Fan-blaster Combustors, Stove Camp 2006, and the Dell-Point Pellet Stove

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I have used this Title / Subject name "Fan-blaster Combustors, Stove Camp 2006, and the Dell-Point Pellet Stove" because all three are related and are topics of recent messages on the Stoves and Gasification Listservs..

1. What is a "fan-blaster"?

Perhaps there is a better name for the combustion technology found in pellet stoves, but I do not know what it is. Essentially a controlled stream of focused air is directed onto a small amount of fuel that is being continually replenished. It is not simply "a fan stove" because that could apply to any stove that uses a fan. This type of combustion is related to the blast of air that is perhaps similar to "blast furnaces" where extra air is forcefully injected and does good things. So I have called it "fan-blaster" technology. It is not sufficiently clear to say "pellet stove" because other combustion technologies can and do burn pellets; and some of the same technology is used in corn burners and where small pieces of wood are used as fuels. Names other than "fan-blaster" are welcome as long as they are clearly defined and do not overlap onto other combustion technologies.

2. What stoves are "fan-blasters"?

A. Standard pellet stoves, corn stoves, etc.
B. The Dell-Point pellet stove.
C. The "Woodflame Gusto" stove

Forced-air T-LUDs when they are NOT used as T-LUDs!!!!!

D. Reed's Woodgas Campstove, when NOT used as a T-LUD.
E. Phillips stove, when NOT used as a T-LUD.
F. Anderson's "Juntos B," when NOT used as a T-LUD.

3. Question: When is a T-LUD not at T-LUD?

Answer: When it is used as a "fan-blaster."

Note: I will defend to the bitter end that T-LUD (Top-Lit UpDraft) refers to a distinctive type of combustion, namely downward pyrolytic gasification with close-coupled combustion. Also, T-LUD technology does not require a fan or forced air, although some T-LUDs have forced air. Please, only use the descriptor "T-LUD" where it is appropriate and accurate.

4. Fan-blaster combustion and operations:

Fan-blasters have the fuel dropped into the combustion area in small quantities and at very frequent intervals. For pellet stoves, it seems (from informal observation) that 2 or 3 pellets fall in every 10 to 30 seconds. For the three fan-blasters tested under the emissions hood at Stove Camp 2006, the fuel was typically small blocks about 2 x 2 x 4 cm of the "official wood", pushed over the top lip of the stove (but under the pot) at about 30 second intervals. While pellet stoves typically have electric-driven augers to feed the fuel, the tested fan-blasters were manually fed, so the operator was never very far from the stove. Because so much attention was needed to maintain the optimal fire, a joke comment was that when stoves are being tested, the operator should be required to care for an uncooperative infant to better replicate the conditions in the kitchens.

The three tested fan-blasters were operated in a similar fashion. A small amount of starter materials plus maybe 5 or 6 of the small block fuel pieces were placed in the bottom of the fuel chamber and ignited, with the fan initially turned off, but soon turned on. When the fire was established, the char and new fuel were subjected to the forced air of the primary air inlets. A vigorous flame occurs from the bottom upwards, showing that fan-blasters are not gasifiers in which the gases are created separately from their combustion. The flames did not go above the ring of the secondary air inlets. (Note, the Woodflame Gusto stove does not have secondary air inlets, but I believe that the flames did not go much higher than the lip of the fuel container, therefore raising questions for research on the possible role of the forced secondary air in fan-blasters.)

When the flame starts to die down, there would be mainly charcoal in the fuel container. Additional raw fuel needs to be added to sustain the flame with the release of more pyrolysis gases. If fuel is not added, the stove moves into a charcoal-burning mode, and the CO emissions rise. If too much fuel is added in a short period of time, there are excessive pyrolysis gases and "smoky-ness" can result.

In essence, this operation is quite similar to that of the pellet stoves.

5. Testing fan-blasters:

At Stove Camp 2006, four stoves from the above list (C, D, E and F) were represented in the emissions contest for fan-driven stoves that had fuel fed from the top.

Photo 1: Four forced-air stoves at Stove Camp 2006 (from left to right):
Anderson's Juntos B. Phillips fan stove. Reed's Woodgas Campstove. Woodflame Gusto.
See text for discussion.

Of the four stoves, Anderson's "Juntos B" was only operated as a true T-LUD gasifier when the emission testing was conducted, not as a fan-blaster. My unsubstantiated conjecture is that the Juntos B would have operated very well as a fan-blaster, especially because it has greater control over the strength of the blower operation. Juntos B is essentially "tincanium" and therefore considerably less expensive than the other three devices. Instructions for making a Juntos B stove (for use either as a T-LUD gasifier or as a fan-blaster device) are in the middle pages of the document at: http://bioenergylists.org/stovesdoc/Anderson/GasifierLAMNET.pdf

Of the three devices operated as fan-blasters, the following observations can be made:

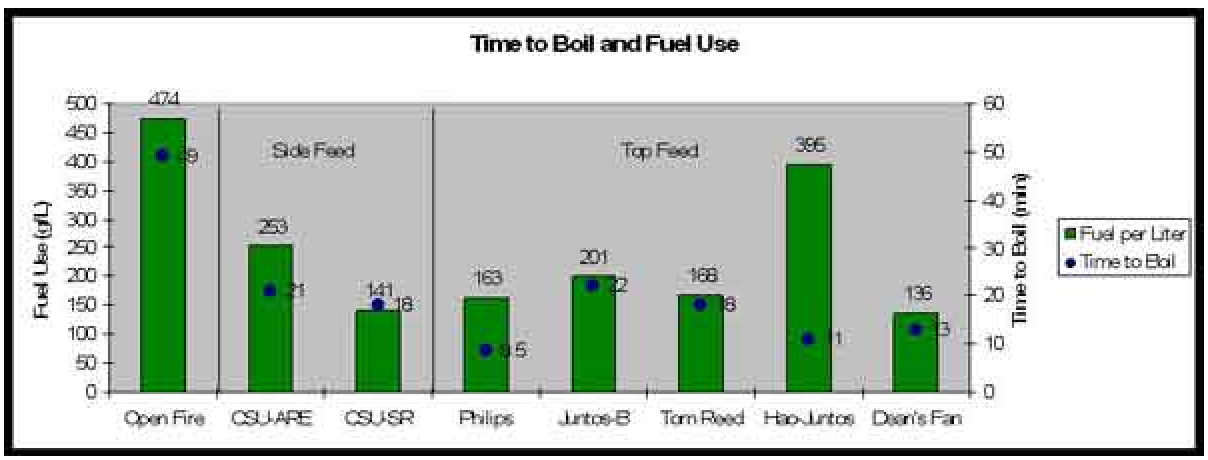
-- Reed's Woodgas Campstove (http://www.woodgas.com/bookSTOVE.htm)was a recently purchased standard item ($55) that is well known to most readers. From it are derived the Phillips stove and the Juntos B stove. All three have similar arrangements of airflow for primary air in at the bottom and secondary air injected laterally in near the top.

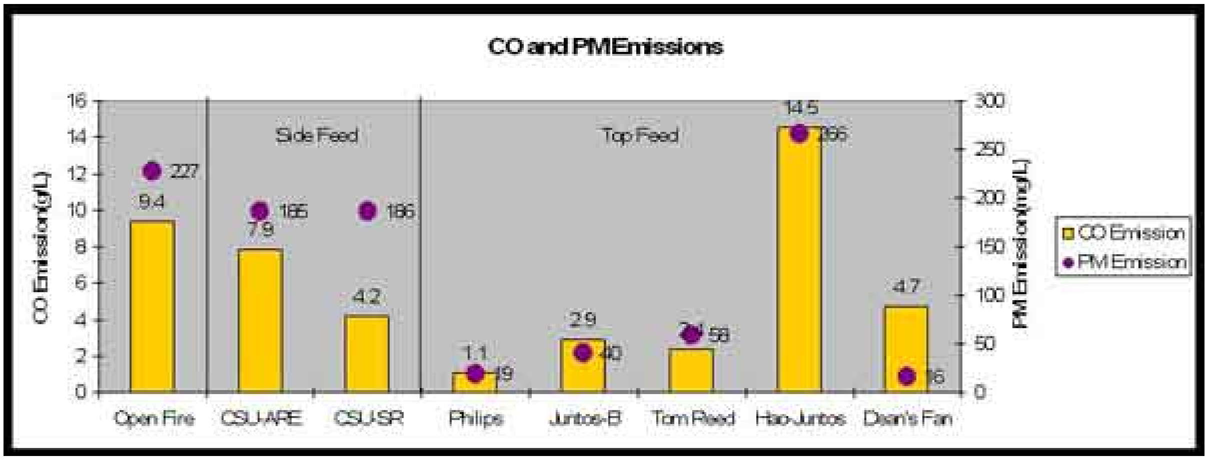
-- The Phillips stove was a prototype unit (not available for purchase as far as I know). (http://www.research.philips.com/newscenter/archive/2006/060227-woodstove.html). It did NOT have any thermo-electric device (TED) to power its fan. The fan was plugged into standard electrical current and seemed to have greater power than the fan in Reed's Campstove. The size of the fuel/combustion chamber is slightly larger than on Reed's Campstove (perhaps one inch deeper).

-- The Woodflame Gusto stove (http://www.woodflame.com/en/ and available on the Internet for $250) was not operational, but Dean Still extracted the fuel container/combustor metal cup (about 4 inch (10 cm) diameter and 3 inch (7.5 cm) high, with many small holes in the flat bottom) and mounted it in an existing stove base and provided forced air from underneath. The Gusto design does NOT have forced secondary air via lateral holes near the top. On the data graphs below it is called "Dean's fan".

6. Emissions data:

The two graphs below are from Dean Still and Nordica MacCarty's summary of Stove Camp 2006 results. See: http://bioenergylists.org/en/aprocamp2006





Based on these results, in the Top Feed category, the Phillips stove (operated as a fan-blaster) was given a "Cat Pee" award. In several ways the award was recognition of the "fan-blaster" combustion technology that performed so well at Stove Camp 2006. (The "Cat Pee" award for Side Feed of fuel was decided between the two fan-driven stoves made by the 5 students from Colorado State University (CSU) and judged as a separate group.)

7. The Dell-Point pellet stove:

The Dell-Point pellet stove can be seen at: http://www.pelletstove.com and its patent is at: http://www.uspto.gov/patft/index.html where you can search by patent number: **6,336,449**

The main thing about the Dell-Point stove to distinguish it from other pellet stoves is that the fan-blaster technology is fully enclosed, providing more control on the air flow and no openness to ambient air. It does have a spiral of air holes instead of Reed's ring of secondary air holes.

I must disagree with Tom Reed's comment from 18 September 2006 to the Stoves and Gasification Listservs. Tom wrote:

> The [Dell-Point] stove operates like a close coupled TLUD gasifier - like our wood
> gas stove. It pyrolyses from below, keeping the temperature around 700
> C and slagging down. It then adds more air above to complete the
> combustion at > 1500 C.

From what I can tell from the patent and websites, the Dell-Point is operating as a fan-blaster, consuming both the raw fuel and the charcoal that remains after pyrolysis. The gases will go upward, through the incoming supply of pellets. But judging by the small size and limited number of the lateral holes, there would not be sufficient air from the spiral of holes to accomplish the secondary combustion. I suspect that the incoming air from the bottom is providing the primary air plus a substantial quantity of the secondary air. Of course, Tom's Campstove can also do that fan-blaster process, but then it would not be operating as a T-LUD.

Agua Das told me of his usage of the Reed Woodgas Campstove first as a T-LUD gasifier to cook food, and then as a nice campfire (no pot, just let the flame rise up) to sit around while talking at the campsite, throwing in small pieces of wood while this fan-blaster-style of combustion was being used. In short, feeding the Woodgas Campstove as a fan-blaster has been done for years, including during the main emissions testing of the Campstove in the earlier tests by Aprovecho [source: Dean Still]. But in those earlier usages, the combustion style was not recognized as being something distinctive.

To clarify and illustrate my point, if you take a typical Rocket-elbow stove and fill it from the top with fuel and then light it at the bottom, it will operate as a traditional fire in a cylinder and not be representative of the innovative Rocket-elbow combustion. The same rationale applies to a T-LUD device that is used in a way that is not "Top-Lit UpDraft" pyrolytic gasification with close-coupled combustion.

8. Conclusion:

To better understand and discuss the different stoves, we need to clearly understand and define the various distinctive types of combustion. The chemical formulae of combustion science might be the same, but if they occur in different times and places in different devices, we need to understand and acknowledge those differences.

Because pellet stoves (of the affluent countries) are generally too large for cooking in developing societies and because they are not actually gasifiers, they have not attracted much discussion on the Stoves and Gasification Listservs. We have not paid much attention to their distinctive form of combustion except for some mention of the Woodflame Gusto stove. But now that the forced-air T-LUDs are found to be able to operate in this additional way, the combustion technology is receiving some attention. To avoid confusion, the name of "fan-blaster" has been proposed for that distinctive type of combustion.

Testing at Stove Camp 2006 reveals very clean burning in the small fan-blaster stoves. This should stimulate further research efforts about the emissions. Avoiding excessive air should be investigated. Interestingly, the major current limitation that prevents useful application of small fan-blaster stoves is a physical/mechanical difficulty to accomplish the necessary "trickle" of fuel. When the fuel-feeding problems are solved, fan-blaster cookstoves could be serious contenders for low-emissions inexpensive cookstoves for developing societies.

(A discussion of these topics will likely occur on the Stoves Listserv. Visit http://bioenergylists.org and check on the "Archives" as of September 2006.)

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