International Workshop Agreement

IWA 11

Guidelines for evaluating cookstove performance

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Lignes directrices pour évaluer les performances d'une table de cuisson

Reference number
IWA 11:2012(E)

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Contents

Page

Foreword

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International Workshop Agreement IWA 11 was approved at a workshop organized by the Partnership for Clean Indoor Air (PCIA) and the Global Alliance for Clean Cookstoves, in association with the American National Standards Institute (ANSI), and held in The Hague, Netherlands, in February 2012.

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Workshop resolutions

Resolution 1

The International Workshop on Cookstoves recognizes that the Volunteers in Technical Assistance Water Boiling Test version 4.1.2 (VITA WBT 4.1.2) protocol (see Reference [2]) referenced in this International Workshop Agreement is not the only valid protocol for rating cookstove performance in the laboratory.

As such, the International Workshop on Cookstoves recommends that:

a) new protocols be developed and/or current protocols be updated to more adequately address all stove and fuel types (e.g. cooking stoves also used for heating, plancha stoves/griddle stoves, batch-loaded stoves, charcoal stoves, double pot stoves and solar cookers);

b) tier level equivalence to those used in this International Workshop Agreement for the VITA WBT 4.1.2 protocol be developed for any protocols created or adapted (e.g. References [4] and [5]);

c) research be conducted for high priority initiatives, such as coupling lab and field testing, improving indoor emissions protocols, climate change impacts, and developing a pool of resources for testing stoves;

d) all protocols be rigorously evaluated by an independent, technically qualified group; and

e) the acceptability of a protocol for a particular stove and tier designation be determined by the ability of the test procedure to repeat the performance metric within one-third of the distance between tiers, under conditions that are consistent with the test specification.

Resolution 2

The International Workshop on Cookstoves recognizes that laboratory testing may not fully reflect performance as seen in the field as performance is dependent on many factors (such as user behaviour, cultural acceptance and operating conditions), and it is critical that these factors be incorporated in future standards and protocols.

Resolution 3

The full range of exposure to household air pollution is currently being compiled by the World Health Organization (WHO) in new indoor air quality guidelines for household fuel combustion (due to be published in 2013). The International Workshop on Cookstoves recommends that the evidence of health risks across these guidelines be reviewed to ensure consistency with future standards or International Workshop Agreements.

Resolution 4

The International Workshop on Cookstoves recommends that a performance indicator (and corresponding protocols) for durability be developed and included in a future standard or International Workshop Agreement. In addition, the International Workshop on Cookstoves recommends further research be conducted and protocols be developed as needed to adequately evaluate the safety of all stove types and fuels (e.g. solar, kerosene, propane and solid fuel).

Resolution 5

The International Workshop on Cookstoves recommends that emissions relevant to health, environment (ambient air quality and climate) and performance, in addition to those currently addressed in this International

Workshop Agreement, be addressed in a future standard or International Workshop Agreement, as data becomes available.

Resolution 6

The International Workshop on Cookstoves recognizes that the quality and type of fuel used by a testing centre may impact the emissions of a cookstove. Because of that, the International Workshop on Cookstoves recommends that testing centres document the key physical and operational characteristics (e.g. fuel, moisture content, pot size and shape) of the system.

Introduction

Nearly half of the world population – three billion people in the developing world – cooks their food by burning coal and biomass, including wood, dung and crop residues over open fires or on rudimentary, often unvented stoves. Indoor burning of these solid and liquid fuels releases dangerous particulate matter, carbon monoxide and other toxic pollutants. This practice can lead to indoor air pollution levels that are 20 to 100 times greater than the air quality guidelines of the World Health Organization (WHO) and release greenhouse gases and black carbon into the environment. WHO estimates that nearly two million people, primarily women and children, die prematurely each year from exposure to indoor smoke from these cooking practices. Open fires and rudimentary cookstoves may also increase pressures on local environmental resources (e.g. forests, habitat) and contribute to climate change at regional and global levels.

The Partnership for Clean Indoor Air (PCIA) and the Global Alliance for Clean Cookstoves are working with more than 550 partners in 117 countries[1)] to achieve the adoption of 100 million clean and efficient stoves and fuels by 2020. Developing globally recognized standards that are widely accepted by the stove community and adopted by country governments could spur wider deployment of clean cookstoves in a number of ways, including defining what an “improved cookstove” is for users, stove makers and policy makers, and enabling the rating of stoves by efficiency, safety and cleanliness (particulate matter and carbon monoxide emissions), while allowing for differences in local conditions and user behaviour.

National performance-based standards have been developed and implemented in a few countries, but no international standard has been developed that contains commonly agreed upon and accepted criteria by which to define “clean” with regard to cookstoves. Such an international standard would significantly enhance efforts to see clean cookstoves adopted at scale.

This International Workshop Agreement serves as a guideline for policy-makers, investors, manufacturers and others in the cookstoves community, and it will inform future work required in developing new or revised internationally agreed upon cookstove standards and protocols.

1) A full list of partner organizations of the PCIA is available at: http://www.pciaonline.org/partners/search.

A full list of the partner organizations of the Global Alliance for Clean Cookstoves is available at: http://cleancookstoves.org/the-alliance/partners.

Guidelines for evaluating cookstove performance

1 Scope

This International Workshop Agreement provides a framework for rating cookstoves against tiers of performance for a series of performance indicators, including

— fuel use (efficiency),

— emissions (carbon monoxide and particulate matter 2,5),

— indoor emissions (carbon monoxide and particulate matter 2,5), and

— safety.

This International Workshop Agreement does not select a single laboratory protocol to determine cookstove performance. Instead, it enables stove testers to use laboratory protocols most appropriate for the stove and performance indicator being tested. Tiers of performance for each protocol chart all stove test results on the same page, in order to ensure equivalent results, regardless of protocol used.

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1
air exchange rate
rate at which the air within a defined space (normally a room or house) is replaced, usually expressed as air changes per hour

2.2
batch-loaded stove
stove in which fuel is loaded once per burn cycle

2.3
biomass stove
apparatus used to cook food and/or provide warmth and/or boil water through the conversion of biomass, typically through combustion

2.4
Biomass Stove Safety Protocol
specific methodology for evaluating the safety of a stove, developed at Iowa State University

NOTE See Reference [1].

2.5
constant volume pump
device which repeatedly moves a standard volume of fluid (liquid or gas)

2.6
dilution tunnel
device in which air is mixed with an emissions stream in a known ratio

NOTE Dilution air is sometimes cleaned with filtration for particles and/or activated carbon for gases.

2.7
electrochemical cell
device in which chemical energy is converted to electrical energy when in the presence of a specific compound

2.8
flow grid
self-averaging pitot tube array
method of evaluating volumetric flow through the measurement of velocity at a series of locations across a path of known cross-sectional area

NOTE Temperature and pressure must also be measured to determine volumetric flow.

2.9
gravimetric measurement
quantification of a sample through the direct measurement of mass

2.10
high power
operation of a stove at maximum (or nearly maximum) rate of energy use

2.11
light scattering
physical process used to quantify particulate matter concentrations

NOTE Scattering is caused by the reflection and refraction of light by particles. The amount of light scattered is based on the concentration of particles and the properties of the particles in the light's path (e.g. the size, shape and colour of the particles).

2.12
low power
operation of a stove at minimum (or nearly minimum) rate of energy use

2.13
non-dispersive infrared
method of determining the concentration of a substance by measuring the absorption of a light wave at a specific frequency

2.14
plancha stove
griddle stove
stove design in which the majority of cooking occurs on a heated surface, usually a metal plate

2.15
site-built stove
stove design in which the majority of assembly and/or construction occurs at the location of final use

2.16
tiers of performance
method of rating stoves by categorizing them in relation to a set of specified ranges

2.17
type K thermocouple
device used to quantify temperature, comprised of two metals (90 % nickel and 10 % chromium)

NOTE It is the most common general purpose thermocouple.

2.18
water boiling test
test in which the performance of a stove is evaluated through the heating of a known quantity of water across a specified range of temperature following a defined protocol

3 Framework for evaluating cookstove performance

3.1 The rating system will define tiers of performance in the areas of fuel efficiency, emissions of fine particulate matter [PM2,5] and carbon monoxide (CO), indoor emissions [PM2,5 and CO] and safety. Each area will be ranked separately.

3.2 Tiered ratings for multiple performance indicators communicate both current performance and the expectation of future performance improvements. The tiers for each performance indicator are developed by choosing values of performance for the upper and lower tier boundaries, and then selecting intermediate values. One end of the spectrum is the performance of a defined laboratory three stone fire. The other end of the spectrum is an aspirational goal specific to each performance indicator. Five tier levels are currently used, with "0" being lowest performing and "4" being the highest performing. The number of tiers (five) reflects a balance between measurement uncertainty and the ability to provide meaningful differentiation between stove performance.

3.3 Emission and efficiency ratings shown here are based on data from multiple versions of the VITA WBT.

3.4 Safety ratings shown here are based on the Biomass Stove Safety Protocol[1] for solid fuels only.

3.5 The methodology below is allowable for certified rating of indoor emissions.

— Method 1: Indoor emissions are captured in a chamber (or "test kitchen") with controlled and measured air exchange rate, measured air volume and well mixed air. Indoor emission rates of PM2,5 and CO are calculated from measurements of pollutant concentrations in the chamber, air exchange rate and air volume.

— Method 2: Indoor emissions are captured with a hood and are mixed with air in a dilution tunnel. Indoor emission rates of PM2,5 and CO are calculated from measurements of pollutant concentrations in the dilution tunnel and air flow rate.

NOTE Concentrations of indoor emissions can be approximated from indoor emission rates (obtained by Method 1 or Method 2) by using an accessible, open source model with the assumption of perfect mixing and with specification of room size and air exchange rate.

3.6 The following minimum equipment or methodology is required for certified testing of emissions, performance and indoor emissions:

a) for carbon monoxide emissions or room measurement, non-dispersive infrared (with calibration consistent with U.S. EPA 40 CFR Part 60, Appendix A, Method 10) (see Reference [3]) or electrochemical cell (with pre/post calibration method);

b) for particulate matter emission or indoor air quality measurement,

   1) real-time measurement of a particulate matter proxy via light scattering, and

   2) PM2,5 gravimetric measurement such as U.S. EPA 40 CFR Part 60, Appendix A, Method 5;

c) for emissions exhaust gas flow, constant volume pump or flow grid both with real-time temperature and pressure correction consistent with U.S. EPA 40 CFR Part 60, Appendix A, Method 1 or 2d, or equivalent;

d) for temperature measurement, type K thermocouple or equivalent.

e) computer data logging of all measurements with a minimum time resolution of one measurement per ten seconds.

f) for measuring fuel and water masses, a calibrated digital scale with 1 g resolution or better.

4 Tiers associated with VITA WBT 4.1.2

Tables 1 to 4 show tiers associated with VITA WBT 4.1.2.

NOTE Similar tiers will be developed for other laboratory tests.

Table 1 — CO emissions

Tier	High power CO g/MJ_d [a]	Low power CO g/min/l
Tier 0	>16	>0,.20
Tier 1	≤16	≤0,20
Tier 2	≤11	≤0,13
Tier 3	≤9	≤0,10
Tier 4	≤8	≤0,09

[a] Grams per megajoule delivered to the pot.

Table 2 — PM2,5 emissions

Tier	High power PM2,5 mg/MJ_d [a]	Low power PM2,5 mg/min/l
Tier 0	>979	>8
Tier 1	≤979	≤8
Tier 2	≤386	≤4
Tier 3	≤168	≤2
Tier 4	≤41	≤1

[a] Milligrams per megajoule delivered to the pot.