Particulate matter emissions and mitigation measures for residential biomass combustion

Estela D. Vicente, Célia Alves, Teresa Nunes, Luís Tarelho
Centre for Environmental and Marine Studies (CESAM), University of Aveiro, 3810-193 Aveiro, Portugal
estelaavicente@ua.pt

Abstract
Residential biomass combustion has been pointed out as one of the main sources of atmospheric pollutants, especially PM. 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).

COMBUSTION APPLIANCES AND FUELS

Traditional fireplace
Operated manually in batch mode and with no control of combustion air

Traditional woodstove
Operated manually in batch mode and with handheld control of combustion air

Eco-labelled woodstove
Operated manually in batch mode

Pellet stove
Automatic feeding

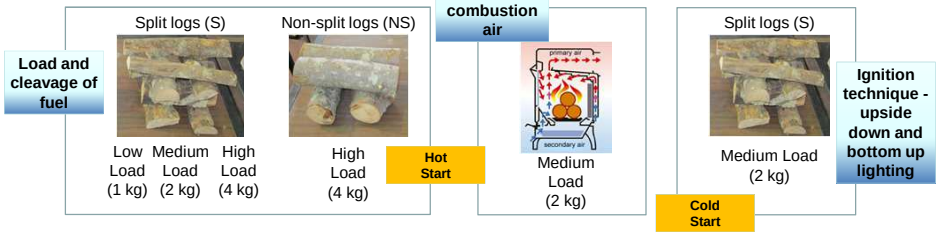
Softwood

Hardwoods

3 types of agro-fuels

4 types of wood pellets

VARYING OPERATING CONDITIONS



DEPOLLUTION TECNOLOGIES

Two pollution control devices - a catalytic converter and an electrostatic precipitator - were applied to the flue gases of the traditional woodstove and pellet stove.

PM emission factors from the fireplace, traditional stove, eco-labelled stove and pellet stove were in the ranges 312-1135, 149-703, 61-156 and 25-156 mg/MJ biofuel (dry basis), respectively. Even the pellet stove, for most fuels, did not meet the emission limits stipulated in countries where certification of combustion appliances is required. Only pellets with ENplus seal met these limits.

The highest PM emissions were recorded for the operation with low loads. Secondary air supply produced the lowest emission factors. Top ignition can decrease the PM EF to less than half when compared with the traditional technique of lighting from the bottom.

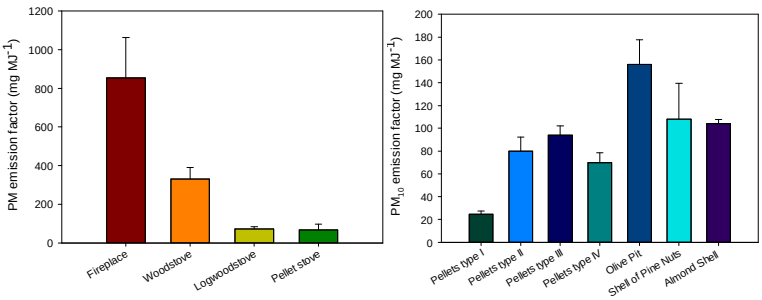


Fig 1 Particle emission factors from different residential combustion appliances and biofuels.

Regarding 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 > 550-600 ºC. When installed in small-scale traditional appliances, these values 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.

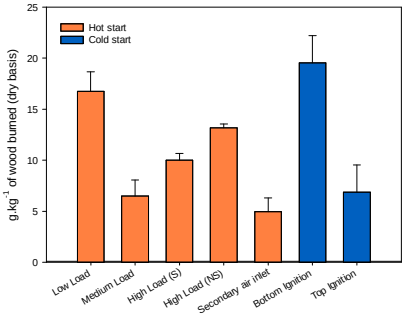


Fig 2 Particle emission factors from a traditional woodstove for different operating conditions (pine combustion).

Conclusions
– Given the interest in increasing the use of pellets as a renewable fuel, standards need to be established in the EU for the elemental composition of commercial wood pellets to avoid the inclusion of extraneous materials.
– Old-type residential appliances should be replaced by certified equipment rather than installing depollution technologies.
– 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.

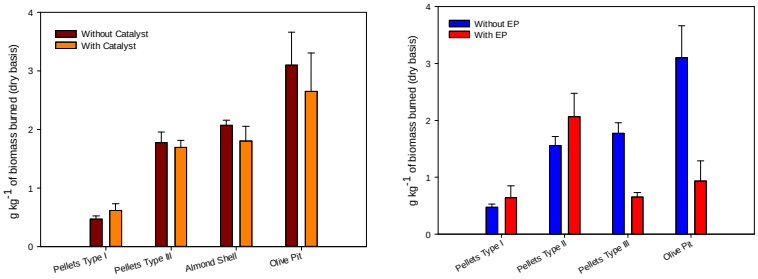


Fig 3 Particle emission factors from a pellet stove with or without catalytic converter and electrostatic precipitator (EP) in the exhaust stack

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