Spontaneous combustion

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Spontaneous combustion or **spontaneous ignition** is a type of combustion which occurs by self-heating (increase in temperature due to exothermic internal reactions), followed by thermal runaway (self heating which rapidly accelerates to high temperatures) and finally, ignition.[1]

A large compost pile can spontaneously combust if not properly managed

Contents

Cause and ignition

1. A substance with a relatively low ignition temperature (hay, straw, peat, etc.) begins to release heat. This may occur in several ways, either by oxidation in the presence of moisture and air, or bacterial fermentation, which generates heat.
2. The heat is unable to escape (hay, straw, peat, etc. are good thermal insulators), and the temperature of the material rises.
3. The temperature of the material rises above its ignition point (even though much of the bacteria are destroyed by ignition temperatures).
4. Combustion begins if sufficient oxidizer, such as oxygen, and fuel are present to maintain the reaction into thermal run-away.

Affected materials

- Haypiles[2] and compost piles[3] may self-ignite because of heat produced by bacterial fermentation.
- Linseed oil in a partially confined space (such as a pile of oil-soaked rags left out in an uncovered container, especially if rags afterward used with anti-moisture solvent to clean up the oil) can oxidize leading to a buildup of heat and thus ignition.[4][5]

- Coal can ignite spontaneously when exposed to oxygen which causes it to react and heat up when there is insufficient ventilation for cooling.[6]
- Pyrite oxidation is often the cause of coal spontaneous ignition in old mine tailings.
- Pistachio nuts are highly flammable when stored in large quantities, and are prone to self-heating and spontaneous combustion.[7]
- Large manure piles can spontaneously combust during conditions of extreme heat.
- Cotton and linen. When these materials come into contact with polyunsaturated vegetable oils (linseed, massage oils), bacteria slowly decompose the materials, producing heat. If these materials are stored in a way so the heat cannot escape, the heat buildup increases the rate of decomposition and thus the rate of heat buildup increases. Once ignition temperature is reached, combustion occurs with oxidizers present (oxygen).

There have been unconfirmed anecdotal reports of people spontaneously combusting. This alleged phenomenon is not considered true spontaneous combustion, as supposed cases have been largely attributed to the wick effect, whereby an external source of fire ignites nearby flammable materials and human fat or other sources.[8]

Hay

Hay is one of the more studied materials in spontaneous combustion. As hay varies by the type of grass and location grown utilized in its preparation, it is very hard to establish a unified theory of what occurs in hay self-heating. It is anticipated that dangerous heating will occur in hay that contains more than 25% moisture. The largest number of fires occurs within 2 to 6 weeks of storage, with the majority occurring at 4 to 5 weeks.

The process may begin with microbiological activity (bacteria or mold), but at some point, the process has to become chemical. Microbiological activity will also limit the amount of oxygen available in the hay. Moisture appears to be quite important, no matter what process. At 100 °C, wet hay absorbed twice the amount of oxygen of dry hay. There has been conjecture that the complex carbohydrates present in hay break down to simpler sugars, which are more readily oxidized.[9]

Charcoal

Charcoal, when freshly prepared, can self-heat and catch fire. This is separate from hot spots which may have developed from the preparation of charcoal. Charcoal that has been exposed to air for a period of eight days is not considered to be hazardous. There are many factors involved, two being the type of wood and the temperature at which the charcoal was prepared.[10]

Coal

Self-heating in coal has been extensively studied. The tendency to self-heat decreases with increasing rank of the coal. Lignite coals are more active than bituminous coals, which are more active than anthracite coals. Freshly mined coal consumes oxygen more rapidly than weathered coal, and freshly mined coal self-heats to a greater extent than weathered coal. The presence of water vapor may also be important, as the rate of heat generation accompanying the absorption of water in dry coal from saturated air can be an order of magnitude or more than the same amount of dry air.[11]

Oil seeds and oil-seed products

Oil seeds and residue from oil extraction will self-heat if too moist. Typically, storage at 9–14% moisture is satisfactory, but limits are established for each individual variety of oil seed. In the presence of excess moisture just under levels required for germinating seed, the activity of mold fungi to generate heat is a likely candidate. This has been established for flax and sunflower seeds, as well as soy beans. Many of the oil seeds generate oils that are self-heating. Palm kernels, rapeseed, and cotton seed have also been studied.[12] Rags soaked in linseed oil can spontaneously ignite if improperly stored or discarded.

References

Notes

1. Babrauskas, p.369
2. "Spontaneous Combustion in Hay Stacks" (PDF). Retrieved 2008-05-09.
3. "Spontaneous combustion in compost piles". Retrieved 2009-01-12.
4. "Fire - Reflectors". Wildwood Survival. Retrieved 2010-03-16.
5. Babrauskas, pp.886-890
6. "The Fire Below: Spontaneous Combustion In Coal". *DOE/EH-0320, Issue No. 93-4*. US Department of Energy. May 1993. Archived from the original on May 27, 2010. Retrieved 22 May 2012.
7. "Pistachio Nuts". Retrieved 2007-11-05.
8. Nickell, Joe. "Spontaneous Human Nonsense" (http://www.csicop.org/sb/show/spontaneous_human_nonsense/), *Skeptical Inquirer*, Volume 6.4 (December 1966)
9. Bowes, pp.376-390
10. Bowes, pp.315-330
11. Bowes, pp.330-333
12. Bowes, pp.396-406

Bibliography

- Babrauskas, Vytenis (2003). *Ignition Handbook*. Boston: Society of Fire Protection Engineers. ISBN 978-0-9728111-3-2.
- Bowes, P. C. (1984) *Self-heating: Evaluating and Controlling the Hazards*, London: Department of the Environment, Building Research Establishment. ISBN 0-11-671364-X

External links

- Article on the spontaneous combustion of coal (http://www.saftek.net/worksafe/bull94.txt)
- Spontaneous combustion demonstration (http://www.wildwoodsurvival.com/survival/fire/spontaneouscombustion/rbjul05/index.html)

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