Towards a standard for clean solid-fuelled cookstoves

Philip Lloyd, Harold Annegarn
and
Crispin Pemberton-Pigott

Cape Peninsula University of Technology

Outline

- The rationale for cleaner cookstoves
- The challenges facing development
- Progress towards cleaner cookstoves
- The origins of the problem
- The development of testing protocols
- Acknowledgements

Cape Peninsula University of Technology

The rationale

- Around 3 billion people cook and heat their homes using open fires and simple stoves burning solid biomass (wood, animal dung or crop waste) or coal
- Each year, over 4 million people die prematurely from illnesses attributable to the pollution of the household air from cooking with solid fuels.

The rationale

- More than 50% of the premature deaths among children under 5 are due to pneumonia caused by inhaling particulate matter (soot) from household air pollution.
- A further cause of mortality is carbon monoxide poisoning, but there is remarkably little firm data on this issue.
  - "From the available data, carbon monoxide poisoning is the most common cause of injury and death due to poisoning worldwide"

The rationale

- The rationale is clear
- At present cooking with solid fuels is a major cause of mortality
- This is particularly because of poor control over emissions
- The target for clean cookstoves must be **lower emissions**

Challenges facing cleaner stoves

- Users employ fuels that are cheap and to hand
  - Even combustible household waste
- Cooking is generally a batch process
  - The fuel will see continually changing conditions during the cooking cycle
- Different foods demand different cooking cycles
  - Starchy foods often require simmering; high protein foods often require rapid heating

Progress towards cleaner stoves

- There has been extensive work
  - HEDON household network
  - Global Alliance for Clean Cookstoves
  - World Bank
  - Asia Development Bank with Energy for All
  - ETHOS annual conferences
  - Shell Foundation with Envirofit
- However, progress has been slow

Progress towards cleaner stoves

- Some of the efforts may be misdirected
  - "the Global Alliance is working closely with our partners to create effective strategies to scale up the dissemination of **cleaner burning fuels**"
  - The Asia Development Bank concludes ""Most of the poor in developing countries are not able to switch to cleaner fuels in the foreseeable future and have to rely on wood or charcoal for cooking and heating."

The origins of the problem

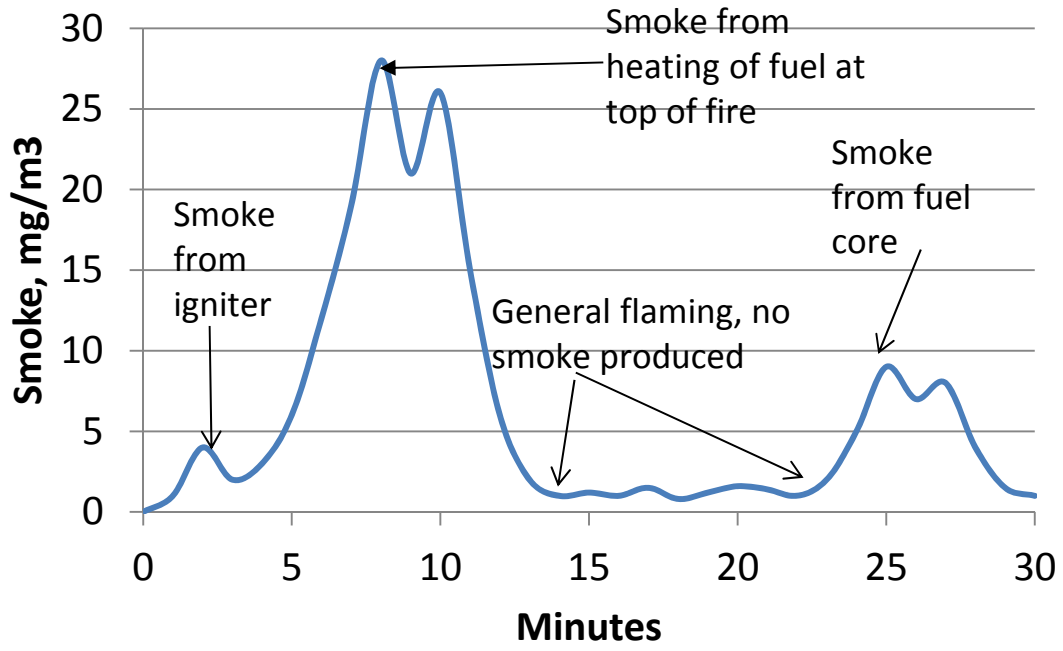
- “Smoke” consists largely of volatile organic carbons
  - As such, its emission represents an energy loss
- Smoke particles are <2.5µm, and therefore of a size to reach the deep lung
- The volatile organic carbon content of the smoke is a good indicator of the health risk smoke presents

The origins of the problem

- Smoke is generated when biomass is heated and the emitted vapours are either:
  - At too low a temperature to ignite; or
  - Emitted into an atmosphere too deficient in oxygen to support combustion
- The rate of heating affects the production of smoke
  - Low heating rate (<5^{o}C/minute) maximizes smoke

The origins of the problem

- What happens in a bottom-lit pile of biomass illustrates these phenomena

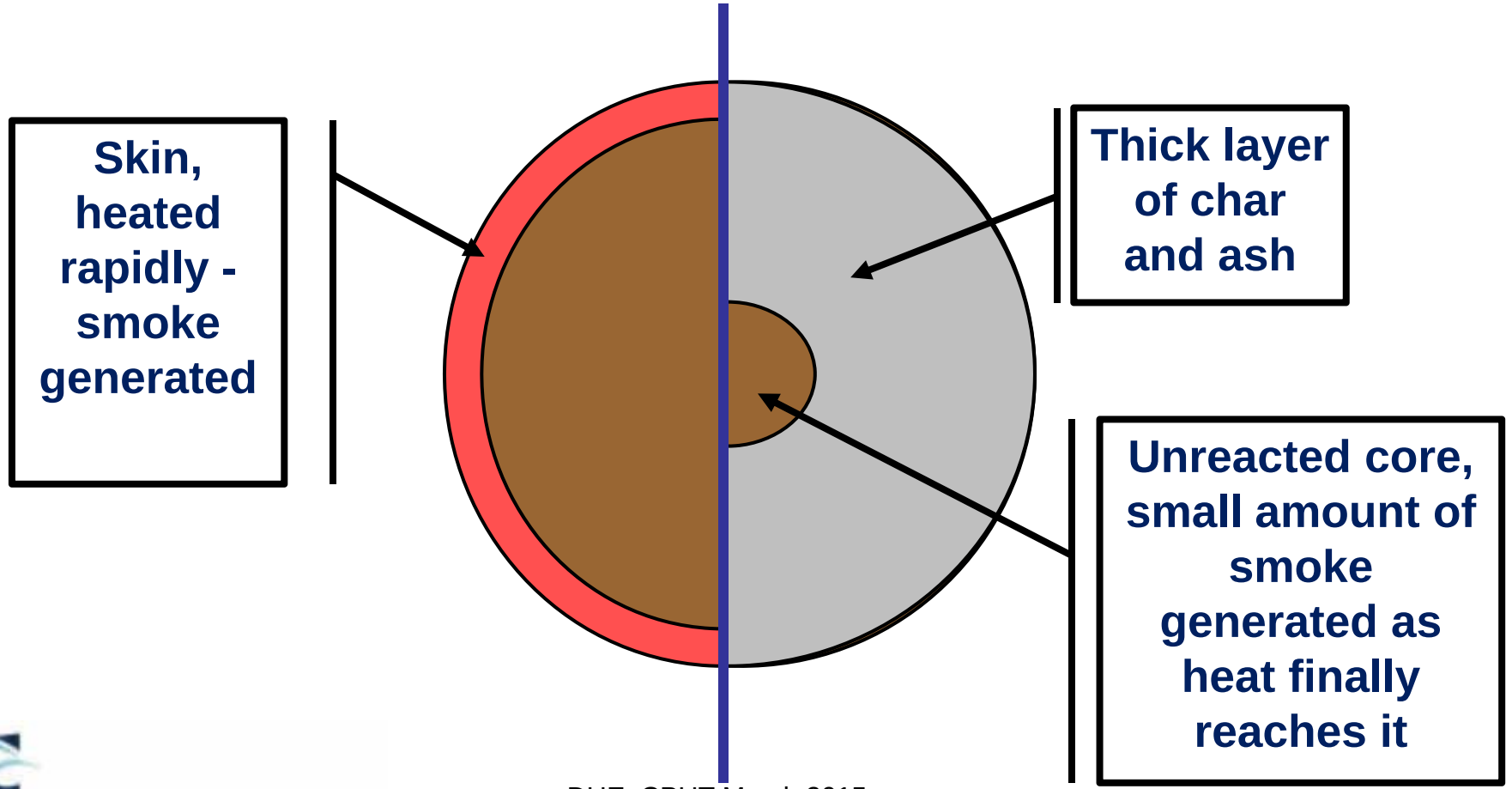


The origins of the problem

- At the start, the biomass at the top is heated, but the vapours are cold and the air lacking oxygen – smoke is produced
- Once things heat up, all the vapours burn and there is no smoke – the few particles emitted are mainly ash and char
- Finally most of the unburned biomass is insulated by ash and char – it is heated slowly in the absence of air, and there is more smoke and carbon monoxide

The origins of the problem

The first and last stages of burning a biomass element



Cape Peninsula University of Technology

Testing protocols

- Much effort has gone into developing a standard test using a standard fuel, a standard pot and fixed cooking cycle
- However, stoves showing improved performance by this test have not shown similar improvements in the field
  - The fuel is different
  - The cooking cycles are different
  - Even different pots make a difference

Testing protocols

- Reductions in emissions have been possible where the stove has been optimized around the fuels in common use locally and the cooking cycles employed in local culture
- So testing should start with the measurement of existing practices, using a social science protocol to determine:
  - The fuel used and its rate of use
  - The cooking utensils and cycles employed, and
- Then use a testing protocol to determine the baseline emissions

Testing protocols

- The stove designer then attempts to improve the performance by modifying the fuel, the stove, or any factor they wish to change, and are able to show their improvement using the same testing protocol that established the baseline.
- There is then an excellent probability that improvements identified in the laboratory will result in improvements in the field

Acknowledgements

- The organisations and people who have contributed to the thinking embodied in this contribution are too many to enumerate here; however, our thinking has crystallized in recent months through work with:
  - The International Standards Organization and its Technical Committee 285
  - The China Agricultural University, Beijing, and Prof Dong Renjie
  - The Stove Discussion List at Bioenergylists.org and all who have taken part in it.
- The financial support of the South African National Research Foundation is gratefully acknowledged

THANK YOU FOR YOUR KIND ATTENTION

ANY QUESTIONS?

Cape Peninsula University of Technology