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Toxic Alcohols in Spirit Burners to test Fuel Efficiency

Posted by Anonymous on Fri, 2016-06-10 12:36

Toxic Alcohols in Spirit Burners to test Fuel Efficiency: We have a year 10 chemistry investigation in which students are provided with six alcohols in spirit burners. Their task is to investigate the usefulness of different alcohols as fuels. Each class is provided with four sets of the spirit burners containing each of the six fuels. The fuels concerned are:

Methanol, HEXAN-1-OL, Ethanol, Propanol, butanol, and pentanol. I am concerned about the safety of using Methanol and Hexanol as they are both toxic. Is there an appropriate substitute or is it safe to proceed with the above? I have recommended students follow basic safety such as PPE, spill kit on hand, limit the quantity of alcohol in each burner and number of burners per class (I am concerned about the risk of explosions), good ventilation, etc. Can you please suggest any additional safety procedures to ensure this investigation is carried out as safely as possible?

Voting:



No votes yet

Year Level:

10

Laboratory Technicians:

Laboratory Technicians

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Toxic Alcohols in Spirit Burners to test Fuel Efficiency

Submitted by sat on 21 June 2016

In brief:

Under controlled circumstances this practical activity is safe to conduct. However the quantity of spirit burners: four sets of six alcohols per class equals 24 spirit burners, which is a considerably high number and would be associated with risks such as inadequate ventilation for a class with 25 students. Oxygen from the room is used up during the combustion reactions and there is an increase in the level of carbon dioxide gas, which can lead to headache, dizziness and fatigue. Science ASSIST strongly recommends that this experiment be conducted as a teacher demonstration or by dividing the class into six groups, with each group investigating one alcohol under an operating fume cupboard or in a well-ventilated room.

Fuel efficiency can be investigated by determining the heat of combustion of fuels such as alcohols using spirit burners. When alcohols are burnt in oxygen, a large amount of heat is released and the reaction is said to be exothermic.

All the alcohols mentioned are safe to use in the spirit burner and Science ASSIST recommends the following:

- carry out a site specific risk assessment see the Science ASSIST [Risk Assessment Template](#)
- refer to Safety Data Sheets (SDSs) of all the alcohols used in the experiment
- wear suitable PPE such as laboratory coat, gloves, safety glasses and closed in shoes.

Safety notes:

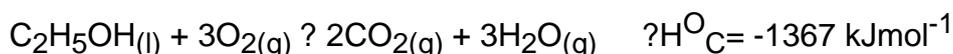
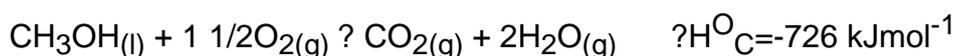
- for safety instructions for the use of spirit burners see a previous question on [Fuels](#). In particular, note the requirement to keep the burners filled to more than half full.
- Some additional features to consider regarding the selection of high quality spirit burners:
 - **Quality of glass:** look for robust uniform thickness, not badly blown items with obvious flaws in the glass
 - **Shape:** ie squat form that is not easily toppled. Many are too narrow in the base.
 - **Quality of the metal screw on wick holder:** this should form a good seal with both the glass and the wick so that in the event of toppling, the spirit does not rapidly leak out and catch fire. Many options fail badly here.
 - **A tight fitting extinguishing cap:** that fits over the wick and extinguishes the flame.
- methanol, ethanol, propan-1-ol, butan-1-ol, pentan-1-ol and hexan-1-ol are all flammable liquids with a range of flash points and any experiment involving combustion is potentially hazardous. Keep all the alcohols away from ignition sources. The alcohol vapours can cause dizziness and drowsiness.
- methanol is highly toxic if swallowed and can cause liver damage and blindness. Propan-1-ol, butan-1-ol and pentan-1-ol are harmful if swallowed and hexan-1-ol is toxic. They can all cause irritation and most can cause serious eye damage. They all have been assigned various categories of acute toxicity, so should all be handled appropriately and ensure that all people handling them observe good laboratory hygiene and wash their hands before leaving the laboratory.

- Methanol and ethanol burn with a nearly colourless flame that is difficult to see in strong light. Ensure that the flame is extinguished before topping up the spirit burner.

Additional Information

Methanol, ethanol, propan-1-ol, butan-1-ol, pentan-1-ol and hexan-1-ol are all aliphatic alcohols with the general formula $C_nH_{2n+1}OH$ where n is greater than or equal to 1. The functional group is the hydroxyl group ($-OH$). Alcohols are good fuels as they burn in oxygen to give a large amount of heat. The standard enthalpy change of combustion of a compound is the heat change that occurs when 1 mole of a substance is completely burned in oxygen under standard conditions (at 1 atmosphere pressure and at $25^\circ C$).

The equations for the combustion of methanol and ethanol are:



A known mass of alcohol is burned in a spirit burner and the heat released is transferred to a copper can containing a known volume of water. From the resulting temperature rise, the enthalpy of combustion of ethanol can be calculated. As the number of carbon atoms increases the enthalpy change of combustion becomes more negative.

$$\Delta H_C^\circ = \text{Mass} \times \text{Specific heat capacity} \times \text{Rise in temperature}$$

$$= mc\Delta T$$

During this experiment the volume of water used and the distance between the wick of the spirit burner and the bottom of the calorimeter should be kept constant.

References

'Butan-1-ol', Safety Data Sheet, Chem-Supply website,
<https://www.chemsupply.com.au/documents/BA0121CH1H.pdf> (June 2014)

'Butan-1-ol', Please visit the Sigma-Aldrich website for their latest Safety Data Sheet:
<https://www.sigmaaldrich.com/australia.html>

'Hexan-1-ol', Safety Data Sheet, Chem-Supply website,
<https://www.chemsupply.com.au/documents/HL0101CHIM.pdf> (February 2016)

'Hexan-1-ol', Please visit the Sigma-Aldrich website for their latest Safety Data Sheet:
<https://www.sigmaaldrich.com/australia.html>

'Methanol', Safety Data Sheet, Chem-Supply website,
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<https://www.chemsupply.com.au/documents/AR1161M.pdf> (April 2011)

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