GOVERNMENT OF WESTERN AUSTRALIA

FESA
Fire & Emergency Services Authority of Western Australia

HAZMAT Articles

Drying Oils & Spontaneous Ignition

Introduction

Drying oils are used as ingredients in certain rust proofing materials and some varnishes. Given the right conditions these materials can cause fire through spontaneous ignition.

What are drying oils?

There are three types of oils:

- Drying
- Semidrying
- Non-drying

When drying oils are applied in a thin film as in paint, they 'dry' to form a durable, elastic coating. The term drying is a misnomer however, since a chemical reaction takes place in which the oil becomes solid.

Drying oils are derived from plants and fish. Plant sources include linseed, dehydrated castor, octicica and walnut oils, while sources from fish include anchovy, pilchard, sardine and cod liver oil.

Linseed oil is the prime drying oil and has been used for hundreds of years as the basic ingredient in paints and varnishes. It has largely been replaced by safer modern drying agents, but is still used in printing inks, some varnishes, and to manufacture linoleum or 'lino' for floor coverings. Linoleum is prepared by spreading linseed oil over hessian together with cork and rosin, and allowing it to harden in air.

Semidrying oils such as sesame, corn, safflower, sunflower and soya bean, react in the same way only they do not become solid, rather, they form sticky, tacky films. They cannot be used as a base for coating materials.

Non-drying oils such as motor oil, olive oil and animal fat, on the other hand, do not react and always remain as oils.

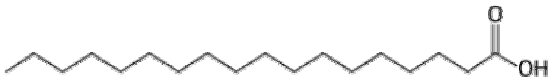
Why are drying oils different?

They are different because:

- Drying oils are polyunsaturated
- Semidrying oils are monounsaturated
- Non-drying oils are saturated.

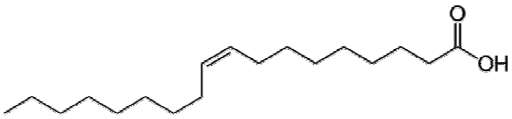
These terms have a definite chemical meaning, as well as the more familiar associations with dietary intake, cholesterol and good health.

In chemical terms, to be saturated means no more hydrogen atoms can be added to an oil molecule.



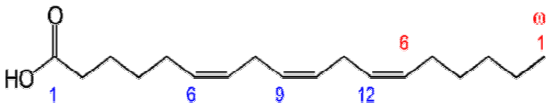
Stearic acid (a saturated oil)

To be monounsaturated means there are two hydrogen atoms missing, which could be added by chemical reaction.



Oleic acid (a monounsaturated oil)

To be polyunsaturated means even more hydrogen atoms are missing, but in multiples of two (i.e. 4, 6, 8, 10 or even 12 can be missing).



Linolenic acid (polyunsaturated Linseed oil)

Oil molecules prefer to be saturated, where they are chemically stable. Unsaturated oils, on the other hand, become increasingly reactive as they move from being monounsaturated, to being increasingly polyunsaturated.

They would all like to become saturated, and to satisfy this demand they will react with oxygen on exposure to air.

However in reacting with oxygen, they form a peroxide which is even more reactive, and this peroxide will in turn immediately react with a neighbouring oil molecule. This process continues so that all oil molecules will eventually become cross-linked to form a solid polymeric material.

This polymerisation reaction also releases considerable heat, and while it does not constitute a problem if has been used as part of a coating material in a varnish or paint, there is enough heat released to cause ignition if the heat is confined such as being locked up in a pile of contaminated rags or newspapers being left behind after a paint job.

Spontaneous heating

Spontaneous heating occurs when heat build-up exceeds heat losses. If rags are contaminated with a drying oil, then the oil will coat the many fibres to form an oil layer with an extremely large surface area. The larger the surface area the greater the potential for heat generation as the reaction with oxygen proceeds.

While oxygen is able to diffuse through the folds and pores in the rags, the rag acts as an insulator and will not let the heat out nearly as quickly. This effect is magnified if the rags are clumped together and even more so if the oil is present in saturation amounts over most or parts of the rag, since the reaction will take place preferentially on the outside first to form an insulating skin.

A runaway reaction

At the chemical level, it is known that reaction rates double for every 10 degrees C rise in temperature. And so, if the temperature rises from 15 to 25 degrees C, the reaction rate between oil and oxygen will increase by a factor of 2. And so:

at 35 degrees C it's 4 times faster

at 45 degrees C it's 8 times

at 55 degrees C it's 16 times

at 65 degrees C it's 32 times

at 75 degrees C it's …

This process will continue until one of two things will happen: either all the oil is consumed, the reaction halts, and the whole mass starts to cool down, or thermal runaway occurs, in which the reaction speed and associated temperature rise "runs-away" to a point where ignition will occur at about 200 to 240 degrees C.

Runaway reactions are dependant on several factors including the type and amount of oil, the degree of insulation and the initial temperature. For this reason, it is not possible to predict whether the heat rise from a given pile of rags will develop into a runaway reaction, or the minimum amounts of each component needed for a runaway reaction to occur. However it can happen and it only needs a few hours.

Problems in laundries

Most vegetable oils, cooking oils and margarines used at home are monounsaturated and are therefore semidrying and slightly reactive towards oxygen. Rags contaminated with such oils are not liable to ignite spontaneously, however there have been cases of hot laundry catching fire.

One washing machine manufacturer conducted tests and found that 30% of oil was still retained in cloths used to wipe kitchen tables after washing. They further found that after being put through a tumble drier, and then left in a hot pile, ignition could occur within 2-3 hours. While thermal runaway was not possible at room temperature, it was possible after being through a tumble drier.

Conclusion

Fires have been caused in Western Australia due to

- incorrect disposal of rags contaminated with rust proofing products containing fish oil,
- from a laundry after tumble drying, and
- from contaminated oily rags stuffed into an ice cream container in a laundry cupboard in a hot summer.

It was on the 21st floor, of a 38 storey building in Philadelphia, on the 23rd February, 1991, when some rags were left behind after linseed oil was used to restore and clean some wood panelling. It caught fire which destroyed 9 floors and 3 fire fighters lost their lives. Something as simple as that became the cause of so much grief and loss.

If rags or paper become contaminated when using varnish or a rust proofing agent, check the label or the Material Safety Data Sheet, to see if it contains an ingredient with a fire potential, and dispose of rags in a manner recommended by the manufacturer. Some of the instructions may include leaving them immersed in water, spreading them out in the open to dry, or seal in a metal container.

As for drying laundry, ensure it is put through the proper cool-down cycle. If this is not possible, dig a doughnut hole in the middle to allow heat to escape and place in open-sided baskets.

Other rags or paper used in the home to do such things as polish furniture or to drain food cooked in vegetable oil should be placed in well ventilated containers and kept away from warm places.

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