



## APPLICATION NOTE | DDS CALORIMETERS

### ALTERNATIVE ENERGY SOURCE: WOOD, PEAT, COAL

#### INTRODUCTION

Many institutions are doing research and development on alternative energy source.

Alternative energy refers to energy sources, which are not based on the burning of fossil fuels or the splitting of atoms. The renewed interest in this field of study comes from the undesirable effects of pollution (as witnessed today) both from burning fossil fuels and from nuclear waste byproducts. Fortunately, there are many means of harnessing energy, which have fewer damaging impacts on our environment.

Part of the research involves determining the calorific value (energy content) of the alternative energy source and extracting as much energy as possible from the substances.

#### SAMPLE PREPARATION

Energy sources in general burn very easy when the moisture is very low. If the moisture is high then the spiking method should be used to ignite the sample. If the sample has been ground into a dry powder it will not easily press into tablets using a pellet press, because the fibers will not adhere to each other irrespective of the pressure exerted during the pelleting process. Igniting a fine powder is not advised.



An alternative method to ignite the fine sample powder without it splattering during the burning process is to place the powder inside a gelatin capsule, which is called spiking (The sample is burned together with a known substance).

There are two piking methods:

Traditional Spiking:	Spike mass and Spike CV are needed
Easy Spiking:	Temperature rise of spike is needed

#### MEASURING THE SPIKE MATERIAL

The Spike material (Gelatin Capsule) must be measured ONCE and then either method can be used.

- Disable the 'MISFIRE LIMIT'=0
- Disable easy spiking by 'SET CAPSULE EN'=NO
- Tare the balance with the crucible
- Put ONE empty capsule into the crucible and weight it (automatic or manual entry)
- Prepare the bomb and run a normal sample
- Once done enter the result in 'SPIKE VALUE'
- Read the temperature rise by 'READ LAST N\_RISE'
- Enter the temperature rise in to 'CAPSULE RISE C'
- Enable the misfire limit 'MISFIRE LIMIT'=0.33

The above measures the spike CV (step f) and the spike rise (step h). Now either spiking method can be used!





## EASY SPIKE METHOD

This method assumes that all capsules have the same CV (Mass and Material). Then:

- Enable Easy spiking by 'SET CAPSULE EN'=YES
- Tare the balance with an empty crucible
- Fill the capsule with the powdery sample and weigh the crucible with the filled capsule
- Enter weight as sample mass either manual or automatically
- Prepare the bomb and run a standard determination
- The displayed result is the CV of the powder less the temperature rise of the capsule.

## TRADITIONAL SPIKE METHOD

- Disable Easy spiking by 'SET CAPSULE EN'=NO
- Tare the balance with crucible
- Weigh the capsule and enter mass in 'SPIKE MASS'. This must be done manually!
- Tare the balance
- Fill the capsule with the powdery sample and weigh the crucible with the filled capsule
- Enter weight as sample mass either manual or automatically
- Prepare the bomb and run a standard determination
- The displayed result is the CV of the powder less the SPIKE MASS x SPIKE VALUE

## RESULTS

### 1. Peat



RESULT	MASS	SID	DATE	BN	INIT DRIFT	FIRING TEMP	AMBIENT TEMP	RS	FINAL TIME
<b>20.919</b>	0.2239	96	10/05/2005	1	0.0010	22.2	22.7	OK	3.1
<b>21.385</b>	0.2214	97	10/05/2005	2	0.0005	23.2	23.2	OK	3.1
<b>20.741</b>	0.2425	98	10/05/2005	1	-0.0007	25.2	23.4	OK	3.1
<b>21.374</b>	0.2440	99	10/05/2005	2	0.0018	21.8	23.7	OK	3.1
<b>21.961</b>	0.2440	101	10/05/2005	2	0.0019	21.7	23.9	OK	3.1
<b>20.621</b>	0.2573	104	10/05/2005	1	0.0014	22.9	24.2	OK	3.1



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<b>19.829</b>	0.2659	105	10/05/2005	2	-0.0013	25.3	24.3	OK	3.1
<b>21.705</b>	0.2854	106	10/05/2005	2	0.0016	21.8	24.4	OK	3.1
<b>Average MJ/Kg = 21.067</b>									

## 2. Peat



RESULT	MASS	SID	DATE	BN	INIT DRIFT	FIRING TEMP	AMBIENT TEMP	RS	FINAL TIME
<b>20.533</b>	0.2595	84	10/05/2005	1	-0.0014	21.4	18.1	OK	3.1
<b>21.173</b>	0.2905	85	10/05/2005	1	-0.0002	20.9	18.3	OK	3.1
<b>20.480</b>	0.2911	86	10/05/2005	1	-0.0002	20.9	18.6	OK	3.1
<b>20.563</b>	0.3062	87	10/05/2005	1	-0.0001	21.2	18.8	OK	3.1
<b>21.032</b>	0.2680	92	10/05/2005	2	0.0014	19.7	20.6	OK	3.1
<b>20.528</b>	0.2798	93	10/05/2005	2	-0.0016	24.8	21.0	OK	3.1
<b>21.001</b>	0.2868	94	10/05/2005	2	0.0007	21.2	21.5	OK	3.1
<b>20.467</b>	0.2817	95	10/05/2005	2	0.0009	21.4	22.0	OK	3.1
<b>Average MJ/Kg = 20.722</b>									

## 3. P5 Wood Pfeifer Sample Whole / P4 ARA Fritzens Sample Crushed





Manufacturers of CAL2K/CAL3K Oxygen Bomb Calorimeters

	RESULT	MASS	SID	DATE	BN	INIT DRIFT	FIRING TEMP	AMBIENT TEMP	RS	FINAL TIME
<b>Calibration</b>	26.454	0.5079	433	28/07/2006	1	0.0015	18.8	20.5	OK	8.2
<b>1</b>	11.577	0.3157	434	28/07/2006	1	0.0000	18.7	20.9	OK	2.2
<b>2</b>	11.980	0.3158	435	28/07/2006	1	0.0006	19.0	21.7	OK	1.5
<b>3</b>	11.202	0.3065	436	28/07/2006	1	0.0005	19.7	22.1	OK	1.7
<b>4</b>	11.857	0.2923	437	28/07/2006	1	-0.0002	21.0	22.3	OK	1.5
<b>5</b>	11.743	0.2900	438	28/07/2006	1	-0.0012	23.8	22.6	OK	2.9
<b>6</b>	11.246	0.2893	440	28/07/2006	1	-0.0004	21.3	23.0	OK	2.4
<b>7</b>	11.358	0.2922	442	28/07/2006	1	0.0012	21.1	23.2	OK	1.1
<b>8</b>	11.514	0.2924	443	28/07/2006	1	0.0014	21.7	23.7	OK	1.0
<b>Control</b>	26.429	0.5105	444	28/07/2006	1	-0.0004	22.0	23.9	OK	2.3
<b>Average MJ/Kg = 11.559</b>										

## 4. Fresh Wood



	RESULT	MASS	SID	DATE	BN	INIT DRIFT	FIRING TEMP	AMBIENT TEMP	RS	FINAL TIME
<b>Calibration</b>	26.454	0.5149	423	28/07/2006	1	0.0004	12.5	14.2	OK	1.9
<b>1</b>	11.580	0.2810	424	28/07/2006	1	-0.0014	16.4	14.5	OK	3.4
<b>2</b>	11.503	0.2916	425	28/07/2006	1	-0.0004	13.9	14.9	OK	2.4
<b>3</b>	11.427	0.2750	426	28/07/2006	1	0.0019	13.1	15.3	OK	1.6
<b>4</b>	10.962	0.2820	427	28/07/2006	1	0.0018	14.3	15.8	OK	1.0
<b>5</b>	11.791	0.3003	428	28/07/2006	1	0.0017	14.8	16.6	OK	4.2
<b>6</b>	11.512	0.2801	429	28/07/2006	1	0.0019	13.0	17.9	OK	11.7
<b>7</b>	11.829	0.3024	430	28/07/2006	1	0.0003	16.3	18.2	OK	1.5
<b>8</b>	11.409	0.2922	431	28/07/2006	1	0.0016	16.8	18.7	OK	3.9
<b>Control</b>	26.426	0.5198	432	28/07/2006	1	0.0016	17.5	19.4	OK	3.2
<b>Average MJ/Kg = 11.502</b>										



## 5. Old Wood (April)



	RESULT	MASS	SID	DATE	BN	INIT DRIFT	FIRING TEMP	AMBIENT TEMP	RS	FINAL TIME
<b>Calibration</b>	26.454	0.4871	804	26/07/2006	1	0.0018	22.6	23.2	OK	2.4
<b>1</b>	18.482	0.4754	805	26/07/2006	1	-0.0004	21.7	23.2	OK	1.5
<b>2</b>	18.609	0.4372	806	26/07/2006	1	0.0015	22.3	23.4	OK	1.6
<b>3</b>	18.570	0.4312	807	26/07/2006	1	0.0000	21.8	23.5	OK	2.2
<b>4</b>	18.834	0.5117	808	26/07/2006	1	-0.0006	21.4	23.6	OK	2.3
<b>5</b>	18.674	0.4992	809	26/07/2006	1	-0.0001	22.1	23.8	OK	1.6
<b>6</b>	18.583	0.4209	810	27/07/2006	1	-0.0013	12.1	13.3	OK	3.5
<b>7</b>	18.712	0.4041	811	27/07/2006	1	0.0002	11.0	14.1	OK	1.9
<b>8</b>	18.209	0.4018	812	27/07/2006	1	0.0018	10.6	14.7	OK	6.5
<b>Control</b>	26.511	0.5186	813	27/07/2006	1	-0.0005	14.5	15.0	OK	1.6
<b>Average MJ/Kg = 18.584</b>										

## 6. Wood (Sawdust)



RESULT	MASS	SID	DATE	BN	INIT DRIFT	FIRING TEMP	AMBIENT TEMP	RS	FINAL TIME
<b>19.029</b>	0.1715	70	09/01/2009	2	-0.0004	25.71	25.21	OK	3.1
<b>18.916</b>	0.1757	72	09/01/2009	2	0.0005	22.95	25.43	OK	3.1
<b>19.346</b>	0.1506	73	09/01/2009	1	0.0010	21.44	25.45	OK	3.1
<b>19.037</b>	0.1558	74	09/01/2009	2	0.0017	21.84	25.51	OK	3.1





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<b>18.553</b>	0.1475	76	09/01/2009	1	0.0002	25.21	25.55	OK	3.1
<b>19.130</b>	0.1613	77	09/01/2009	1	0.0019	22.59	25.57	OK	3.1
<b>Average MJ/Kg = 19.002</b>									

## 7. Fresh Wood



	RESULT	MASS	SID	DATE	BN	INIT DRIFT	FIRING TEMP	AMBIENT TEMP	RS	FINAL TIME
<b>Calibration</b>	26.454	0.487	414	27/07/2006	1	0.0018	22.6	23.2	OK	2.4
<b>1</b>	11.873	0.301	415	27/07/2006	1	0.0017	22.6	23.7	OK	2.2
<b>2</b>	11.833	0.326	416	27/07/2006	1	0.0015	22.6	23.8	OK	6.4
<b>3</b>	11.918	0.322	417	27/07/2006	1	0.0009	22.6	24.1	OK	1.9
<b>4</b>	11.702	0.300	418	27/07/2006	1	0.0013	22.3	24.2	OK	1.8
<b>5</b>	12.358	0.319	419	27/07/2006	1	0.0019	22.2	24.3	OK	1.6
<b>6</b>	12.200	0.329	420	27/07/2006	1	0.0016	22.5	24.4	OK	5.6
<b>7</b>	12.437	0.336	421	27/07/2006	1	0.0012	22.7	24.5	OK	2.3
<b>Control</b>	26.440	0.427	422	27/07/2006	1	-0.0003	22.3	24.6	OK	1.0
<b>Average MJ/Kg = 12.046</b>										

## 8. Wood Pellets

RESULT	MASS	SID	DATE	BN	INIT DRIFT	FIRING TEMP	AMBIENT TEMP	RS	FINAL TIME
<b>18.459</b>	0.2232	52	09/05/2005	2	0.0007	20.2	20.3	OK	3.1
<b>18.550</b>	0.2960	53	09/05/2005	1	0.0005	21.0	20.6	OK	3.1
<b>19.010</b>	0.2050	54	09/05/2005	2	0.0010	20.5	20.9	OK	3.1
<b>19.005</b>	0.2065	55	09/05/2005	1	0.0010	20.9	21.2	OK	3.1
<b>19.066</b>	0.2207	57	09/05/2005	1	0.0013	21.1	21.7	OK	3.1
<b>18.577</b>	0.2961	60	09/05/2005	2	-0.0012	23.4	23.4	OK	3.1
<b>Average MJ/Kg = 18.778</b>									



## 9. Sample 9997 – Local Coal

**ASTM D1989-97 | ISO 1928:1995**

RESULT	MASS	SID	DATE	BN	INIT DRIFT	FIRING TEMP	AMBIENT TEMP	RS	FINAL TIME
31.055	0.5003	37	31/05/2005	1	-0.0010	17.9	16.9	OK	3.1
31.170	0.5000	38	31/05/2005	2	0.0011	17.3	17.2	OK	3.1
31.092	0.5000	39	31/05/2005	1	-0.0013	19.1	17.7	OK	3.1
31.199	0.5000	40	31/05/2005	2	-0.0002	17.5	18.3	OK	3.1
<b>Average MJ/Kg = 31.129</b>									

## 10. Sample 9674 – Local Coal

RESULT	MASS	SID	DATE	BN	INIT DRIFT	FIRING TEMP	AMBIENT TEMP	RS	FINAL TIME
28.488	0.5001	26	30/05/2005	2	0.0012	24.1	26.3	OK	3.1
28.425	0.5004	25	30/05/2005	1	0.0003	25.2	26.4	OK	3.1
28.465	0.5000	28	30/05/2005	2	0.0017	22.6	26.6	OK	3.1
28.618	0.5001	27	30/05/2005	1	0.0019	22.3	26.7	OK	3.1
<b>Average MJ/Kg = 28.499</b>									

## 11. Sample 1733 – Local Coal

RESULT	MASS	SID	DATE	BN	INIT DRIFT	FIRING TEMP	AMBIENT TEMP	RS	FINAL TIME
31.379	0.5000	29	30/05/2005	1	0.0017	22.8	26.8	OK	3.1
31.159	0.5002	30	30/05/2005	1	0.0013	22.9	26.8	OK	3.1
31.837	0.5003	31	30/05/2005	1	0.0018	22.3	26.8	OK	3.1
31.667	0.5002	32	30/05/2005	2	0.0018	20.8	26.6	OK	3.1
<b>Average MJ/Kg = 31.511</b>									

## 12. Woodchips (Dust)





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RESULT	MASS	SID	DATE	BN	INIT DRIFT	FIRING TEMP	AMBIENT TEMP	RS	FINAL TIME
19.675	0.2025	61	09/05/2005	1	0.0018	22.6	24.0	OK	3.1
19.371	0.1995	62	09/05/2005	2	0.0017	21.3	24.5	OK	3.1
19.584	0.1858	63	09/05/2005	1	0.0013	22.6	24.6	OK	3.1
19.690	0.2148	64	09/05/2005	2	0.0019	21.6	24.8	OK	3.1
19.268	0.2707	65	09/05/2005	1	0.0018	22.0	24.9	OK	3.1
19.761	0.1889	68	09/05/2005	2	0.0015	22.9	25.2	OK	3.1
<b>Average MJ/Kg = 19.558</b>									

## 13. P6 Waste



	RESULT	MASS	SID	DATE	BN	INIT DRIFT	FIRING TEMP	AMBIENT TEMP	RS	FINAL TIME
<b>Calibration</b>	26.454	0.4739	446	28/07/2006	1	0.0005	22.2	24.0	CA	1.9
<b>1</b>	7.057	0.8872	447	28/07/2006	1	0.0017	22.7	24.1	OK	6.2
<b>2</b>	6.980	0.8381	448	28/07/2006	1	0.0018	22.3	24.2	OK	1.5
<b>3</b>	6.917	0.8781	449	28/07/2006	1	0.0016	22.9	24.2	OK	5.6
<b>4</b>	6.894	0.8327	450	28/07/2006	1	-0.0003	22.2	24.3	OK	2.2
<b>5</b>	6.930	0.8533	451	28/07/2006	1	-0.0006	22.2	24.4	OK	2.4
<b>6</b>	7.006	0.8559	452	28/07/2006	1	0.0016	22.5	24.3	OK	4.3
<b>7</b>	6.908	0.7768	453	28/07/2006	1	0.006	22.4	24.4	OK	1.7
<b>Control</b>	26.440	0.4270	454	28/07/2006	1	-0.0003	22.3	24.5	OK	1.0
<b>Average MJ/Kg = 6.956</b>										

## 14. P4 ARA Sample Whole P4 / ARA Sample Crushed







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	RESULT	MASS	SID	DATE	BN	INIT DRIFT	FIRING TEMP	AMBIENT TEMP	RS	FINAL TIME
<b>Calibration</b>	26.454	0.5704	794	26/07/2006	1	0.0017	15.0	17.4	OK	9.9
<b>1</b>	10.205	0.5007	795	26/07/2006	1	-0.0004	17.1	18.1	OK	1.3
<b>2</b>	9.706	0.6151	796	26/07/2006	1	-0.0016	20.7	18.8	OK	4.0
<b>3</b>	9.833	0.6334	797	26/07/2006	1	-0.0007	18.8	19.6	OK	2.0
<b>4</b>	10.221	0.7210	798	26/07/2006	1	-0.0008	19.7	20.0	OK	2.2
<b>5</b>	10.124	0.6654	799	26/07/2006	1	-0.0005	19.2	20.5	OK	1.5
<b>6</b>	10.060	0.7008	800	26/07/2006	1	-0.0003	19.6	20.9	OK	2.2
<b>7</b>	9.796	0.5918	801	26/07/2006	1	0.0015	20.3	21.4	OK	3.9
<b>8</b>	10.239	0.6834	802	26/07/2006	1	0.0001	19.8	22.2	OK	1.5
<b>Control</b>	26.493	0.5114	803	26/07/2006	1	0.0014	21.3	22.5	OK	2.3
<b>Average MJ/Kg = 10.023</b>										

## CONCLUSION

The calorific value of almost any alternative energy source type can be determined. Calorific value analysis of this nature is one of many results required to determine the energy content of these substances.