Combustion Efficiency and Thermal Efficiency

Combustion efficiency is a measure of what percentage of the fuel is completely oxidized (burned).

Thermal efficiency is the percentage of energy that is not lost with the flue gases.

High combustion efficiency does not necessarily mean high thermal efficiency as most of the energy can be lost via the flue gases. High thermal efficiency requires high combustion efficiency and a properly designed wood stove that is operated properly. There is a “sweet spot” where combustion efficiency is high, and where the thermal efficiency is maximized.

Low combustion efficiency = pollution by unburned hydrocarbons and soot.

Thermal Efficiency

Exit temp °C	Combust temp °C	Thermal efficiency %	T1 K	T2 K	Comment
100	900	68	1173	373	Hardwood Regular
150	900	64	1173	423	Hardwood Regular
175	900	62	1173	448	Hardwood Regular
200	900	60	1173	473	Hardwood Regular
250	900	55	1173	523	Hardwood Regular
250	800	51	1073	523	Hardwood green
275	800	49	1073	548	Hardwood green
100	1000	71	1273	373	Dry wood + HB
100	1100	73	1373	373	Dry wood + HB
275	700	44	973	548	Green wood
200	700	51	973	473	Green wood
350	1100	55	1373	623	High fire
350	700	36	973	623	High fire wet wood

Be aware that wood stove manufacturers like to publish efficiency numbers without specifying test conditions. A “combined” efficiency may be used. Blue coloured flue gas indicates unburned hydrocarbons. White smoke that does not disappear indicates the presence of particulate matter.

Efficiencies vary with operating conditions and fuel quality. This is why it is important to know what operating conditions were when the efficiencies were determined. The above table illustrates this. One of the most important factors is good dry wood. Water is not fuel, and H_2O requires much energy to be evaporated. If possible, build a solar heated wood drying container. It makes a huge difference for the efficiencies. High efficiencies = less wood to handle.

A properly designed wood stove will achieve complete combustion with a minimum of excess air at medium to high fires.