

**REPORT ON COMBUSTION EFFICIENCY  
AND EMISSIONS FROM 'CZK3' STOVE**

Commissioned by co2balance UK Ltd

Dr J Kithinji – 09<sup>th</sup> February 2011

**University of Nairobi – Department of Chemistry**



## REPORT ON COMBUSTION EFFICIENCY AND EMISSIONS FROM CZK3 STOVE

### EXECUTIVE SUMMARY

#### Scope of work

The scope of work, commissioned by co2balance UK Ltd, was to conduct a standard water boiling test on the company's CZK3 stove; the purpose of the test was to measure the performance of the stove in terms of four key parameters: fuel use, thermal efficiency, carbon monoxide and particulate matter. Comparisons of particulate and carbon dioxide emissions from CZK3 and those from 3 stones stove are presented as the stove is intended as an energy efficient/cleaner indoor air solution to the widely used 3 stone.

#### Summary of Findings

The results of the test are presented within this report. The key findings of the various tests are as follows:

- The average **thermal efficiency** of the CZK3 stove as established in the water boiling test was 36% (high power/hot start), 31% (high power/hot start) and 37% (low power/simmer). This provides an overall average of **34.67%**.
- The **particulate emission ratio** (measured in  $\mu\text{m}^3$ ) of the CZK3 stove compared to a 3 stone fire was 123:305 or **1:2.4**
- The **Carbon Monoxide emission** ratio (measured in ppm) of the CZK3 stove compared to a 3 stone fire was 666:8466 or **1:13**



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**METHODOLOGY AND DETAILED RESULTS****WATER BOILING TESTS**

The water boiling tests were tested in accordance with the "University of California Berkeley Revised Water Boil Test Version 3.0". The water boiling test results carried out using the CZK3 stoves are summarized in Table 1, below.

**Table 1: water Boiling Tests for Cold, Hot and Simmering phases**

<b>1. HIGH POWER TEST (COLD START)</b>					<b>Average</b>	<b>St Dev</b>
	<b>Units</b>	<b>Test 1</b>	<b>Test 2</b>	<b>Test 3</b>		
Time to boil Pot # 1	Min	18	18	22	19.8	2.2
Temp-corrected time to boil Pot # 1	Min	21	20	26	22.6	3.0
Burning rate	g/min	8	9	7	8.0	1.3
<b>Thermal efficiency</b>	<b>%</b>	<b>37%</b>	<b>30%</b>	<b>41%</b>	<b>36%</b>	<b>6</b>
Specific fuel consumption	g/liter	63	71	64	65.9	4.1
Temp-corrected specific consumption	g/liter	73	78	74	75.1	2.4
Firepower	Watts	2,472	2,836	2,024	2444	406.7

<b>2. HIGH POWER TEST (HOT START)</b>					<b>Average</b>	<b>St Dev</b>
	<b>Units</b>	<b>Test 1</b>	<b>Test 2</b>	<b>Test 3</b>		
Time to boil Pot # 1	Min	17	16	17	16.9	1.1
Temp-corrected time to boil Pot # 1	Min	20	17	20	19.2	1.7
Burning rate	g/min	11	18	8	12.1	5.1
<b>Thermal efficiency</b>	<b>%</b>	<b>30%</b>	<b>20%</b>	<b>44%</b>	<b>31%</b>	<b>12</b>
Specific fuel consumption	g/liter	82	117	58	85.6	29.6
Temp-corrected specific consumption	g/liter	93	130	68	96.9	31.1
Firepower	Watts	3,343	5,441	2,368	3717	1,570.7

Continued



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<b>3. LOW POWER (SIMMER)</b>	<b>Units</b>	<b>Test 1</b>	<b>Test 2</b>	<b>Test 3</b>	<b>Average</b>	<b>St Dev</b>
Burning rate	g/min	8	10	7	8.4	1.7
Thermal efficiency	%	34%	44%	33%	37%	6
Specific fuel consumption	g/liter Watt	237	616	222	358.3	223.2
Firepower	s	2,336	3,176	2,253	2588	510.4
Turn down ratio	--	1.06	0.89	0.90	0.95	0.1



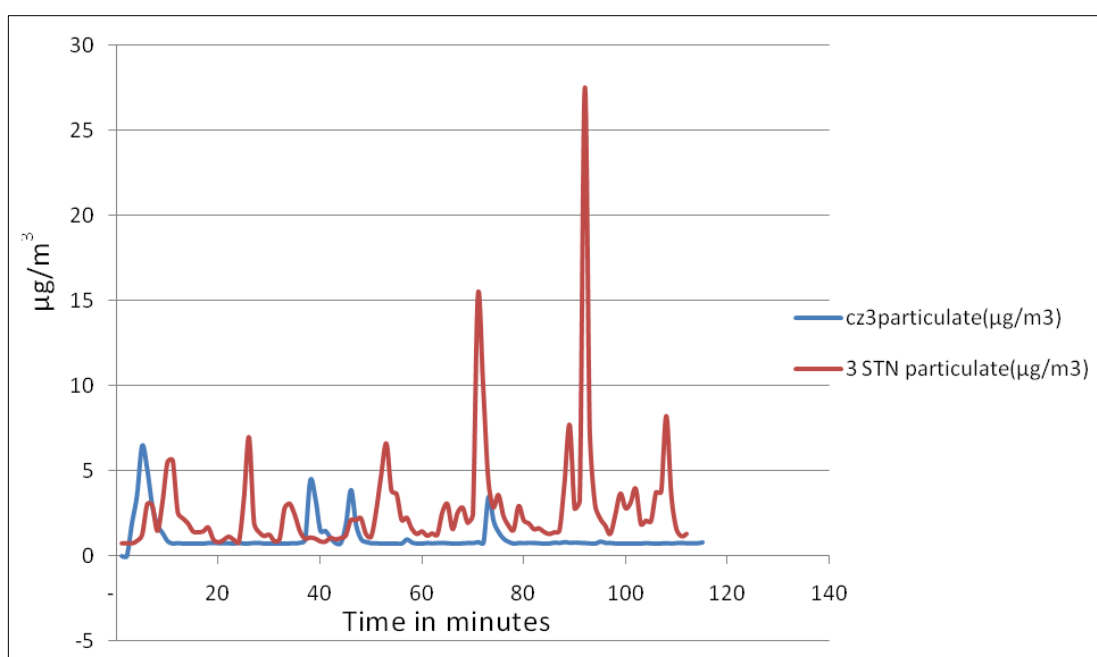
**Report on combustion efficiency and emissions from 'CZK3' stove****PARTICULATE and CARBON DIOXIDE EMISSIONS**

The particulate matter ( $\mu\text{g}/\text{m}^3$ ) and carbon dioxide (ppm) were obtained in real time from a cooking position at equal distances from the fire for (CZK3 and 3-stone fire) during the three tests:-cold, hot and simmering phases. The particulate matter was obtained using University of California Berkeley (UCB)- Particulate Monitor at a rate one record per minute and CO using Easy log monitor at a rate of six records per minute.

**PARTICULATE MATTER**

The comparison between the particulate matter emission levels from CZK3 and 3-stone fire are given in Figure 1.

The particulate emission ratio in ( $\mu\text{g}/\text{m}^3$ ) of CZK3 to 3-stone is 123 to 305 or (1 to 2.4) for the three phases.

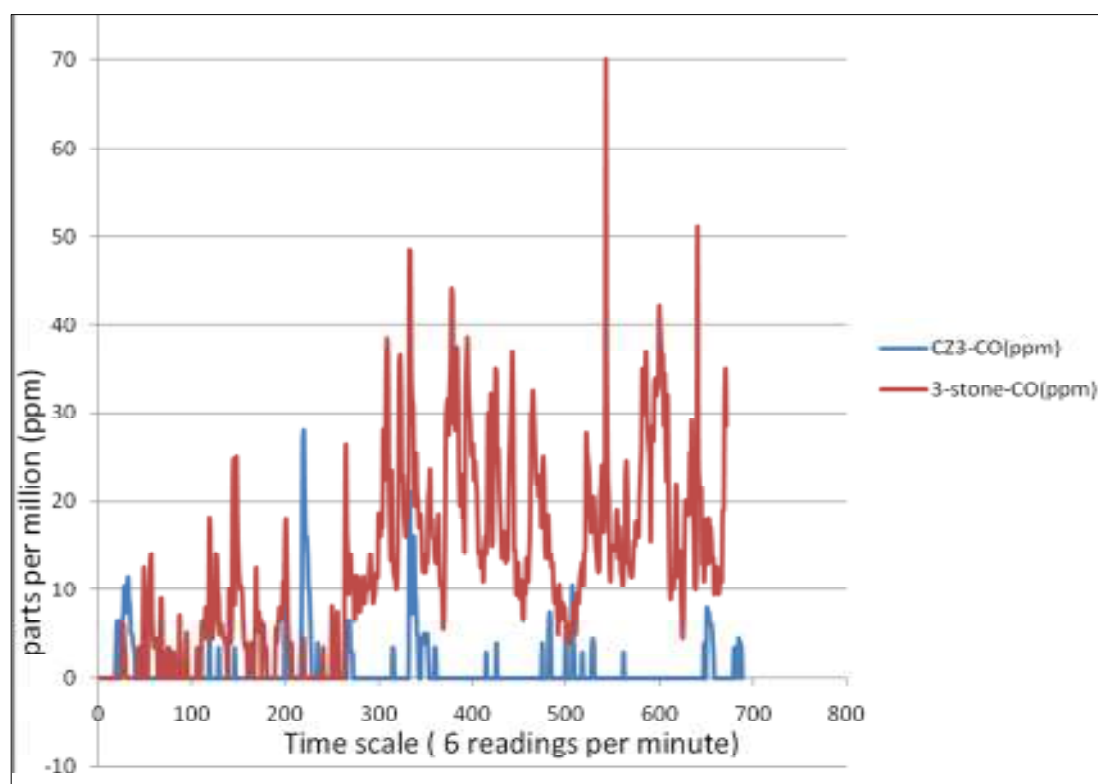


**Figure 1: Particulate emissions from CZK3 and 3-stone stoves**



**Report on combustion efficiency and emissions from 'CZK3' stove****CARBON MONOXIDE**

The comparison between the carbon dioxide emission levels from CZK3 and 3-stone fire are given in Figure 2. The carbon monoxide emission ratio in ppm of CZK3 to 3-stone is 666 to 8466 or (1 to 13).



**Figure 2: The carbon dioxide emission levels in parts per million(ppm) from CZK3 and 3-stone stoves**



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**UNIVERSITY OF NAIROBI****Department of Chemistry****P.O. Box 30197-00100****Tel: 254-02-1446138; Cell: 254-722-850-702****E-mail: [jkithinji@uonbi.ac.ke](mailto:jkithinji@uonbi.ac.ke); Website: [www.uonbi.ac.ke](http://www.uonbi.ac.ke)****9<sup>th</sup> February 2011****CERTIFICATION OF CZK3 COOKING STOVE**

This is to certify that Carbon Zero Cooking stove tested on behalf of co2balance Ltd (UK) was tested in Chiromo Campus, University of Nairobi, Nairobi, Kenya. The CZK3 stove listed below has been tested in accordance with the "University of California Berkeley Revised Water Boil Test Version 3.0".

Results averaged of the three tests.

<b>MEASURED VALUES</b>	<b>HIGH POWER TEST (COLD START)</b>	<b>HIGH POWER TEST (HOT START)</b>	<b>LOW POWER TEST (SIMMER)</b>
Thermal efficiency (%)	36±6	31± 12	37±6
Burning (g/min)	8.0±1.3	12.1±5.1	8.4±1.7
Specific fuel consumption (g/liter)	65.9±41	85.6±29.6	358.3±273.2
Firepower (watts)	2,444±406	3,717±1,570	2,588±510
Particulate matter (μ/m <sup>3</sup> )	123		
Carbon monoxide (ppm)	666		

Certified by

Dr. Jacob Kithinji

Senior Lecturer  
Department of Chemistry  
University of Nairobi

