Composition of Emissions from the Combustion of Solid Fuels Used on the Navajo Nation

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Abstract
The contribution of human related activities to indoor air pollution is a major concern in developing communities. Products of combustion and biological components of particulate matter (PM) have been shown to have high levels of organic compounds and elemental compounds. Preliminary results of experimental studies are presented, which highlight the differences in the amounts and compositions of the PM produced from combustion of Black Mesa Bituminous Coal, Kingsford Charcoal, and Pinion Pine Wood.

Background
In the Navajo Nation, household heating with inexpensive and highly available solid fuels contributes to elevated levels of indoor air pollutants. (Bunnell et al., 2010; Breyesse et al., 2012). The most common heating fuel in households was wood alone and the combination of wood plus coal (Robin et al., 1996). The Navajo reservation is a semi-arid land in the northeastern part of Arizona consisting of solid fuels such as Pinion pine forests and the Black Mesa coal mine near the Utah state line (Kirshbaum et al., 2013).

Methods and Materials
For each test, the Water Boiling Test protocol was used. Total PM was collected onto two distinct filters (Tissuquartz and Teflon) for elemental and organic carbon (ECOC), gravimetric, and elemental analyses. A TSI DusTrak was used to provide real-time mass concentration values of PM-10.

Recommendations
Further characterization of the PM produced from these solid fuels is important. The composition of the organic carbon (OC) may be analyzed to determine tar contents, and the total PM may be further discretized into sub-micron sizes. The authors recommend that residents consider stove upgrades.

Results

Black Mesa Bituminous Coal

Figure 1. Schematic of Experimental Setup

Figure 2. PM Concentration vs. Time for Black Mesa

Figure 3. Total PM and OC for Black Mesa WBTs

Kingsford Charcoal

Figure 4. PM Concentration vs. Time for Kingsford

Figure 5. Total PM and OC for Kingsford WBTs

Pinion Pine Wood

Figure 6. PM Concentration vs. Time for Kingsford

Figure 7. Total PM and OC for Pinion Pine WBTs

Discussion
Average emissions of total PM per WBT were higher for Black Mesa coal (21 g) when compared to both Kingsford Charcoal and Pinion Pine (5.1 and 6.0 g). PM emissions from Pinion Pine were continuously expelled during the entire WBT (cold start and simmer), while Kingsford and Black Mesa emitted much less PM during the simmer phase. Much higher levels of OC were emitted from Kingsford and Black Mesa than elemental carbon (EC); Black Mesa was not analyzed for OC/EC. Kingsford (3.1 - 7.9 g) and Pinion Pine (1.7 - 2.3 g) produced much less total PM compared to Black Mesa (17 - 24 g) during the cold start phase. For all fuels, PM, comprised over 99% of the total PM.

Recommendations
Further characterization of the PM produced from these solid fuels is important. The composition of the organic carbon (OC) may be analyzed to determine tar contents, and the total PM may be further discretized into sub-micron sizes. The authors recommend that residents consider stove upgrades.

References

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