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Self-heating tendency evaluation of some vegetable oils by Iodine value

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Abstract: Vegetable oils are oils derived from plants, such as palm oil, pine oil, tung oil, cashew oil, etc. Their composition contains mainly glycerin fats with unsaturated fatty acids, such as oleic acid C17H33COOH, lioleic C17H31COOH, lioleolic C17H29COOH, and other unsaturated fatty acids. The molecules of those acids contain double bonds, different from the double bonds in the molecules of unsaturated hydrocarbon compounds. These double bonds are not stable, they are easily oxidized, so they are capable of spontaneous combustion. There have been many fires in the world caused by self - heating of vegetable oil. Therefore, research and evaluation of the spontaneous combustion ability of vegetable oils is essential to avoid risks during production, transportation, storage or use.

Keywords: Vegetable oil, self-heating, iodine value, unsaturated fatty acids.

1. Introduction

According to data reported by the General Statistics Office, in the period from 2015 to 2018, the whole country had more than 14,000 fires and explosions, killing 1,105 people and causing more than 6,079 billion VND in damage. From the data on the investigation of the causes of fires in Vietnam (period 2015 - 2018), although the number of fires has decreased, the nature of causing damage to people and property has increased significantly, with complex direction. In addition to the usual fire-causing agents (such as electrical short circuits, gasoline, chemicals, etc.), these newly identified agents also cause great damage to society; at the same time, it causes many difficulties for fire prevention and fighting and rescue work. Typically, in recent times, there have been many fires related to vegetable oil (especially due to its spontaneous combustion), causing serious consequences such as: the Gao market fire (Hung Yen City, Hung Yen) burned down all 200 kiosks and goods of the market, causing tens of billions of dong in damage; The factory fire at Viet Ha Food Processing Company (Thanh Tri, Hanoi) caused billions of dong in damage or the fire at the Trang An 3 confectionery factory (Bim Son Town, Thanh Hoa) caused 5 casualties. and burned down 4,000 m2 of factories (estimated damage of about 80 billion). Based on these practical requirements, research on the properties of vegetable oils, especially their spontaneous combustion in the context of Vietnam is very relevant. Based on this, a solution can be proposed to prevent the risk of fire and explosion from vegetable oil according to the actual requirements of Vietnam. With the desire to apply research results to fire prevention propaganda, help improve people's understanding and minimize damage from fires related to vegetable oil.

Table 1. Introduction of some typical fatty acids

Fatty acids	Formula	Melting point (°C)	Oils and fats
Acid Caprilic	C_8:0	16	Coconut oil,sheep fat
Acid Capric	C_{10}:0	31,3	Coconut oil
Acid Lauric	C_{12}:0	43,5	Coconut oil, palm oil
Acid Myristic	C_{14}:0	54,4	Palm oil
Acid Palmitic	C_{16}:0	62,9	Palm oil and other
Acid Stearic	C_{18}:0	69,6	Beef fat, sheep fat
Acid Arachidic	C_{20}:0	75,4	Peanuts oil
Acid Oleic	C_{18}:1	16,3	Peanuts oil, Olive oil
Acid Elaidic	C_{18}:1	43,7	Olive oil and other
Acid Eruxic	C_{22}:1	33,5	Canola oil
Acid Linoleic	C_{18}:2	-5	tung oil
Acid Linolenic	C_{18}:3	-11	Linseed oil, tung oil

2. Object and subject of research

For the paint industry, vegetable oil plays a very important role, because it is a glue to bond pigments to the surface of products such as: tung oil, hybrid oil, linseed oil, turpentine oil. Assessing the self-flammability of vegetable oils plays an important role not only for the paint industry, but also for all fields related to vegetable oils in general, especially in prevention. fire fighting. However, there has not been any research on the possibility of forming spontaneous combustion conditions for oils used in the paint industry today on cotton fiber carriers.

3. Target of research

The iodine index is the amount of iodine that saturates the double bonds in the oil molecule. The higher the iodine index, the greater the oil's ability to self-heating tendency. Experiments have shown that if the iodine index of grease is below 50, it cannot self-heat.
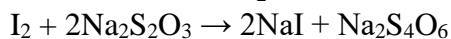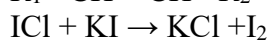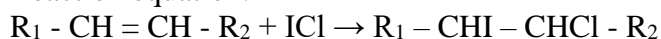
Fig.1. Titrate with sodium thiosulfate standard solution.

4. Literature analysis

According to national standards (TCVN 6122:2015,ISO 3961:2013), to determine the Iodine index of oil, Wijs reagent is used according to the principle of dissolving the test sample (oil) in the solvent and adding the drug. try Wijs. After a specified time, add potassium iodide solution and water, titrate the liberated Iodine with sodium thiosulfate solution.

Reaction equation:

$R_1 - CH = CH - R_2 + ICl \rightarrow R_1 - CHI - CHCl - R_2$

$ICl + KI \rightarrow KCl + I_2$

$I_2 + 2Na_2S_2O_3 \rightarrow 2NaI + Na_2S_4O_6$

5. Research methods

By chemical method, determine the iodine index of vegetable oil according to national standards (TCVN 6122:2015, ISO 3961:2013) on that basis to evaluate the ability (tendency) of vegetable oil to spontaneously burn. Some flammable substances are oxidized in the air at a certain temperature. The oxidation process is accompanied by heat release. If the temperature released by the reaction is greater than the rate of heat transfer, the combustible substance will self-heat and may lead to combustion. In fact, some flammable substances, when left at normal ambient temperature conditions in the air, oxidize and self-heat, leading to combustion.

Fig.2. Prepare Wijs reagent.

6. Research results

The spontaneous combustion process, the self- heating of vegetable oil depends on the rate of heat release and the rate of heat transfer during its oxidation. This means that there will be certain conditions for spontaneous combustion of vegetable oil. Those specific conditions are: vegetable oil must contain a certain amount of unsaturated fatty compounds. The higher this content, the higher the ability of vegetable oil to self-heat.

Table 2.

Iodine values of various oils and fats

Fat	Iodine value (gI/ 100g)	Fat	Iodine value (gI/ 100g)
Beef tallow	42 – 48	Kapok seed oil	86 – 110
Beeswax	7 – 16	Lard	52 – 68
Butter	25 – 42	Linseed oil	170 – 204
Canola oil	110 – 126	Olive oil	75 – 94
Castor oil	81 – 91	Oiticica oil	139 – 185
Cocoa butter	32 – 40	Palm kernel oil	14 – 21
Coconut oil	6 – 11	Palm oil	49 – 55
Cod liver oil	148 – 183	Peanut oil	82 – 107
Corn oil	107 – 128	Pecan oil	77 – 106
Tung oil	160-175	Pistachio oil	86 – 98

From the above results, it can be seen that some vegetable oils have high iodine values such as: tung oil, linseed oil, cod liver oil …., they will have the ability to self-heat. However, this is only a small aspect of evaluating the self-heating ability of vegetable oils and cannot confirm that they have self-heating ability.

7. Prospects for further research development

Research on the properties of vegetable oils, especially their self - heating in the context of Vietnam, is very urgent. From there, propose solutions to prevent the risk of fire and explosion from vegetable oil in accordance with Vietnam's actual requirements. We hope to apply research achievements to fire prevention propaganda, helping to improve people's understanding and minimize damage from fires related to vegetable oil.

8. Conclusions

It is urgent to study the properties of vegetable oils, especially their self-heating, in the paint and coating industry in Vietnam. From there, it is possible to propose solutions to prevent fire and explosion risks from vegetable oils during transportation, storage, and use in accordance with the actual requirements of Vietnam. With the desire to apply research achievements to fire prevention and fighting propaganda, help improve people's understanding and minimize the damage of fires related to vegetable oil.

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