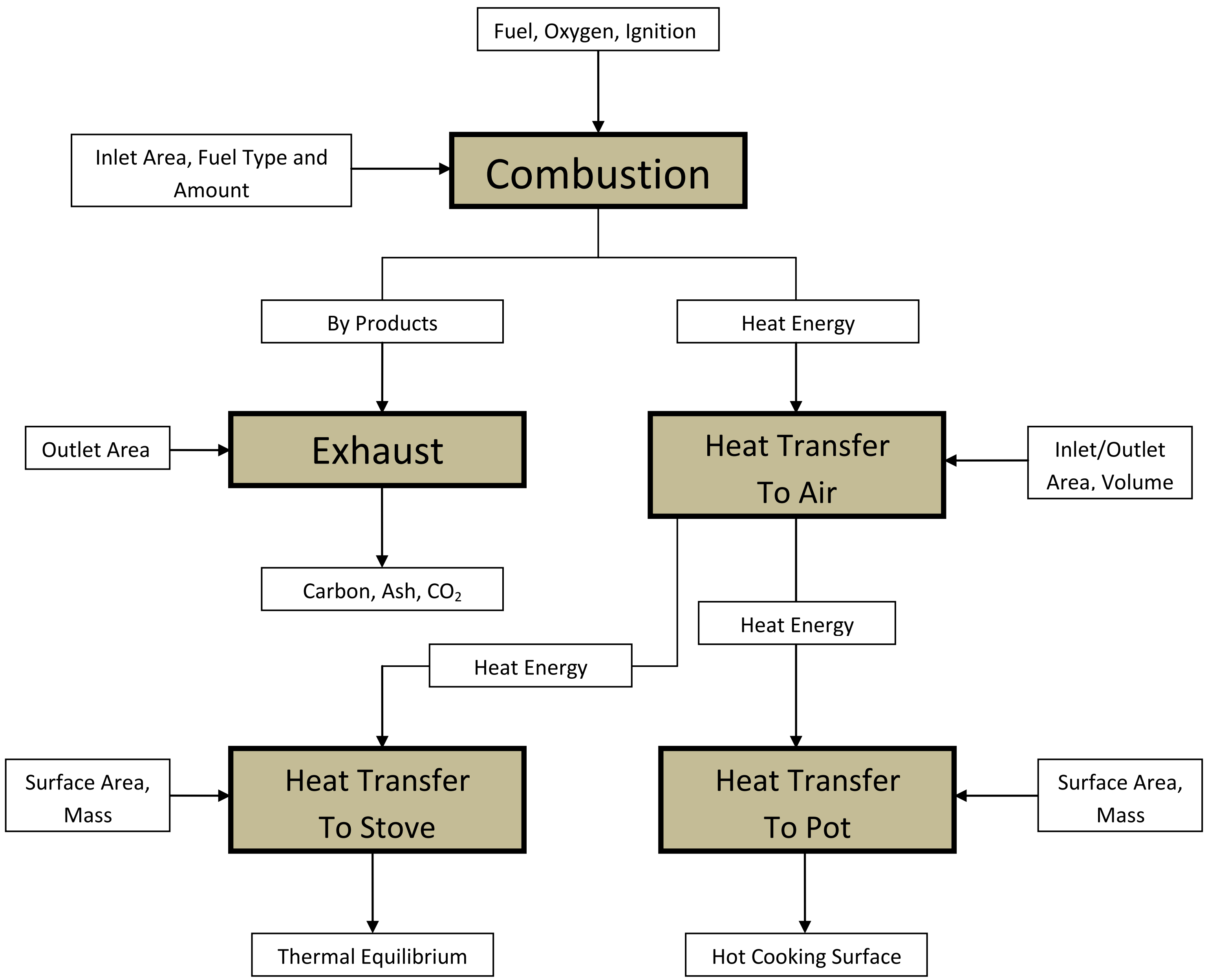
FUNCTIONAL ANALYSIS

Process Step	Description of Process Step	Input Variables (from other Process Step)	Input KPP	Step Control Variables	Input KPP	Output Variables	Output KPC
1	Combustion of fuel and air mixture.	Fuel, oxygen, ignition source		Oxygen inlet size		Heat energy, Byproducts	
2a	Exhaust	Byproducts		Outlet area		Carbon; Ash; CO2	
2b	Heat transfer to air	Heat Energy		Volume		Heat Energy	
3a	Heat transfer to pot	Heat Energy		Surface area/mass		Hot cooking surface	
3b	Heat transfer to stove	Heat Energy		Surface area/mass		Thermal equilibrium	



MODELING

Ein-Eout=Echange + Losses

Energy in	**Energy in: wood**		
Ein=Mf*Lf-Mc*Hc	**Ein=**	2670	KJ
Mf = mass of wood	Mf=	0.25	kg
Lf = lower heating value of wood	Lf=	17500	KJ/kg
Mc = mass of remaining char	Mc=	0.05	kg
Hc = Higher heating value of char	Hc=	34100	KJ/kg

Energy Out	**Energy out: boiling water**		
Eout = Mw*Cp*dT+Me*L	**Eout=**	908.17	KJ
Mw = initial mass of water	Mw=	1	kg
Cp = specific heat of water	Cp=	4.185	KJ/kgK
ΔT = change in water temperature from initial to boiling	ΔT =	82	K
Me = mass of water evaporated	Me=	0.25	kg
Lv = Latent heat of vaporization of water	Lv=	2260	KJ/kgK

Energy changes	**Change in Energy of Stove**			**Change in Energy of Pot**		
$\Delta E = m*C_p*\Delta T$	ΔE=	737.89152	KJ	ΔE=	17.25	KJ
m = mass of stove, pot	m(stove)=	17.436	kg	m(pot)=	0.5	kg
Cp = specific heat	Cp(clay)=	0.92	KJ/kgK	Cp(pot)=	0.46	KJ/kgK
ΔT = Change in Temeprature	ΔT =	46	K	ΔT =	75	K

clay = 0.92 KJ/Kg K pot (iron) = 0.46 KJ/Kg K

Convection loss						
$q = hA(T_s-T_\infty)$	**Heat loss from stove convection**			**Heat loss from pot convection**		
q = Heat transfer	q=	327.6	W	q=	272.6	W
h = Convection heat transfer coefficient	h=	20	W/m^2	h=	20	W/m^2
A = Surface Area	A=	0.252	m^2	A=	0.145	m^2
Ts = Surface temperature	T(surface) =	344	K	T(surface) =	373	K
T∞ = ambient fluid (air) temperature	T(air) =	279	K	T(air) =	279	K
t = duration of burn	t=	600	s	t=	600	s
	Estoveconv =	196.56	KJ	**Epotconv=**	163.56	KJ

Radiation loss							
$q = (\varepsilon\sigma T_s^4 - \alpha\sigma T_\infty^4)A$		**Heat loss from stove radiation**			**Heat loss from pot radiation**		
q = heat transfer		q=	85.13680209	W	q=	33.89306708	W
σ = Stefan-Boltzmann constant	$\sigma = 5.6703\ 10^{-8}\ W/m^2K^4$	σ=	5.6703E-08	W/m^2K^4	σ=	5.6703E-08	W/m^2K^4
α = Absorbtivity	Iron = .31 Brick, Fireclay=.75	α =	0.75		α =	0.31	
ε = Emissivity	Iron = .31 Brick, Fireclay=.75	ε =	0.75		ε =	0.31	
T_s = Surface temperature		T(surface) =	344	K	T(surface) =	373	K
T_∞ = Ambient fluid (air) temperature		T(air) =	279	K	T(air) =	279	K
A = Surface Area		A=	0.252	m^2	A=	0.145	m^2
t = duration of burn		t=	600	s	t=	600	s
		Estoverad=	51.08208126	KJ	**Estoverad=**	20.33584025	KJ

Heat loss to air	**Air Loss**		
q=m_dot*Cp*(T2-T1)	q=	1.422	KJ/s
m_dot=mass flow rate of air	m_dot=	0.006	kg/s
T2=temperature of air at exit	T2=	516	K
T1=temperature of air at inlet	T1=	279	K
Cp=specific heat of air	Cp=	1.0035	KJ/KgK
	t=	600	s
	Eair=	853.2	KJ

Ein-Eout = Estoveconv+Estoverad+Epanconv+Epanrad+ΔEstove+ΔEpan

h = Eout/Ein

Change in Energy: from wood Ein and water Eout

Ein-Eout= 1761.83 KJ

Change in energy: Due to losses and energy change of pot and stove

Estoveconv+Estoverad+Epanconv+Epanrad+ΔEstove+ΔEpan = 2039.87944 KJ

Stove Efficiency

h = 34.01386 %

DFMEA

Line No:	Device Function	System, subsystem, or Part Description	System, Subsystem, or Part Function	Potential Failure Mode	Potential Failure Effects	SEV	Root Cause	OCC	Current Design Evaluation or Control	DET	RPN	Actions Recommended	Resp.
Line No:	What are the primary functions of the device?	What is the system, subsystem or part under evaluation?	What is the Function Provided by the system, subsystem or part?	In what ways does this function lose its functionality?	What is the impact to the Customer? (internal or external)	How Severe is the effect to the cusotmer?	What root cause of the loss of function?	How often does the root cause or failure mode occur?	What are the tests, methods or techniques to discover the root cause before design release?	How well can you detect cause or failure mode?		What are the actions for reducing the occurrance of the Cause, or improving detection? **Should have actions only on high RPN's or easy fixes.**	Whose Responsible for the recommended action?
1	**Combustion**		Provides heat	Doesn't burn	No heat	7	No air, fuel, or ignition	3	Combustion test	1	21		
2		Air Intake	Provides air to fire	Doesn't burn	No heat	7	Constriction or blockage	1	Geometric analysis	3	21		
3		Fuel intake	Provides fuel to fire	Doesn't burn	No heat	7	Lack of fuel, poor flamability	1	Flamability test	1	7		
4		Ignition	Ignites fuel	Doesn't burn	No heat	7	No access to fuel, lack of ignition source	1	Geometric analysis, research current ignition methods	1	7		
5	**Exhaust**		Removes byproducts	Doesn't remove byproducts	Puts out fire	7	Constriction or blockage, ability to remove ashes	3	Performance test	3	63		
6		Ash removal	Removes ash from fuel	Doesn't remove byproducts	Puts out fire	7	Limited access to ashes	3	Geometric analysis	3	63		
7		Exhaust leaving the top	Expells CO_2 and airborn ashes	Doesn't remove byproducts	Puts fire out	7	Gap between stove and pot	1	Geometric analysis	3	21		
8	**Heat Transfer**		Transfer heat from combustion to pot	No heat transfer	No hot cooking surface	9	Loss of heat to stove or surroundings	3	Efficiency test	3	81		
9		Heat transfer to air	Heats up air within stove	No heat transfer to air	No heat to cook food	7	Fuel doesn't burn	3	Heat transfer test	3	63		
10		Heat transfer from air to pot	Hot air heats up pot	Too little or no heat transfer to pot	Doesn't cook food	7	Size of chimney; gap between pot and stove; lack of combustion	5	Geometric analysis; pot temperature test	3	105	Conduct further research on geometric relationships to heat transfer	
11		Heat transfer from air to stove	Hot air heats stove	Too much heat lost to stove	Decreases heat output to pot	7	Material composition; wall thickness; insulation properties	3	Material/ insulation thermal test	1	21		
12		Heat transfer to surroundings	Hot air, stove, and pot heat up surroundings	Too much heat lost to surroundings	Decreases heat output to pot	3	Pan stove gap, material compostion, air/fuel inlet sizes; chimney size	3	Efficiency test	5	45		
13	**Safety**		Keeps user safe	Risk of injury to user	User gets injured	10	Contact with the hot flame or surface; dangerous ignition methods	3	Operations/safety test	3	90		
14		Ignition	Ignites fuel	Method is not safe	User gets injured	10	Difficult to access fuel; use of an accelerant	3	Ignition test	1	30		
15		Stove walls	Keeps flames enclosed within stove	Flames are exposed	User gets injured	10	Walls have failure; holes in walls; stove outlet is too large	3	Geometric analysis	1	30		
16	**Portability**		Easy to maneuver stove	If it is hard to move the stove	Tough to handle	7	No handles, heavy, large size	3	Portability test	3	63		
17		Handles	Easy to maneuver stove	If the user can't use the handles	Tough to handle	5	High temperature of material or if handles break off	3	Thermal test of materials used; strength test on the joints where the handle is connected to stove	5	75	Use a low thermal conductive material for safety reasons	
18		Light weight/ minimal materials	Easy to maneuver stove	Stove is not light weight	Tough to handle	5	Use of heavy materials or the need of thicker walls for added strength	3	Weight test, weigh the stove to determine its weight	1	15		
19		Small size	Easy to maneuver stove	Stove is large	Tough to handle	3	Tall chimney/ large diameter for increased efficiency	3	Measure the dimensions of stove	1	9		
20	**Structure**		Strength to support a pot	Doesn't support a pot	Stove is useless	7	Poor material strength/ structural design	5	Geometric analysis; material strength test	3	105	Angled brick design for weight support; use high strength clay	
21		Composition of materials	Toughness	Cracking	Doesn't support a pot	5	Poor composition	5	Material research, Composition testing	3	75		
22		Side walls	Lean together	Don't stand up/ walls crumble	Doesn't support a pot	7	Bad angles; wall thickness	3	Geometric analysis	3	63		
23		Base plates	Contains side walls	Sides slipping out	Doesn't support a pot	7	Grooves are too shallow	3	Geometric analysis	3	63		
24		Fuel inlet plate	Supports itself	Legs break off	Doesn't support a pot	7	Small features	5	Geometric analysis	3	105	Find a new method for fuel inlet	