Technical Report No. 5: Emissions from Domestic Solid Fuel Burning Appliances

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Wood-heater Emissions - and Controlling Factors

The study objective relevant to this section is "to gain an understanding of the emissions from a range of types of domestic solid-fuel-burning appliances using a variety of fuels under conditions of maximum and minimum (as permitted by the appliance)".

4.1 Methodologies used in this study

4.1.1 AS4013 heater test rig.

Effective sampling of smoke from wood fires is a challenging technical task. Along with the copious particulate emissions there are substantial emissions of water from both free water in the fuel and combustion water. This water, together with the tarry condensates, can readily block filters and any unprotected instruments can rapidly become contaminated. One generally successful strategy for sampling these emissions is the use of a dilution tunnel, as for example in the AS4013 heater test methodology (AS/NZS4013, 1999). In this procedure all the emissions are captured by entrainment into a much larger volume of clean, flowing air. Typically this is larger by a factor of around 10 to 20, diluting the emissions substantially and reducing the relative humidity. In practice, because of the very concentrated particulate emissions from wood heaters, room air is used for dilution and this procedure was followed for this study. In addition to the wanted smoke samples, a series of four room, or background, samples were also taken during operation of the heaters to determine typical concentrations of all analysed species in the dilution air.

Standard procedures, including AS/NZS 4013, attempt to minimise variance in emissions by controlling several burn variables within relatively narrow limits. The present study specifically involves selected variations from the standard procedures, but otherwise, wherever possible the standard procedure has been followed. To summarise, the AS/NZS 4013 procedure includes three test burns for each of three flow settings (high, medium and low) and includes a conditioning burn for each change of conditions. Fuel moisture and density are prescribed within narrow limits, as is the volume that fuel takes up in the combustion chamber. For each burn a single uniform charge of fuel is placed onto a prepared coal bed, with emission factors determined as an integral over combustion of this fuel charge. For burns on low flow settings, 20% of the fuel mass is consumed in establishing sustainable combustion before filter collections are initiated. The major variations for the present study include use of selected high or low flow settings only, specific variations in fuel type, moisture content and density and a varied number of repetitions. Test burn conditions and their effects are discussed more fully in later sections.

9			background					
10	9		non-compliant	redgum	seasoned	high	standard	extra run
6	6		Open fireplace	redgum	seasoned	open	standard	
7	7		Open fireplace	redgum	seasoned	open	standard	
8	8		Open fireplace	redgum	seasoned	open	standard	
16	15	Constantly	C2 (3.7 g/kg)	redgum	seasoned	low*	overloaded	
17	16	low -	C2 (3.7 g/kg)	redgum	seasoned	low*	overloaded	
14	13	overnight *	non-compliant	redgum	seasoned	low*	overloaded	
15	14		non-compliant	redgum	seasoned	low*	overloaded	
18			background					

Table 2. Sampling program showing organisation by the different type of test, and the systematic variation in operating parameters that was employed (indicates low flow rate from fuel insertion).*

For four burns, separate samples were taken in the early and late phases of the burn and four room samples were taken to establish typical background levels in the dilution air.

Emission compositions from four different appliances were studied. These were two (new) modern AS4013:1999 - compliant heaters, a widely-used heater manufactured in 1985 and in well-used condition and finally, a new open fireplace insert. The first three devices were operated as controlled-combustion heaters and the fireplace insert was operated as an uncontrolled-combustion heater. The three controlled-combustion heaters were free-standing models and the fireplace insert was shrouded with insulating bricks to simulate the thermal surrounds of a

41	48	4.0	3.5	0.4	3.1	302.0	10	1.17
42	49	4.7	4.1	0.0	4.1	373.0	0	6.89
43	50	8.9	4.1	-0.3	4.3	232.0	20	0.72
44	51	4.5	4.0	0.2	3.7	382.0	10	1.06
45	52	7.2	4.0	0.2	3.8	271.0	20	1.18
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Table 5. Sampling conditions - part 2.

Burn	Sample	Minutes HRL	Dilution at 5.5 l/min	Power av. (kW)	Heat o/p (MW)	Efficiency (%)	Aerosol (g/kg)
1	1	154	1098	7.3	67.2	41.7	1.2
2	2	182	1108	8.7	95.0	58.2	0.8
3	3	180	1069	8.3	89.9	60.8	0.4
4	4	190	1114	7.9	90.2	62.8	0.8
5	5	184	1120	7.8	85.6	59.2	0.2
6	6	94	1014	8.3	46.6	35.8	1.4
7	7	170	1069	5.6	57.3	44.2	2.6
8	8	82	1021	7.8	38.1	29.4	2.8
	9						0.0