

# TEST REPORT



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## TEST REPORT

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**Prepared for Mr. S.A. Danielsson**

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### TEST METHOD USED:

The tests were performed as per supplied instructions. The test room volume approximated 35m<sup>3</sup>. The nitrous fumes, carbonmonoxide and –dioxide were determined with Dräger color-tubes. The methanol and ethanol exposure were analyzed by GC/MS and the Formaldehyde was determined using a KLM color comparator.

### RESULTS:

Analyte	Unit	Test 1	Test 2	Test 3	Test 4
Time to burn ~500mL fuel	minutes	129	127	130	125
Water left from 2500mL	mL	509	899	412	738
Carbonmonoxide, CO	ppm	19	17	20	20
Carbondioxide, CO <sub>2</sub>	ppm	2050	2100	2450	2400
Nitrous fumes, NO <sub>x</sub>	ppm	<1	<1	<1	<1
Formaldehyde, HCHO	ppm/hrs	<1	<1	<1	<1
Ethanol, C <sub>2</sub> H <sub>6</sub> O	mg/m <sup>3</sup>	2.97	<0.01	3.77	<0.01
Methanol, CH <sub>4</sub> O	mg/m <sup>3</sup>	<0.01	6.54	<0.01	11.15

Note: The room after tests 1 and 3 burned the eyes and nose more than tests 2 and 4. Methanol seems a cleaner fuel than Ethanol, but its heat of combustion is lower. The methanol combusted more incompletely than the ethanol. This could be due to the oxygen being non-atmospheric.

Compiled by W.D.Wepener

## **Evaluation of emission products from Origo stove**

### **Test Protocol**

Fuel shall be burned in a reasonably tight test room, no ventilation.

One burner of an Origo 3000 stove shall be used.

Burn a total of about 0.5L per 60 m<sup>3</sup> of test room volume.

Fill tank with at least 1.5 times the burned volume of fuel up to 1.2 L, but not less than 0.5 L.

During each test keep a pot with water on the burner. Pot diameter about 180 mm to 200 mm. Water temperature at start about 20°C. Water volume at start 2.5 L. During a test, the water will gradually heat until boiling occurs; let it continue to boil until test is ready.

Make a first test to find out the approximate time needed to burn the required amount of fuel.

Example: test room of 30 m<sup>3</sup> volume. Burn 30/60\*0.5L of fuel total i.e. 0.25L. In this case fill the tank with 0.5 L (minimum volume, see above).

After each test is completed, enter the test room quickly and close the door. Note any significant smell and use instrument to quantify the following substances: NO<sub>x</sub>, Formaldehyde, Ethanol, Methanol, CO.

### **Test no. 1**

Run a test in accordance with the above, using Ethanol.

### **Test no. 2**

Run a test in accordance with the above, using Methanol

### **Test no. 3**

Run a test in accordance with test 1 above, but burn twice as much Ethanol by using both burners with water pot on each.

### **Test no. 4**

Run a test in accordance with test 2 above, but burn twice as much Methanol by using both burners with water pot on each.

### **Discussion:**

#### **Provided by Dr. Charles A. Stokes**

The tests on emissions are gratifying with regard to formaldehyde because it is considered carcinogenic. Thus we want to avoid having any significant amount, and that is indeed the case.

The reason for the greater eye irritation with ethanol is probably the formation of another aldehyde, acetaldehyde, which causes irritation of the eyes and mucus membrane. It is not dangerous except at higher concentrations and for longer times. The ACGIH maximum allowable concentration of acetaldehyde (TLV) is 100 ppm, according to my most recent reference data. The PEL TWA is 100 and the STEL level is 150.

A concentration of less than 1 ppm of formaldehyde essentially means no formaldehyde, insofar as these test results are concerned.

The most recent exposure standards for formaldehyde are as follows.

American Conference of Government Industrial Hygienists (ACGIH) "threshold limit value" (TLV).....0.3 ppm  
OSHA "permissible exposure level" (PEL) time weighted average (TWA) is.....0.75 ppm  
The "short-term exposure limit" (STEL) is.....2.00 ppm

TWA is the allowable time-weighted average concentration for a normal 8-hour workday/40-hour workweek.

STEL is the short-term exposure limit for a continuous 15-minute exposure period, with 4 such periods allowed in the workday.

It is not surprising to detect both ethanol and methanol in the air since each vaporises into the flame and some will escape around the edges. If one burns kerosene or gasoline one will also detect fumes of these. Probably a propane stove releases some free propane. There is more methanol released because it has a slightly higher vapour pressure than ethanol. The figure of  $6.54 \text{ mg/m}^3$  for methanol in Test 2 is about 5 ppm by volume.

Returning to formaldehyde, what is of interest, of course, is the comparison to wood, dung, kerosene, etc., rather than the absolute value. Also, the tests were in a room with no ventilation at all. With any ventilation, formaldehyde would be much less. Whether or not we will have to measure below 1 ppm I am not sure. If it is less than 1 ppm obviously it could be 0.1 or 0.01. Please consult your lab contractor as to the limits to which formaldehyde can be measured and whether or not they can measure acetaldehyde separately from formaldehyde. If they are detecting the aldehyde group and calling it formaldehyde, (which I suspect), that is another complication. Formaldehyde is the most problematic of the aldehyde group, so far as published standards go.

As it stands, formaldehyde might really be less than 1 ppm in all cases but possibly acetaldehyde is 1-2 ppm for ethanol, while none for methanol -- because it is simply not possible for methanol to form it. (Acetaldehyde is a 2-carbon-atom material, as is ethanol, whereas methanol is a one-carbon-atom material.)

The latest Sasol MSD sheet for methanol cites an OSHA limit of 250 ppm, which is probably the TLV limit. We are way below this level.

The carbon monoxide levels are all the same but higher than I would have thought. Formerly, 100 ppm was considered safe for 4 to 5 hours and 400-500 ppm for one hour. The best view of modern standards is to look at what Swiss or Swedish authorities allow at the auto tailpipe and in ambient air. It varies from country to country. The US Consumer Products Safety Association says no adverse effects from 35 ppm for 8 hours and mild headaches after 2-3 hours at 200 ppm.

Sweden: TWA = 35 ppm, 100 ppm for 15 minutes.

United Kingdom: TWA = 50 ppm, STEL = 300 ppm (10 minutes)

These results are in a closed and unventilated room.

The negligible concentration of nitrous fumes (NO<sub>x</sub>) is as expected.

I do not agree with the analyst's remark that methanol combusted more incompletely. The carbon monoxide values are all the same within the precision of the test. Perhaps the analyst is basing his conclusion on the greater escape of free vapour of methanol.

These results are generally superior to what a natural gas or typical LP gas mix would have achieved.