The Evolution of the Mayon Turbo Stove: The Next Generation of Household Cookers Developed in the Philippines

Breakthrough in clean combustion provides low cost and convenient cooking fuel from rice hull

The Mayon Turbo Stove was developed by Resource Efficient Agricultural Production (REAP)-Canada in cooperation with local workshops the Philippines. The development of the stove was part of a three year Canadian International Development Agency (CIDA) funded project aimed at alleviating poverty and reducing greenhouse gas emissions in the Philippines through the clean combustion of crop residues.

In selecting a suitable stove for the project, all the major rice hull stoves available in the Philippines including versions from the International Rice Research Institute (IRRI), Philrice, the Central Philippine University (CPU) and a version of the Lo-Trau model developed in Vietnam were accessed. Some of these stoves were superior to others but all suffered from one or several deficiencies, such as: incomplete combustion; excess air; uncontrollable fuel bed fires; high rice hull consumption; and/or were too highly priced for rural peasants to purchase. To reach our targeted consumers we needed to compete with charcoal and firewood stoves made from clay that sell for about (US)$0.50; therefore we had to build a stove for under (US) $10.00 (as this represented one weeks salary in rural areas of the Western Visayas).

We decided to work with the Lo-Trau model because of its relatively low cost and simple basic design. With our local NGO partner organizations: Sustainable Rural Enterprises (SRE), PDG and MASIPAG, we streamlined production improvements to manufacture the stove to get production costs down to (US)$10 per stove. However, we observed that the stoves we were introducing to communities were experiencing problems of incomplete combustion and required constant maintenance and tapping. We made some initial combustion improvements to the stove by lengthening the frustum (the center cone) from 5 to 7 inches (which also shrank the cone top and concentrated the flame under the pot), and drilled secondary air holes at the top of the cone. Although these changes made some improvements to the stove, the flame still remained excessively smoky and required regular tapping to maintain a steady fire.

Of the stoves tested, the CPU stove appeared to have the least smoke events due to the presence of a single air vent pipe through the bottom of the ashpan. We also noticed that the single pipe caused a blue flame in the center of the cone, but the surrounding flame was still an orange-yellow colour. We therefore decided to experiment with different sized pipes to determine a level of air that would be adequate but not excessive. After doing so we realized we needed more air mixing in the cone as there were still oxygen dead spots that prevented the complete combustion of gases.

The best option we found of introducing more oxygen into the combustion chamber was the introduction of twin air pipes 1 inch in diameter. This addition increased turbulence inside the cone creating vortexes in the flames and slowed the rate of air flow out of the cone (compared to the use of a single large air pipe). The end result of the twin air injectors was that after 3-5 minutes, a blue or nearly colourless flame was present throughout the cone. However, even with the addition of airjets we still experienced some smoke events after ten minutes of burning when the rice hull turned to ash and airflow from the holes at the base of the fuel bin was reduced. To prevent this problem we decided to increase the size of the 10 secondary air vents from 1/4” to 3/8”. This modification drastically reduced smoke events due to oxygen problems, so as now smoke events are infrequent and generally only occur when the flame is going out due to lack of fuel. The addition of twin airjets in combination with the larger secondary air vents has extended the time period between the *‘tappings’* required to maintain a steady flame from every 3 minutes to about every 5 minutes.

This new design appears to increase the gases residence time in the inner cone and exposes them to higher temperatures resulting in a cleaner combustion process. Consequently, the rice hull ash is now of a whitish grey colour. The changing nature of the airflow through the fuel bed (as the relatively porous hull turns to ash) is dealt with through the twin air pipes and secondary air at the top of the inner cone. The most important new design improvements appear to be the twin air injectors that create a swirling and mixing action. To minimize fuel bed fires, we also created a heat shield to protect the fuel from contact with the hot inner cone. The end result has been the introduction of a new model that is both easier to start and use, and that produces much less smoke than before.

We have had very favorable feedback thus far from communities using the stove. With the above modifications households are experiencing reductions in rice hull fuel requirements, maintenance, and smoke. In a recent unpublished study (2003) in Southern Panay, respondents rated the stove highly and reported using it an average of 2.5 times/day for the last 2 years[1].

[1] The average ranking of the stove was 4 out of 5; where 1 is very poor and 5 is very good. As well, after two years of use the average expected lifespan remaining of their stove was estimated at 1.5 years!