2018 in case you mist it

Oakland, CA       September 2018:

Air Sensors International Conference
Advancing Science and Engaging Communities
Portable Dilution Sampling Equipment for Climate-Relevant Emission Source Characterization:

Ratnoze

Problem:
Solid fuel combustion sources are difficult to characterize due to:
- high particle emissions
- large emission fluctuations
- remote locations

Solution:
The Ratnoze is a versatile sampling system that provides climate-relevant emission characterization.
- Dilution Sampler: The emission sample is mixed with clean, dry dilution air to reduce particle concentrations and humidity for representative partitioning of semi-volatile species.
- A complete sampling kit that includes Probe, Sensor Box, Accessories, and Software
- Open source design

Ratnoze4 Sampling System

Probe
- Modular probe 0.5-3 m length
- Isokinetic Nozzle for Stack Sampling
- Multi-point Area Nozzle for Open Plume Sampling

Sensor Box
- 2.5 μm cutpoint cyclone (1.5 and 3 lpm)
- Two parallel 47 mm filter holders for PM gravimetric and composition analysis
- On-board data logger
- Forced dilution up to 20:1 DR
- 1Hz sampling rate
- 15 hour battery life

Measures:
- CO
- CO₂
- PM₁₀
- SO₂
- NO
- NO₂
- Ambient Pressure
- H₂S
- Dilution Ratio
- CH₄
- O₃

Software (Python)
- Real-time data plotting software:
  - Wireless Transmitter
  - Computer
  - Tools
  - Bubble Meter
  - Safety Masks
  - Travel Cases

Data Post-Processing Software:
- Calculates emission factors, emission rates, and other reporting metrics using Carbon Balance and Stack Flow methods
- Includes uncertainty propagation

Fuels:
- Biomass
- Coal
- Diesel
- Gas

Sources
- Brick Kilns
- Natural draft, Forced Draft, No Chimney
- Charcoal kilns
- Biochar stoves
- Cookstoves
- Space heating stoves
- Engines

Locations:
Ratnoze1: ICIMOD, Nepal
Ratnoze2: Corporation Ambiental Empresarial, Colombia
Ratnoze3: Beijing University of Business and Technology, China
Ratnoze4: Mountain Air Engineering, USA

More Information
Contact: rong@missouri.edu
Equipment Documentation: www.mse.missouri.edu/education/equipment/
Lawrence Berkeley Lettuce and Tomato
Current Project:

New ISO standard - Field test methods for hair

- length
- diameter (including taper)
- growth rate
- strand density
- curliosity
household biogas

Benefits:
• Clean, local, renewable fuel
• Source of organic fertilizer

Limitations:
• Temperature dependence (seasonal variability)
Biogas monitoring in Nepal

• Partners:
  • MAE, UIUC, Basudev Upadhyay, HSU, LEADERS Nepal, CRT/N, CCAC, CCA

• Measure:
  • Stove emissions (PM2.5, BC, OC, CO)
  • Usage
  • Energy consumption

• Biogas, LPG, and wood

• Uncontrolled cooking emissions
Biogas System
Biogas System
Equipment
Results

- PM$_{2.5}$ emission factors of gas cooking events are 50 times lower than wood cooking events
- BC emission factors of gas cooking events are 200 times lower than wood cooking events
- Black carbon is a small fraction (3%) of particle emissions
- The climate impact of aerosols from gas cooking is negligible
- Majority of PM$_{2.5}$ emissions are from frying food, not from the fuel
Results

- Biogas and LPG stoves are clean in real-world settings (Tier 4)
- Average firepower = 1500 W
- Gas stoves do not meet all household energy needs – wood remains a major household energy source

Performance Tiers are adapted from ISO/TR 19867-3:2018 assuming thermal efficiency = 0.5
Upriver biogas system
• Tea = 1 cubic foot = 0.6 MJ = $0.005 natural gas = $0.02 LPG
• 1 meal = 3 cubic feet = 1.7 MJ = $0.015 natural gas = $0.05 LPG
• Total usage since August = 441 cubic feet = 250 MJ = $2.35 natural gas = $7.39 LPG

CH4 = 60% vol
CO2 = 25% vol
LHV = 21 MJ/kg
Future biogas work: pilot biogas systems

Bag in a greenhouse

- Low-cost
- Amazing co-benefits
- Appropriate for cold climates
- Oregon, Nepal, etc.
- Monitor performance
yore welcome