

地表火灾排放 PM_{2.5} 中无机元素与森林地表可燃物含水率的关系

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摘要:森林地面可燃物含水率由于环境因素而不断变化,直接影响火灾过程中释放的颗粒物的成分和排放强度。在本研究中,使用室内生物质燃烧分析装置分析了不同含水量(0%、15%和30%)的草本可燃材料燃烧产生的细颗粒物(PM_{2.5})的排放特性。采用电感耦合等离子体质谱仪(ICPMS)测定了PM_{2.5}中无机元素(Zn、K、Mg、Ca等13种可测元素)的组成。结果表明,PM_{2.5}排放因子随着可燃物含水率的增加而显著增加,范围为 $(11.63 \pm 0.55) \sim (36.71 \pm 1.21)$ g/kg。PM_{2.5}的主要元素成分为K、Zn、Ca、Mg和Na,K、Ca、Mg和Na的排放因子随着可燃物含水率的增加而增加。随着含水率的升高各草本燃烧释放PM_{2.5}中常量元素占比增加,但微量元素占比逐步降低。含水率与草本可燃物燃烧颗粒物元素释放存在相关性。研究结果表明,可燃物含水率对颗粒物中无机元素的排放有显著影响,因此在减少可燃物处理过程中应注意,例如计划火烧。

关键词: 林火; PM_{2.5}; 草本可燃物; 可燃物含水率; 元素分析

Composition of inorganic elements in fine particulate matter emitted during surface fire in relation to moisture content of forest floor combustibles

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Abstract: The moisture content of combustible material on the forest floor is constantly changing due to environmental factors, which have a direct impact on the composition and emission intensity of particulate matter released during fire. In this study, an indoor biomass combustion analysis device was used to analyze the emission characteristics of fine particulate matter (PM_{2.5}) from combustion of herbaceous combustible materials with different moisture contents (0%, 15%, and 30%). The composition of inorganic elements in PM_{2.5} (Zn, K, Mg, Ca, and other 13 measurable elements) were determined by inductively coupled plasma-mass spectrometer (ICPMS). The results showed that the PM_{2.5} emission factor increased significantly with the increase of moisture content of combustible materials in the range of 11.63 ± 0.55 for dry samples to 36.71 ± 1.21 g/kg for samples with 30% moisture content. The main elemental components of PM_{2.5} were K, Zn, Ca, Mg, and Na and K, Ca, Mg, and Na emission factors increased with the increase of moisture content of combustibles. The proportion of macronutrients in PM_{2.5} released by combustion of each herb increased as the moisture content increased, but the proportion of trace elements gradually decreased. There was a good correlation between elemental composition of PM_{2.5} and that of herbaceous combustibles. The results provide evidence that the moisture content of combustible materials has a significant effect on the emission of inorganic elements in particulate matter, and hence cautions should be exercised during fuel reduction treatments, such as early prescribed fire.

Key words: Forest fire; PM_{2.5}; Herbaceous combustibles; Fuel moisture; Elemental analysis