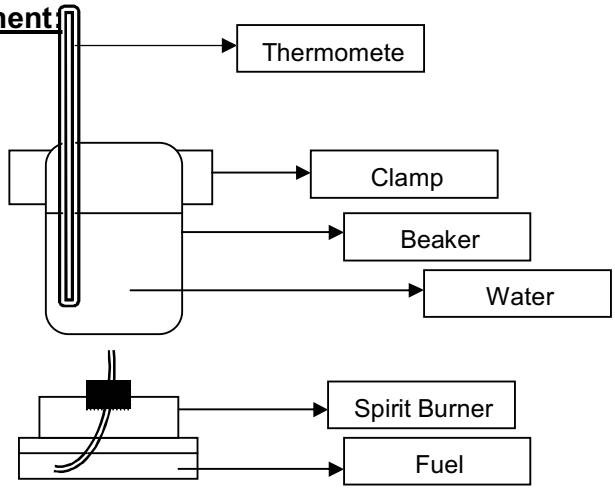
Alternative Fuels

Aim: I am a part of the research and development department for an oil fired power station selling electricity to a local provider. I am going to test out 5 spirit burners' (liquid fuels) and 3 different types of nuts (solid fuels) and t est to see which one is the most efficient and also produces a good amount of energy.

Due to the dramatic recent increases in oil prices and the possibility of a shortage in the near future the company are looking for a renewable alternative to oil to run the station.

Equipment:
5 x Spirit Burners (Hexane, Ethanol, Methanol, Propanol & Butanol)
3 x Nuts (Peanut, Cashew & Brazil)
250cm^3 Beakers
100cm^3 measuring cylinder
50cm^3 measuring cylinder
Electric Balance
Clamp Stand
0 - 110°c Thermometer
Bunsen burner
Mounted Needle

Diagram of Experiment:



For the solid fuels replace spirit burner with nut

Method:
1. Measure 100cm^3 of cold water into a beaker
2. Clamp the beaker over one of the spirit burner containing as shown in the diagram above.
3. Weigh the spirit balance and record the weight.
4. Measure and record the temperature of the water in the beaker.
5. Heat the water until it reaches +20°c of its original temperature.
6. Record the final temperature of the water.
7. Weigh the final weight of the spirit burner and record the mass.
8. Take note of the observations.
9. Repeat the steps 1 – 7 for each liquid fuels

For Solid Fuels (Continue from step 6 liquid fuels):

7. Place one of the three nuts onto a needle and weigh it with the needle. Record weigh
8. Place 100cm^3 of water in the 250cm^3 beaker and record the temperature.
9. Set the nut on fire using the Bunsen burner.
10. Use the burning nut to heat the water as before.
11. Blow out the nut once the water rises by +20°c.
12. Record the temperature of the water and then the weight of the nut (what's left) with the needle.
13. Repeat steps 6 – 12 for each nut.

Results:

Liquid Fuels:

Fuel	Initial Mass	Final Mass	Mass Used	Final Temp.	Initial Temp.	Temp. Change	Energy Released	Energy Per g of fuel	$\frac{\Delta H}{1000}$
Hexane	237.64	235.28	2.36	75.5	23.0	52.5	100x4.2xT=	22050	22.05
Ethanol	206.12	204.96	1.16	44.5	44.5	24.0	100x4.2xT=	10080	10.08
Methanol	207.36	206.37	0.99	42.5	21.0	21.5	100x4.2xT=	9030	9.03
Propanol	73.31	72.71	0.60	42.0	21.5	20.5	100x4.2xT=	8610	8.61
Butanol	237.83	236.84	0.99	45.5	23.0	22.5	100x4.2xT=	9450	9.45

Solid Fuels:

Fuel	Initial Mass	Final Mass	Mass Used	Final Temp.	Initial Temp.	Temp. Change	Energy Released	Energy Per g of fuel	$\frac{\Delta H}{1000}$
Peanut	5.57	4.92	0.65	22.0	33.5	11.5	100x4.2xT=	4830	4.83
Cashew Nut	6.42	5.29	1.13	22.0	46.5	24.5	100x4.2xT=	10290	10.29
Brazil Nut	7.13	6.67	0.46	22.5	35.0	12.5	100x4.2xT=	5250	5.25

Calculations:

Liquid Fuels (Spirit Burners):

Hexane:

I.M: 237.64 F.T: 75.5 100 x 4.2 x 52.5 = 22050 ÷ 1000 = **22.05**
F.M: 235.28 I.T: 23.0
M.U: 2.36 ∆.T: 52.5

Ethanol:

I.M: 206.12 F.T: 44.5 100 x 4.2 x 24.0 = 10080 ÷ 1000 = **10.08**
F.M: 204.96 I.T: 20.5
M.U: 1.16 ∆.T: 24.0

Methanol:

I.M: 207.36 F.T:42.5 100 x 4.2 x 21.5 = 9030 ÷ 1000 = **9.03**
F.M: 206.37 I.T: 21.0

M.U: 0.99 ∆.T: 21.5

Propanol:

I.M: 73.31	F.T:42.0	100 x 4.2 x 20.5 = 8610 ÷ 1000 = **8.61**
F.M: 72.71	I.T: 21.5	
M.U: 0.60	∆.T: 20.5	

Butanol:

I.M: 207.36	F.T:42.5	100 x 4.2 x 21.5 = 9030 ÷ 1000 = **9.03**
F.M: 206.37	I.T: 21.0	
M.U: 0.99	∆.T: 21.5	

Solid Fuels (Nuts):

Peanut:

I.M: 5.57	F.T: 33.5	100 x 4.2 x 11.5 = 4830 ÷ 1000 = **4.83**
F.M: 4.92	I.T: 22.0	
M: 0.65	∆.T: 11.5	

Cashew:

I.M: 6.42	F.T: 46.5	100 x 4.2 x 24.5 = 10290 ÷ 1000 = **10.29**
F.M: 5.29	I.T: 22.0	
M: 1.13	∆.T: 24.5	

Brazil:

I.M: 7.13	F.T: 35.0	100 x 4.2 x 12.5 = 5250 ÷ 1000 = **5.25**
F.M: 6.67	I.T: 22.5	
M: 0.46	∆.T: 12.5	

Cost of Fuels

Hexane – 22.050KJg – 5p
Ethanol – 10.080KJg – 0.4p
Methanol – 9.030KJg – 0.1p
Propanol – 8.610 KJg – 0.1p
Butanol – 9.450KJg – 38p
Peanut – 4.620KJg – 15p
Cashew Nut – 10.290KJg – 8p
Brazil nut – 5.250KJg – 6.8p

Cost of fuels per/g

Hexane –22.050 x 5p = 110.25
Ethanol – 10.080 x 0.4 = 4.032
Methanol – 9.030KJg x 0.1p = 0.903
Propanol – 8.610 KJg x 0.1p = 826.56
Butanol – 9.450KJg x 38p = 359.10
Peanut – 4.620KJg x 15p = 69.30
Cashew Nut – 10.290KJg x 8p = 82.32
Brazil nut – 5.250KJg x 6.8p = 35.70

Observations:

Fuel	Observations	Combustion
Hexane	Carbon Solid. Strong Black Fumes. Luminous Flame.	**Incomplete**
Ethanol	No Carbon Solid. No Black Fumes. Yellow Flame (almost colourless).	**Incomplete**
Methanol	No Carbon Solid. Black Fumes. Luminous Flame.	**Incomplete**
Propanol	No Carbon solid. No Black Fume. Luminous Flame Pale Yellow.	**Incomplete**
Butanol	Carbon Solid. Weak Black Fumes. Luminous Yellow Flame.	**Incomplete**
Peanut	Carbon Solid. Black Fumes. Luminous Yellow Flame.	**Incomplete**
Cashew	Carbon Solid. Black Fumes. Luminous Yellow flame.	**Incomplete**
Brazil	Carbon Solid. Black Fumes. Luminous Yellow Flame.	**Incomplete**

Analysis and Conclusion

I have collected data on all the liquid and solid fuels and have come to the conclusion that ethanol is the best fuel out of the liquids as it produces a lot of energy; the energy Ethanol releases burns with an almost colourless flame without any black fumes, because it burns so well it releases more energy. It also has a lower risk of health and safety hazards. It also produces less carbon solid, however is still incomplete. Ethanol has it's pros and cons; Ethanol produces little pollution and produces an adequate amount of energy, Ethanol comes from sugar cane; it is produced through a process of fermentation ($C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$), this makes it a renewable fuel, however can be expansive at times but cheaper at other times, depending on the quality of the ethanol; we also need plenty of land to produce tons of ethanol this means cutting down a huge amount of trees, leaving no land to grow food, it would also take a huge amount of money to do so, compared to Hexane; Hexane produces a lot of pollution, however, also produces a great amount of energy as well. Hexane is also a fossil fuel which is non-renewable. Out of the solid fuels the cashew produced a lot of energy, however produced a lot of black fumes, carbon solid. It also had a luminous (yellow) flame. The Peanut produced the smallest amount of energy and also produced a large amount of black fumes as well as carbon solid and had a luminous (yellow) flame. Peanuts are not a very good source of fuel because they leave a lot of residue behind after being burned and also need a lot of land to be produced. However we could also extract the oil from the peanuts which then can be used to produce diesel oil. Overall ethanol would be the best fuel to use rather than hexane as it produces an adequate amount of energy and produces little pollution. Below is a table and bar chart which shows the liquid and solid fuels in order of energy produced going from smallest amount to largest amount.

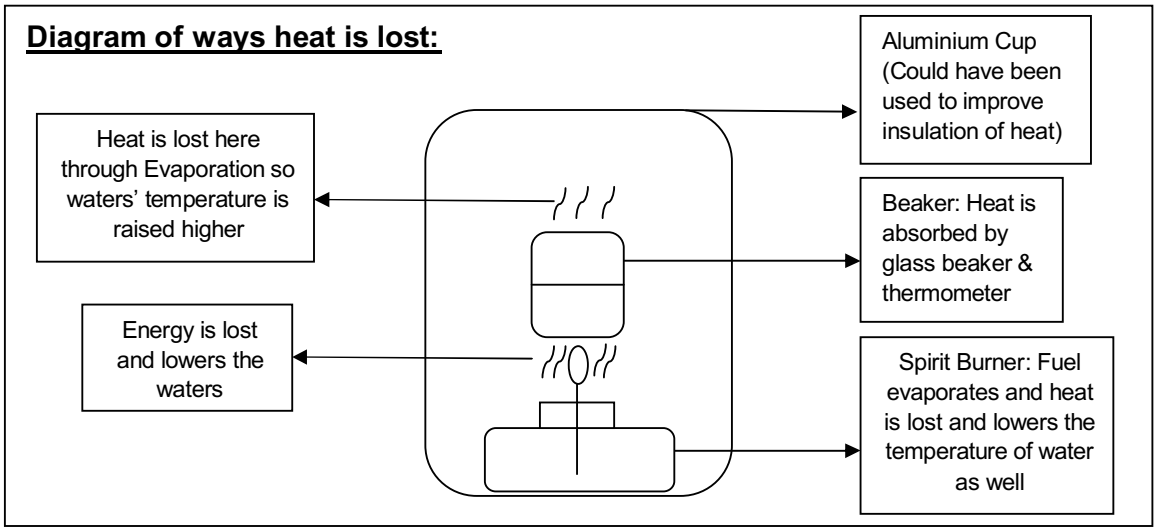
Fuel	Combustion	Energy Produced (KJ)
Peanut	Incomplete	**4.83**
Brazil	Incomplete	**5.25**
Propanol	Incomplete	**8.61**
Butanol	Incomplete	**9.03**
Methanol	Incomplete	**9.03**
Ethanol	Incomplete	**10.08**
Cashew	Incomplete	**10.29**
Hexane	Incomplete	**22.05**

The Peanut produced the **smallest** amount of energy (**4.83 KJ**) overall.
The Hexane produced the **largest** amount of energy (**22.05 KJ**) overall.
The Peanut produced the **smallest** amount of energy (**4.83 KJ**) out of the solid fuels.
The Propanol produced the **smallest** amount of energy (**8.61 KJ**) out of the liquids fuels.
The Cashew produced the **largest** amount of energy (**10.29 KJ**) out of the solid fuels.
The Hexane produced the **largest** amount of energy (**22.05 KJ**) out of the liquid fuels.

Evaluation

Procedural Errors

Heat loss is one of the biggest procedural errors in this experiment. Heat is lost through a number of ways. Below is a diagram of ways heat is lost.



To stop such procedural errors we could use a good conductor which can control heat loss efficiently such as an aluminium cup; it insulates the heat and also doe s not absorb the energy. We could also use a calorimeter to accurately find out how much heat has been lost; a calorimeter is an instrument that measures heat. We could use a calorimeter to measure the heat loss more accurately and efficiently. There are a many different ways of losing heat such as the ones above. Incomplete combustions mean that a certain amount of energy loss was produced.

Measurement Errors

Name of Equipment	Tolerance	Smallest measurement measured with equipment
Balance	± 0.05g	0.05 ÷ 5.57 x 100 = **0.89**
Thermometer	± 0.5°c	0.5 ÷ 20.5 x 100 = **2.43**
Measuring Cylinder	± 1cm^3	1 ÷ 100 x 100 = **1.00**

No measurement is 100% accurate, all measuring equipment will have some sort of measurement error; measurement errors happen due to flaw(s) in the measuring instrument. The worst measurement error is the measurement with the largest % uncertainty this means it is also the least accurate. The worst measurement error is the thermometer as it has the largest % uncertainty. We can improve this by taking and noting down larger measurements, e.g. the smallest temperature is 25°c, 0.5 ÷ 25 x 100 = 2.00. So the larger the measurement the more the percentage uncertainty will decrease.

References:

http://autos.yahoo.com/green_center-article_46/: I used this link to get information about the pro ands cons of ethanol. This link was very useful.

http://www.wisegeek.com/what-is-hexane.htm: I used this link to get information about hexane. This link was very helpful in getting information about this fuel.

http://en.wikipedia.org/wiki/Calorimeter: I used this link to get information to find out what a calorimeter is and what its uses are. This link was very informational and helpful.