AIRUSE LIFE+: Mitigation strategies for biomass burning emission in Southern Europe

C.A. Alves[1], E. Vicente[1], M. Duarte[1], L. Tarelho[1], F. Amato[2], and X. Querol[2]

[1]Centre for Environmental and Marine Studies, Department of Environment, University of Aveiro, 3810-193 Aveiro, Portugal

[2]Institute of Environmental Assessment and Water Research, Spanish Research Council, 08034 Barcelona, Spain

Keywords: biomass burning, depollution technologies, mitigation measures, operating conditions.

Presenting author email: celia.alves@ua.pt

Residential biomass combustion has been pointed out as one of the main sources of atmospheric pollutants, especially PM (Gonçalves *et al*., 2012). Reduction of emissions can be achieved by either avoiding the formation of pollutants (primary measures) or by removal of such substances from the exhaust gases (secondary measures).

Aiming at defining which are the lowest emitting biofuels and burning appliances, wood species widely used as biofuels in Southern European countries have been burned in different combustion equipment (fireplace, traditional cast iron stove and an eco-labelled stove). The emissions from these devices have been compared to those from a pellet stove with increasingly market share. In the pellet stove, besides four types of wood pellets, the emissions from the combustion of three agricultural fuels (olive pit, shell of pine nuts and almond shell) were also studied. In order to evaluate which practices offer the greatest emission reductions, different operating conditions were investigated: fuel load (1, 2 and 4 kg), degree of cleavage of the logs, moisture and ash contents of biofuels, ignition technique (upside down and bottom up lighting) and injection of secondary combustion air. With respect to secondary measures, two pollution control devices (a catalytic converter and an electrostatic precipitator) were applied to the flue gases of the woodstove and pellet stove.

PM emission factors (EFs) from the fireplace, traditional cast iron stove, eco-labelled stove and pellet stove were, respectively, in the following ranges: 312-1135, 149-703, 61-156 and 25-156 mg/MJ biofuel burned (dry basis). Even the pellet stove, for most biofuels, did not meet the emission limits stipulated in countries where certification of combustion appliances is required (e.g. 35 mg/MJ for wood fuels and 25 mg/MJ for pellets in Austria; 27 mg/MJ in Germany). Among all the biofuels tested, only the pellets with ENplus quality certification, met these limits. Some heavy metals (such as Zn, Pb, Fe and As) were found to be higher in PM_{10} emissions from some types of pellets, which were made of recycled wood waste. The higher mass fractions of these metals are likely due to the use of painted and phyto-treated woods. Given the interest in increasing the use of pellets as a renewable fuel, standards need to be established in the European Union for the elemental composition of commercial wood pellets and chips to avoid the inclusion of extraneous materials.

Regarding primary mitigation measures, the highest PM_{10} EFs were recorded for the operation with low loads. Particle EFs increased with increasing fuel moisture and ash contents. Secondary air supply produced the lowest PM_{10} EFs. Top ignition can decrease the PM_{10} EF to less than half when compared with the traditional technique of lighting from the bottom.

With respect to secondary measures, for most cases, any significant reduction of PM emissions could be documented. Although the catalytic converter is designed to clean the flue gas, most of the chemical compounds in wood smoke are only combustible at temperatures higher than 550-600 ºC. When installed in small-scale traditional appliances, these temperatures are hardly achieved. In the case of electrostatic precipitators, possible particle formation due to condensation of organic compounds, which result from poor burnout conditions, may contribute to particle formation downstream the charging electrode leading to a higher aerosol load at the filter outlet. Thus, depollution of flue gas from traditional appliances is very problematic, due to incomplete combustions and high emissions of condensables.

Results from several measurement studies, together with disaggregation of emissions factors by technology and fuel type, lead to quite large differences, especially between old-type residential appliances, which dominate in Southern European countries, versus modern woodstoves and boilers with higher combustion efficiency. The old-type residential appliances should be replaced by certified equipment, rather than installing depollution technologies. The cost for a new stove will for many installations be comparable to the cost for the installation of an electrostatic precipitator and the maintenance for some years. Without national policies promoting the replacement of older appliances by cleaner home heating, the main focus should be on the reduction of particulate emissions by primary measures. Emission requirements for the eco-labelling of small-scale combustion appliances must be mandatory in all countries. The requirement for selling only certified pellets should also be widespread.

This work was supported by AIRUSE – Testing and development of air quality mitigation measures in Southern Europe, LIFE 11 ENV/ES/000584.

Gonçalves, C., Alves, C., Pio, C. (2012) *Atmos. Environ*. **50**, 297–306.