ISO 19869:2019 (E)

Clean cookstoves and clean cooking solutions — Field testing methods for cookstoves

Contents

Foreword Introduction 1 Scope 2 Normative references 3 Terms and definitions 3.1 **Cooking system** 3.2 Adoption 3.3 **Fuel consumption** 3.4 Emissions 3.5 Safety and durability 4 Symbols, abbreviated terms, and units 5 Field study development 5.1 General Selection of testing strategy 5.2 5.2.1 General 5.2.2 **Preliminary assessment** 5.2.2.1 Laboratory tests 5.2.2.2 Usage Usability 5.2.2.3 5.2.3 Performance assessment 5.2.4 **Outcomes assessment** 5.2.4.1 General 5.2.4.2 General design issues 5.2.4.3 Study design options 5.2.4.3.1 General Experimental study design 5.2.4.3.2 Observational study design 5.2.4.3.3 5.2.4.3.3.1 Cross-sectional study (independent samples) 5.2.4.3.3.2 Before-and-after/longitudinal study (paired samples) 5.2.4.3.4 Benefits and challenges of cross-sectional vs. before-and-after studies 5.3 Sample selection guidance 5.3.1 General 5.3.2 Efficacy versus effectiveness 5.3.3 Uncontrolled cooking test (UCT) Representative site selection 5.3.4 5.3.4.1 Generalizability Identifying representative communities 5.3.4.2 5.3.4.3 Obtaining data on representative practices **Representative household selection** 5.3.4.4 Selection of representative sampling times 5.4 5.4.1 Seasonal 5.4.2 **Events** 5.4.3 Harvest 5.4.4 Weather constraints 5.5 Sample size Field technician capacities 5.6 5.7 **Measurement statistics**

- 5.7.1 General
- 5.7.2 Reporting guidelines
- 5.7.3 Mitigating bias and managing uncertainty

6 Usage and usability

- 6.1 General
- 6.2 Sample selection and timing
- 6.3 Cookstove usage
- 6.3.1 Usage reporting metrics
- 6.3.2 Usage claims
- 6.3.2.1 Performance assessment
- 6.3.2.2 Sustained adoption
- 6.3.2.3 Changes in time use
- 6.3.3 Measurement methods
- 6.3.3.1 General
- 6.3.3.1.1 Observational-based usage measurements
- 6.3.3.1.2 Interview/survey-based usage measurements
- 6.3.3.1.3 Sensor-based usage measurements
- 6.3.3.1.4 Combining measurement approaches
- 6.3.3.2 Observation, interview, and survey-based time measurements
- 6.3.3.2.1 Potential constraints of observational and interview measurements
- 6.3.3.2.2 Cooking time
- 6.3.3.2.3 Labour time
- 6.3.3.2.4 Time to complete tasks
- 6.3.3.3 Continuous (cook)stove monitoring (CSM) measurement method
- 6.3.3.3.1 General
- 6.3.3.3.2 Piloting placement of temperature sensors
- 6.3.3.3.3 Installing CSMs during a study
- 6.3.3.3.4 Analysing CSM data
- 6.3.3.3.5 CSM usage reporting
- 6.4 Cookstove usability

7

Fuel measurement

- 7.1 General
- 7.2 Output metrics
- 7.2.1 Specific energy consumption
- 7.2.2 Kitchen energy consumption
- 7.2.3 Comparison between specific energy consumption and kitchen energy consumption
- 7.2.4 Energy consumed
- 7.2.5 Effective fuel heating value
- 7.2.6 Effective fuel carbon fraction
- 7.3 Equipment
- 7.4 Moisture measurement
- 7.4.1 Hand-held moisture meter
- 7.4.2 Oven dry method for wood and other non-wood solid fuels
- 7.5 Fuel heating value measurement
- 7.6 Specific fuel consumption
- 7.6.1 Test conditions
- 7.6.2 Sample selection
- 7.6.3 Measurements
- 7.6.4 Equipment
- 7.6.5 Protocol
- 7.6.5.1 Determining the standard cooking task
- 7.6.5.2 Conducting the test
- 7.6.6 Calculations
- 7.6.6.1 Energy consumption
- 7.6.6.2 Mass of food cooked
- 7.6.6.3 Specific energy consumption (as fired)
- 7.6.6.4 Aggregated results
- 7.6.7 Reporting
- 7.7 Kitchen energy consumption measurement
- 7.7.1 Considerations
- 7.7.2 Reporting
- 7.8 Fuel measurements for emissions by carbon balance

- 7.8.1 Test conditions
- 7.8.2 Equipment
- 7.8.3 Required measurements
- 7.8.4 Determination of moisture content
- 7.8.5 Determination of lower heating value
- 7.8.6 Determination of fuel carbon fraction
- 7.8.7 Protocol
- 7.8.8 Calculations
- 7.8.8.1 Energy consumption
- 7.8.8.2 Effective fuel heating value
- 7.8.8.3 Effective fuel carbon fraction
- 7.8.9 Reporting
- 7.8.9.1 General fuel measurement report
- 7.8.9.2 Carbon balance fuel report
- 7.9 Limitations

8

Emission measurement

- 8.1 Emission species measured
- 8.2 Emission output metrics
- 8.3 Sample selection
- 8.4 Sampling methods
- 8.5 Emission measurements using partial capture sampling with carbon balance
- 8.5.1 Test conditions
- 8.5.2 Required measurements
- 8.5.3 Equipment specifications
- 8.5.3.1 Emission sampling system
- 8.5.3.1.1 Sampling probe
- 8.5.3.1.2 Particle size separating device
- 8.5.3.1.3 Temperature and relative humidity sensors
- 8.5.3.1.4 PM2,5 gravimetric filter and filter holder
- 8.5.3.1.5 EC/OC filter holders
- 8.5.3.1.6 Carbon dioxide sensor
- 8.5.3.1.7 Carbon monoxide sensor
- 8.5.3.1.8 Flow control
- 8.5.3.1.9 Vacuum pump
- 8.5.3.1.10 Data acquisition system
- 8.5.3.1.11 Dilution train
- 8.5.3.1.12 Tubing
- 8.5.3.2 Additional equipment
- 8.5.3.2.1 Primary flow calibrator
- 8.5.3.2.2 Ambient pressure, temperature, and RH measurement device
- 8.5.3.2.3 Vacuum gauge
- 8.5.3.2.4 Fuel measurement equipment
- 8.5.4 Sampling protocol
- 8.5.4.1 Onsite preparation
- 8.5.4.2 Sampling event
- 8.5.4.3 Onsite post-sampling
- 8.5.5 Gravimetric analysis of PM2,5 mass
- 8.5.6 Thermal optical analysis of EC/OC mass
- 8.5.7 Gas sensor calibration
- 8.5.8 Filter blanks
- 8.5.9 Leak testing
- 8.5.10 Flow rate quality control and tolerances
- 8.5.11 Dilution
- 8.5.12 Background concentration measurement
- 8.5.12.1 Measurement location
- 8.5.12.1.1 General
- 8.5.12.1.2 Unvented cookstoves
- 8.5.12.1.3 Vented cookstoves
- 8.5.12.2 Background gas sampling methods
- 8.5.12.2.1 General
- 8.5.12.2.2 Pre/post cooking event background
- 8.5.12.2.3 Real-time background
- 8.5.12.2.4 Integrated bag sample background

- 8.5.12.3 Background PM sampling methods
- 8.5.12.3.1 General
- 8.5.12.3.2 Assumed to be negligible background
- 8.5.12.3.3 Pre/post cooking event background with real-time sensor
- 8.5.12.3.4 Pump and filter background
- 8.5.12.4 Background EC/OC sampling methods
- 8.5.12.4.1 Assumed to be negligible background
- 8.5.12.4.2 Pump and filter background
- 8.5.13 Fuel measurements
- 8.5.14 Metric calculations
- 8.5.14.1 General
- 8.5.14.2 CO and CO2 concentrations
- 8.5.14.3 PM Concentration
- 8.5.14.4 EC/OC concentration
- 8.5.14.5 Total carbon concentration
- 8.5.14.6 Modified combustion efficiency
- 8.5.14.7 Carbon emission ratio
- 8.5.14.8 Emission factor, fuel mass based
- 8.5.14.9 Emission factor, fuel energy based
- 8.5.14.10 Average emission rate
- 8.5.14.11 Relative humidity criteria
- 8.5.14.12 Uncertainty
- 8.6 Reporting

9 Power measurement

- 9.1 General
- 9.2 Cooking power
- 9.3 Average firepower
- 9.3.1 Test conditions
- 9.3.2 Required measurements
- 9.3.3 Required equipment
- 9.3.4 Measurement protocol
- 9.3.5 Data analysis and calculations
- 9.3.5.1 Burn sequence time
- 9.3.5.2 Average firepower
- 9.3.6 Reporting
- 9.3.7 Limitations
- 9.4 Power calculations for solar thermal cookstoves
- 9.4.1 Cooking power
- 9.4.2 Cooking efficiency

10 Safety assessment

- 10.1 Context
- 10.2 Purpose
- 10.3 Assumptions
- 10.4 Serious hazards
- 10.5 Training of safety inspectors
- 10.6 Field safety assessment procedure
- 10.6.1 General
- 10.6.2 Background information gathering
- 10.6.3 Household setting risk factors survey
- 10.6.4 Physical checks of cookstove and kitchen safety
- 10.6.4.1 General
- 10.6.4.2 Equipment
- 10.6.4.3 Test 1: Cookstove and cooking vessel stability test
- 10.6.4.4 Test 2: Containment of liquid fuels test
- 10.6.4.5 Test 3: Flames surrounding cooking vessel test
- 10.6.4.6 Test 4: Surface temperatures test
- 10.6.4.7 Test 5: Flames exiting fuel chamber test
- 10.6.4.8 Test 6: Carbon monoxide test
- 10.6.4.9 Test 7: Cookstove shutdown test
- 10.6.4.10 Overall summary of physical test scores
- 10.7 Hazard likelihood matrix
- 10.8 Safety assessment report

- 11 Durability assessment
 - 11.1 General
 - 11.2 Test schedule
 - 11.3 Sample size
 - 11.3.1 Preliminary assessment sample size
 - 11.3.2 Performance assessment sample size
 - 11.4 Durability assessment tool outline
 - 11.4.1 General information
 - 11.4.2 Overall cookstove functionality
 - 11.4.3 Cookstove condition
 - 11.4.4 Potential reasons for changes in cookstove condition and functionality
 - 11.5 Data aggregation and interpretation
- 12 Exposure to airborne pollutants
 - 12.1 Area concentration measurements
 - 12.1.1 General
 - 12.1.2 Measurement of area concentrations
 - 12.1.3 Modelled area concentrations
 - 12.2 Personal exposure measurements
 - 12.2.1 General
 - 12.2.2 Measurement of personal exposure concentrations
 - 12.2.3 Constructed exposure estimates

Annex A (informative) Key concepts and conventions in emission sampling

- A.1 Species recommended for measurement
- A.2 Emission reporting metrics
- A.2.1 Emission ratios
- A.2.2 Emission factors
- A.2.2.1 Fuel-based emission factor, EFmass (g/kg)
- A.2.2.2 Fuel energy-based emission factor, EFenergy (g/MJ)
- A.2.3 Emission rate (ER)
- A.3 Emission sampling methods
- A.3.1 General
- A.3.2 Partial capture method
- A.3.2.1 Partial capture method bias and uncertainty
- A.3.2.2 Carbon balance method bias and uncertainty
- A.3.3 Total capture method
- Annex B (informative) Safety assessment questionnaire
- Annex C (informative) Uncertainty estimates and uncertainty propagation
 - C.1 General
 - C.2 Estimating input uncertainties
 - C.3 Limit of detection and limit of quantification

Page count: 108