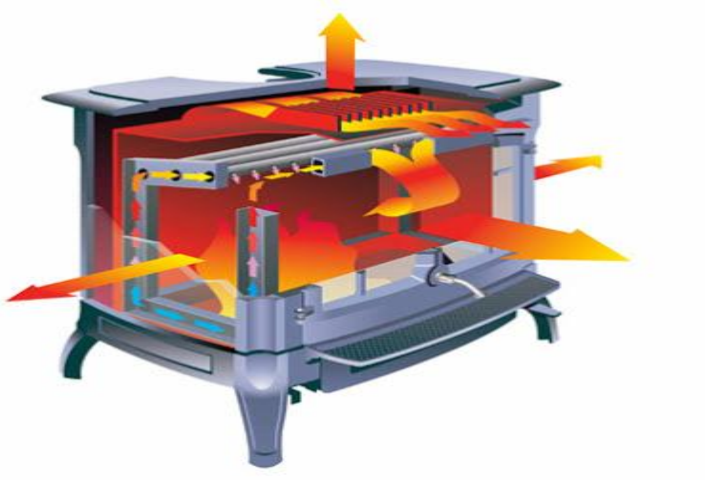
DESIGNING A WOOD STOVE: SIMPLE, CONVENIENT AND EFFICIENT COMBUSTION



Picture: Hergóm

To find an optimal design in an oven, we must analyze and understand the process of combustion of wood; variables involved, phases, each phase processes, better combustion conditions, etc., a theme to spare studied by engineers and encompasses knowledge of different subjects: thermodynamics, fluid dynamics, chemical dynamics, mechanical properties and thermal properties of various materials etc.

When designing an effective, safe and easy to build homemade stove, we find the following dilemma:

As the efficiency of the stove grows, so the complexity of it.

However **we must look for a committed performance and simplicity and ease of construction that fits the overall needs in burning wood design** , and our goal should be that, later to be implemented improvements (also easy to implement if possible) that can increase performance.

Slow Combustion with Dual chamber

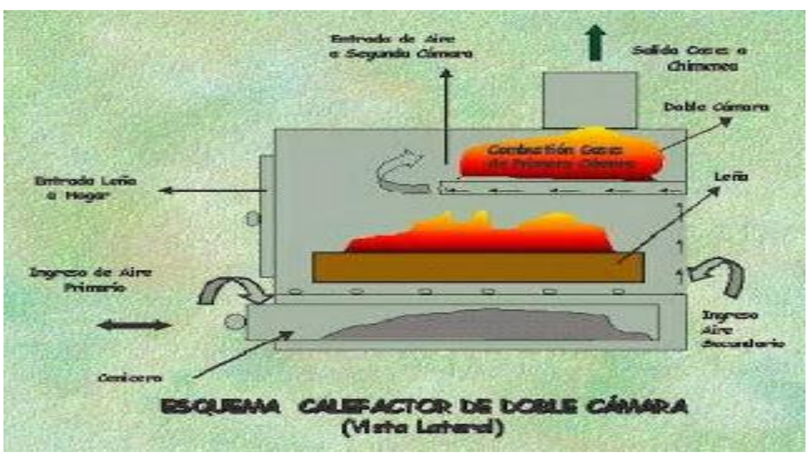
A dual fuel stove has a double combustion chamber with controlled metered supply preheated secondary air. With this second camera is able to perform the most complete combustion possible, reducing the emission of gases and unburned particles. **The most advanced technology currently marketed, corresponds to models retardant dual camera that ensures a post-combustion**. With this technology are drastically reduce levels of emissions.

Details of a stove with Dual Camera:

Each camera should have its own air intake (T1> T2).

In the 1st camera logs is entered. The flame is yellow (about 600oC).

In the 2nd chamber gases are burned first blue flame (800 / 1000oC).



Efficient design stove Dual Camera (source)

To ensure complete post-combustion gases from the thermal decomposition of wood, in this second chamber heater must have an optimum design that properly mix the gases in combustion with oxygen in the primary and secondary air. Furthermore, this mixture must be greater to the ignition temperature and residence time should be ensured that suitable phase for the reaction to fully develop. Simply installing a double chamber in a slow combustion stove does not ensure that these are met **conditions of time, temperature and turbulence** to ensure complete combustion (rule 3 T.).

Looking at the commercial heaters "gasification" high performance, in the second combustion chamber, constructed with materials that can withstand high temperatures (up to 1600), is long enough phase, with a design that promotes turbulence and mixing of source gases, where it is injected in a controlled manner by the preheated primary air and especially the secondary. Some of them control the exhaust with a lambda probe suitable for regulating oxygen supply and combustion speed.

To better understand the whole process, we analyze the chemical events involved.

Analyzing the process of combustion of wood

Stages of burning wood

Wood is not a homogenous fuel such as oil or natural gas. Compared to liquid and gaseous fuels, the combustion process of wood is a complex process where several reaction stages that can be identified:

1) Drying of wood:

For the fuel begins to burn, **you need to apply heat and raise the temperature thereof to the point of ignition (each material according to its characteristics will have a different ignition temperature) in the presence of oxygen necessary for combustion.**

Wood consists mainly of carbon (cellulose), and when burned combining with oxygen produces the dangerous $CO2$ is removed by the fireplace. When a piece of wood reaches the ignition point, this piece of wood chemically reacts with oxygen releasing heat (in the form of radiation and hot gases) and light, and part of that heat is applied to release the adjacent pieces, also reaching the ignition point and repeating the process, extending the flame slowly.

The wood also has a water; initially the outer surface of wood receives radiant heat from the flames, heating the water in the timber above its evaporation point. At this time the drying process is initiated, releasing moisture in the form of steam. **This drying process consumes a significant fraction of the energy released in the combustion process.**

The higher the initial water content, a greater amount of energy is consumed in the process of drying and slower the first step of heating the wood becomes , and is inefficient combustion with a consequent increase in harmful emissions, Ultimately the difference between "dead wood" and "green wood" or freshly cut.

If the wood is very wet and combustion is not adequately produced in the smoke will, besides water, the presence of tars tend to accumulate on cold surfaces such as the chimney. If we get an almost perfect combustion (> 90%), no material may accumulate or be produced in very small quantities.

It is highly recommended to save the wood of the following winter in a cool, dry place with ventilation at least 12 months before use.

2) Gasification and oxidation of volatile matter:

Dry wood when heated above the boiling point of water, the second stage of pyrolysis begins with the release of the volatile matter. At this stage, the wood starts to smoke. Smoke is the visible result of thermal decomposition of wood and consists mainly of a cloud of combustible gases and hydrocarbon droplets (tar). These are oxidized at high temperatures and only if there is also the presence of sufficient oxygen. This process combustion heat release produces long and bright flames that are characteristic of combustion of dry firewood.

$$C_1 H_{1.4} O_{0.66} + {}_{1.04} O2 \rightarrow CO_2 + {}_{0.7} H_2 O + \text{Energy}$$

If the volatile matter is not burned completely into the fire, unburned gases, which condense on the cold walls of the exhaust ducts, forming creosote deposits issued. Also these unburned compounds will be issued later as visible smoke color with strong air pollution in the area. Smoke also represents a loss of efficiency, because it contains a large portion of the energy present in the wood.

3) Burnt char:

The volatile matters completely free timber, residual product remains solid coal ash with no fuel. This solid compound is equivalent to charcoal and its surface is characterized by a red glow combustion and very small or no flame flame, generating high temperature between 600 and 1000 ° C. Coal is a clean fuel that burns easily in the presence of sufficient oxygen without generating fumes.

In practice, the three phases of wood combustion occur simultaneously as described above. This means that the gases of the volatile matter may be burning with large flames while on the fuel surface coal is burned with the characteristic red glow and water in the center of the wood evaporates slowly. To achieve complete combustion Products of thermal decomposition of wood the following required conditions **are summarized in 3Ts rule known to those skilled in combustion; temperature (between 600 and 1000 ° C), time (> 0.5 seconds) and turbulence (to ensure that the gases are well mixed with oxygen)** .

Source: http://crecimiento-sostenible.blogspot.in/2015/01/designing-wood-stove-simple-convenient.html