Linseed Oil & Spontaneous Combustion

The following article, taken from the SINTEF website, is worth reading.

Self-ignition tendency of some wood coating oil products

According to Directorate for Civil Protection and Emergency Planning (DSB) wood coating oil products (wood oils) are causing several fires in Norway each year. DSB asked SINTEF NBL to investigate the liability of self-heating and self-ignition from use of wood oil.

The investigation includes the following aspects of the problem:
A survey of the fire hazard of different wood oil products with respect to their tendency to cause self-heating and self-ignition.
A survey of which wood oil products available on the Norwegian market that may cause self-heating and possible ignition of oil soaked material (rags, brushes etc.).
Evaluate the possibilities of self-ignition in connection with different application clothing (rag, brushes etc.).
Recommend actions for safe use, storage, disposal or destruction of equipment in connection with the use of wood oils.

MAIN CONCLUSIONS AND RECOMMENDATIONS

The conclusions from the investigation may be summerized as follows:

Wood coating oil products (wood oils) containing drying oils may along with other commonly used products cause self-ignition by *oxidation* of the product. Oxidation is the main chemical process causing self-ignition.
Porous rags soaked in wood oils will only cause self-ignition and fire under special circumstances.
This fact is also confirmed by the rather low number of registered fires each year due to self-ignition by chemical processes (approximately 10 fires in residential buildings and 10 fires in other buildings), compared to the very high consumption of products that are capable of causing this specific type of self-ignition in addition to wood oil products.

A total of 33 experiments were carried out in order to find the self-heating and self-ignition tendency of different wood oils. Eight different wood oils, including boiled linseed oil, one penetration oil and one anti-rust oil, as well as two types of rags (i.e. cotton rags and waste wool or 'Twist' rags) was tested in two different experimental setups.
Real spontaneous combustion was achieved in only 5 of 33 tests. Most of the tests resulted in self-heating and a sub-critical temperature development, i.e. the temperature increased to a maximum temperature, which was not high enough to cause self-ignition, followed by a temperature decrease down to the ambient temperature.

The main reasons for this fact might be as follows:
a) A too small size of the experimental setup (causing high transmission heat loss)
b) A too high packing density of the rags (causing low ventilation (oxygen supply) and a corresponding low heat generation rates).

The following main requirements must to be fulfilled for self-ignition of oil soaked rags to take place, provided that the oil is prone to cause self-ignition:

Insulation: The rags soaked with wood oil have to be located somewhere where heat loss by transmission is minimized. The rags have to be stored for example in a waste container of a certain minimum size filled with other waste with good insulation properties. However, under optimum ventilation conditions of the rags and elevated temperatures on hot summer days, the necessary size of the container to cause self-ignition may be strongly reduced.

Ambient temperature: The spontaneous heating is favoured by high ambient temperature. By increasing the ambient temperature from 24 °C to 44 °C in tests with 'Faxe' wooden floor oil a sub-critical temperature development was changed to a critical temperature development, which caused almost complete spontaneous combustion of the 3 x 1 m² rags.

Minimum ambient temperature: Based on the experiments carried out, it can be concluded that it is unlikely that ordinary wood oils in ordinary waste containers will self-ignite at temperatures below 10-15 °C.

Ventilation: If the ventilation rate is too high, the heat will dissipate. If the ventilation rate is too restricted, the oxidation and the heat generation will be too low. The ventilation rate is probably the single most critical factor for self-ignition. A too high packing density of the rags will restrict the ventilation of the rags. Restricted ventilation of the rags was probably the case more often than the opposite during the tests carried out. Not even 0.3 litre of the highly pyrophoric boiled linseed oil absorbed in a 3 m² cotton rag caused self-ignition at high packing density.

Amount of wood oil: It seems as if the needed amounts of boiled linseed oil and cotton rags to cause critical temperatures and self-ignition under normal indoor conditions have to be 0.075-0.1 litre evenly distributed in a 1 m² cotton fabric. For the wood oils the needed quantity was 0.3 litres. However, more optimal ventilation conditions, increased ambient temperature and increased size of the waste container may reduce the needed amount of wood oil.

Oil loading: If the oil loading (in l/m²) is larger than the optimum content, the temperature increase of the oil is restrained due to too much heat is used to increase the temperature of the excess oil. The optimum oil loading area densities seemed to be in the range 0.1-0.15 l/m².

Waste wool or *'Twist' rags* seemed to be more prone to self-ignition than *cotton rags*. This is indisputable due to the fact that the twist rags have a larger surface area than the cotton rags.
Even though *sub-critical temperature development* was achieved in the far most of the 33 tests (primarily due to the small insulation thickness and too high packing density of the rags), the tendency to cause self-ignition may also be deduced from these tests. The most hazardous oils are those oils with the most rapid and highest temperature increase of the oils with sub-critical temperature development, provided the experimental conditions were equal.

The oils tested can be divided into three classes with respect to fire hazard:

Class I - Extremely Hazardous oils:
- *Linseed oil.*

Class II - Hazardous Oils (ranked, i.e. the oil listed first is most hazardous):
1. *Faxe* wood floor oil,
2. *Owatrol* anti-rust oil,
3. *Trip trap* wood floor oil and
4. *Butinox* wood oil

Class III - Non-hazardous or less hazardous oils:
1. *Junker Rustic* oil
2. Wood oil from *'Norsk Trepleie'*
3. *Faxe* oil care

By examination of the comments made by the police investigators in statistics from DSB with respect to the cause of fire, *Faxe wood oil* and *linseed oil* were mentioned in 27 and 26 of 268 cases of ignition by chemical processes, while the other wood oils were hardly mentioned.
Among the five wood oils that were characterized as hazardous, it was only *Trip trap wood floor oil* that did not have any safety marking or warning tag against the risk of self-ignition and fire.

Recommendations for safe handling and disposal of equipment for wood oil.

The following procedures are recommended:
Put application equipment in a container filled with water
Burn application equipment in a fire place or oven
Store the rags in an *air tight metal container* intended for fire hazardous waste in case of short time storage or transport.

Final Conclusion

On the basis of this experimental series it can be concluded that wood oil products do represent a risk of self-ignition and fire, even though self-ignition occurs only under certain circumstances. Due to the fact that these circumstances may occur rather frequently, especially indoors as well as outdoors in the summer time, we recommend a clearly visible warning label on such products. That is, with respect to the fire hazard and how to treat application equipment after use.

Defects in the Statistics

Processes causing spontaneous ignition

Three processes can cause spontaneous combustion. These are:
physical
biological
chemical

Erroneous determination of cause of fire

Many fires in the statistical data from DSB (which are based on reports from investigation by the police) are obviously due to other causes than spontaneous combustion. The heat necessary to cause a self-ignition must come from the ignited matrial itself, not externally supplied heat.

Examples of fires erronously categorized as self-ignition fires, were actually caused by:
sawing (friction)
sparks
hot ash with glows
combustible liquid on a hot surface (e.g. gasoline or diesel leakage on the exhaust manifold in a car or a bus)
oil in a deep-fryer or fat in a hot frying pan
ignituion of pyrophoric wood due to heat transfer from different fireplaces or heaters
burning-glass effect
textiles or paper in contact with a luminous lamp
dust in a television set
chimney fires

Common for all these cases are that the necessary heat to cause the ignition are supplied externally to the ignited material.

This indicates poor knowledge of spontane ignition. On the other hand, it is expected that several fires caused by spontane combustion never are revealed as such due to the same reason.