

Досліджено вплив застосування 4-полюсного магнітного кола (N-S-N-S) послідовно на горіння попередньо приготовленої суміші рослинного ароматичного масла при співвідношенні компонентів, що наближається до стехіометричного. Реакція реагенту призводить до того, що теплопередача характеризується підвищенням температури і має основну силу, яка об'єднує атоми металу завдяки цікавому тяжінню (N-S) і (S-N), що змушує електрони вільно переміщатися завдяки енергії електрона. Взаємодія електронів викликає відділення атомів від реагентів з подальшим розпиленням і перенесенням палива в краплю, а потім зіткнення в меншу краплю, більш гладку і ізольовану, утворюючи клітинні АПІ. Результати дослідження показали, що магнітне поле підвищує інтенсивність реакції горіння суміші, оскільки магнітне поле робить спін електрона і протонного водню більш енергійним. Більш енергійні електрони і протони більш активно змінюють структуру вуглецевих зв'язків в насичених і ненасичених жирних кислотах, як довголанцюгових, так і коротколанцюгових. Довголанцюгові насичені жирні кислоти і полярні форми більш активні, ніж коротколанцюгові і прямі, так як вони мають більш сильну полярність і більш вільний рух електронів. Введення магнітного поля підвищує реактивність вогню, швидкість, так як парамагнітний O_2 виділяється більше через вогонь від Південного полюса (S) до Північного (N), в той час як тепло, що переноситься H_2O , який є діамагнітним, виділяється більше через вогонь з Північного полюса (N) на Південний (S). Це відбувається при зміщенні магнітної котушки U і S. Отже, в зоні перемикання відбувається утворення клітинного полум'я і зростання еквівалентності радіуса

Ключові слова: рослинна олія, магнітне поле, співвідношення компонентів, тригліцериди, оптимізація геометрії, напрямок магнітної лінії, біодобавки

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1. Introduction

In general, vegetable oil or fuel oil as fossil fuel is used by industry, transportation facilities, especially in the automotive sector, and household needs. In the case of the combustion process, the most important thing is perfect combustion and assessing the nature of flame behavior.

The application of the combustion process, especially the flame, can be done by influencing the magnetic or electromagnetic fields of the fire. The influence of the magnetic field is indicated by the paramagnetic attraction of O_2 electrons and H_2O as a source of heat in the flame, some O_2 breaks away from homogeneity and some fuels experience changes in temperature and fuel heat is absorbed by the magnetic field, due to H_2O droplets as a heat source, the hot steam emitted by a magnetic field leads to a flame.

The concept that has been built by Wardana [1] observes the ignition of castor oil droplets occurs twice the combus-

ADDITION OF BIO-ADDITIVE AS A CATALYST OF BURNING VEGETABLE OIL INFLUENCED BY 4 POLE MAGNETIC FIELD

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tion step, that is the first time the fatty acids burn and with increasing temperature of the glycerol burning, the second time a micro explosion appears at a smaller droplet size. Observations of Canakci [2] explain that the phenomenon of ignition delay parameters and the rate of combustion in the evaporation of vegetable oil droplets (vegetable oil) are relevant for the use of biofuels as combustion at pressure atmosphere and temperature increase while the average evaporation rate increases with temperature rise. According to Jin et al. [3] and Saroso [4], the use of vegetable oil (biodiesel) increases efficiency, decreases exhaust gas temperatures, emissions and saves fuel consumption and as an alternative indicator of pressure spraying pumps and nozzles both at initial temperatures and engine working temperature.

It has been studied in an experimental investigation concerning the influence of fuel type and properties on the injection and atomization of liquid biofuels in the optical chamber [5], which uses palm oil, rapeseed oil and animal

fats as diesel engine fuel, that vegetable oil has an effect on temperature, even small changes in temperature (25–450 °C) of fuel produce a significant effect on the injection pressure of pump systems and nozzles while animal fats require temperatures of more than 60 °C. Experimental and numerical studies were carried out for the assessment of safety parameters for the mixture of methane, propane and hydrogen with air at initial ambient pressure. The addition of hydrogen in large quantities reduces the ability to reproduce fuel explosion behavior [6]. According to Rakopoulos [7], the use of cotton oil mixture with n-butanol/diethyl ether (DEE) shows very significant physical and chemical properties of the combustion chamber pressure, the rate of heat release and good emissions from the performance of diesel engines and biofuel and diesel blends show that the higher the biofuel composition, the higher the fire, while the soot has decreased. Therefore, this research is devoted to the exploration of methods that facilitate the combustion of vegetable oils through the addition of bio-additive essential oils and exposure to magnetic fields.

2. Literature review and problem statement

It has been reported that burning vegetable oils is very complex. Many factors affect the combustion process, among which are fatty acids, polarity and the potential of electricity from fatty acids. Gas-fired research has also been examined by [8,9], revealing speed in the combustion chamber. The results showed that the hydro ethanol combustion rate was higher than anhydrous ethanol and N-Heptane in the stoichiometric mixture. The application of the addition of bio-additives as catalysts of burning vegetable oil to the combustion process that occurs in the reactants can be done by providing a reference to the electron bond that occurs in the flame of the reactants of premixed combustion. The bio-additive reactant reaction causes the heat transfer to be characterized by the rise in temperature and has the main strength to unite the metallic atoms due to the tensile pull of the internal magnetic charge of the free-moving electrons because of ionisation energy. Other studies have shown that oscillation disappears when the flame is exposed to magnetic fields [10]. Numerical simulations found about 1–2 times the flame thickness of the inner layer. Cellular APIs with higher density ratios and thinner and shorter fires for mobile starters are cellular instability to the adiabatic flame burner due to the heat-up effect [11]. Other researchers stated that the cellular fire structure appeared near the skinny mixed combustion conditions. The cellular number of fire is a hydrodynamic factor and thermal instability-diffusive, while the loss of heat makes the flame more stable [12]. For some slender blends, the flame shows the cellular structure, positive stretch levels, high volumetric heat release rate and rapid reaction rate [13]. A premixed flame that propagates shock due to hydrodynamic instability, resulting in a fractal structure that can be determined from flame speed dependence [14]. The phenomenon of cellular fire is caused by intrinsic instability by the thermal expansion of the diffusive due to the diffusion of mass preference compared to heat. That cellular size and fluctuations of experiments were designed as the intensity of air and burn instability [15]. Mobile continuously develops on a fire-growing flame of mobile-phones thereby increasing global propagation, resulting in the possibility of self-acceleration and diffusion-thermal instability [16]. Reduced combustion speed with pressure and increased temperature show

that higher pressures have a lower laminar combustion velocity causing heat loss so that the flame has not been identified as cellular [17]. Hydrodynamic instability is weakened but thermally diffusive instability is more apparent. This happens due to the unstable behaviour of the mobile front generated by intrinsic instability [18]. The characters of cellular fire premixed caused by intrinsic instability are extracted and well defined [19]. The diffusion effect has been revealed by [20] in a throbbing flame near a porous plug burner, found a higher density ratio, and the loss of radiation heat from the flame can further promote the onset of pulsed fire and mobile flame. Clove oil is the essential oil composition of eugenol acting as the main component, two atoms of oxygen and can form a eugenyl acetate from the ester's reaction, thereby reducing fuel consumption and reducing exhaust emissions. Potential bio-additives based on clove and eugenol oils and about the influence of oxygen enrichment with eugenol can help achieve optimal fuel combustion [21]. The combined citrus oil and eucalyptus oils show the oxidation of stability above minimum standards. Interestingly, the eucalyptus oil mixture enhances the stability of the oxidation diesel and fused to emit the fewest CO and nitrogen oxide (NO_x) [22]. The interaction between oil and catalyst as the product of the reaction of viscosity, kinematic viscosity, pour point and cloud point is discovered. That is a prepared catalyst will create a new idea in the efficient catalytic grip of vegetable oil to produce alternative green energy sources and is suitable for having an energy state impact to reduce the greenhouse effect [23]. Research that has not been the concern of previous researchers is the process of burning vegetable oil because it is difficult to burn with the addition of bio-additive influenced by the 4 pole magnetic field. In general, the fuel used is a gas fuel. The research that will be done this time is to use vegetable oil mixed bio-additives and circular magnetic field as a new thing, while the type of flame in the study is a flame premixed.

3. The aim and objectives of the study

The aim of the study is to study the effect of bio-additive addition as a catalyst of burning vegetable oil influenced by the 4 pole magnetic field. To achieve this aim, the following objectives are accomplished:

- to analyze the colour of the flame from vegetable oil if it will or will not be affected by the magnetic field;
- to analyze the role of carbon bonding in evaporation and ignition of vegetable oil;
- to analyze the effect of bio-additives addition to vegetable oil;
- the role of magnetic field on premix combustion of vegetable oil.

4. Equipment for recording the combustion process

Fig. 1 shows the equipment used to record the combustion process. This equipment consists of 3 separate parts, namely vegetable oil evaporation system, combustion system and data recording system.

The evaporation system for vegetable oils begins with preparation to heat vegetable oil until reaching boiling point temperature in pirez measuring glass tubes. Before use, vegetable oil is mixed with bio-additives (eucalyptus oil, clove

oil and carbon active) by stirring until evenly. The vegetable oil used in this research is coconut oil. Then hot steam in the suction with squid (injections) that have determined the comparison of fuel and air approaching stoichiometry. By means of sucking hot steam vegetable oil 1 (one) piece the volume of the next Spuid Air 5 (five) parts volume Spuid According to the measured calculation of the composition of AFR. Fuel that has been mixed with air (premix), injected into the Tube chamber equipped with igniter, thermocouple, infraRed as a temperature gauge and other measuring instruments connected with computer devices then there is an explosion in the form of Flame burning premix from biofuels (pure coconut oil, jatropha castor oil, cotton ore oil). In the same way, flame burning premix was recorded using a high-speed camera (CASIO Exilim EX-ZR1500), used to record video data is then processed into still images. At the time of data retrieval, the condition of the dark environment/night so that the image of the flame is clear, the recording is done for 2 minutes. Recorded results are stored as data, the recording process can be repeated again to 4 repetitions, import data files, performed visualization of Flame reactants, and the behaviour of the APIs is being carried out.

vary with the speed of the flame propagated (Fig. 2, *d-f*). From the flame vines and radius of equivalence, the transition can be seen from the mobile regular flame state to the state where the cells are rotated around the lines of the magnetic polar axis. Speed weakens due to heat loss from the flame.

Due to the heat loss, the thickness of the flame decreased tends to dim its fire (Fig. 2, *d-f*). The flame of coconut oil-activated carbon is dimmer following coconut oil-the next-white wood oil of coconut oil-clove oil. This is due to the influence of the dominant composition of activated carbon as much as 77.7 % (that can be found from the properties data of that kind of oil), causing the molecular geometry to what the fire is less intense. The flame of coconut oil – eucalyptus oil is lighter, this is due to the 1.8-cineol (Eucalyptus) bonds to have the highest composition and the dominant nature of the coconut oil. The shorter the carbon chain saturated fatty acids the stronger the polarity [23, 24]. On the flame of coconut, oil-clove oil is brighter than coconut oil-activated carbon and slightly dim from coconut oil-eucalyptus oil. The premixed flame that propagates freely away from the igniter, indicating that the hydrodynamic mechanism can trigger the cellular flame. Further observations help understand the mobile flame start and growth mechanisms.

Fig. 3 shows the role of a magnetic field against the premixed combustion process of the castor oil first mixed with bio-additives (activated carbon, eucalyptus oil and clove oil). Without magnetic field, castor oil-Oil of eucalyptus and castor, oil-oil clove flame of flame vines forms the equivalent radius (Fig. 3, *a-c*). On the flame castor oil-castor oil is the dimmest active, castor oil-castor oil is dim, and the brightest oil castor-oil Eucalyptus (Fig. 3, *d-f*).

Castor oil flame is the brightest of eucalyptus oil because it is composed of long-chain and non-polar saturated fat due to 1.8-cineol (Eucalyptus) reaction causing stronger and more reactive bonding. The fewer long-chain saturated fats and more and more unsaturated fats are like in the oil-castor oil, clove oil-castor oil, the dimmer it is because it is less reactive.

On the flame of white wood-castor oil and castor oil, red spots are seen in the centre of fireballs. It is hard-burning glycerol because it is very wet [1]. Glycerol is hygroscopic and the water content in castor oil is the highest (0.45 %). With the provision of a fire magnetic field becomes brighter that indicates that the magnetic field makes the spin electron and proton become more energetic so that the combustion reaction becomes more intense. Red Flame on castor oil – Oil of eucalyptus and castor oil – Oil of clove without magnetic field and when given a magnet, there are still visible red spots. This suggests that the distance oil-burning reaction and the weaker cotton oil are less react [23, 24], so the heat from burning is not enough to burn the wet glycerol because the water content is also high (0.36 %).

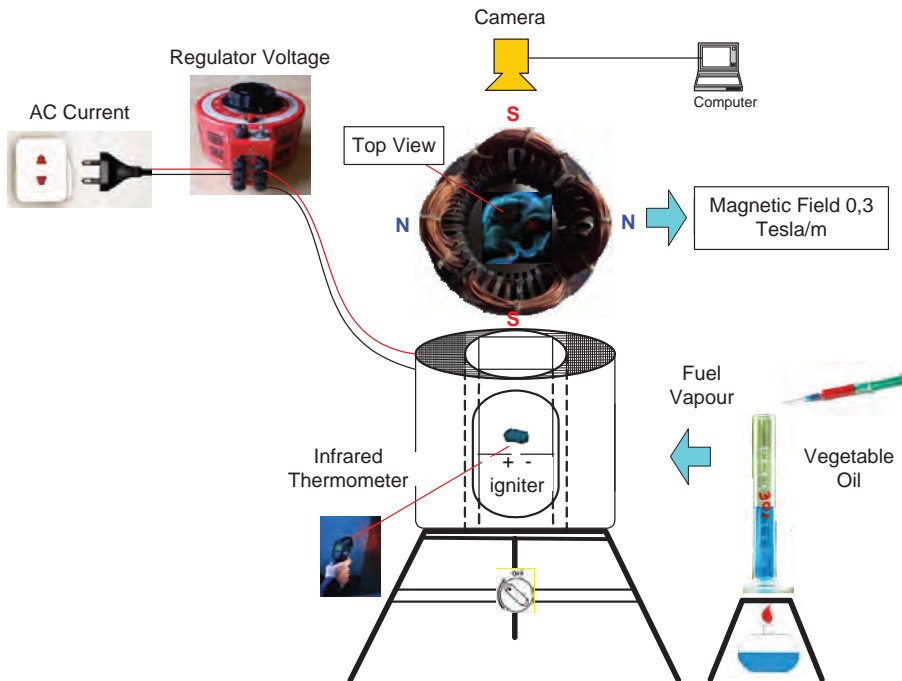


Fig. 1. Experimental equipment design

5. Results of Combustion Process

5.1. Effect of magnetic field on vegetable oil combustion with the bio-additives addition

Fig. 2 shows premixed flame stability in coconut oil burner mixed with bio-additives (activated carbon, eucalyptus oil and clove oil). Fig. 2, *a-c* shows the flame not influenced by magnetic fields, then Fig. 2, *d-f* shows the results under the influence of magnetic fields.

In Fig. 2, *a-c*, the flame experiences an equivalent radius growth without being given a magnet. Magnetic administration of premixed flame can evolve into cellular form, with the onset of cellular form to ensure the flame is stretched. Cellular APIs can appear on all equivalence and cellular-size ratios

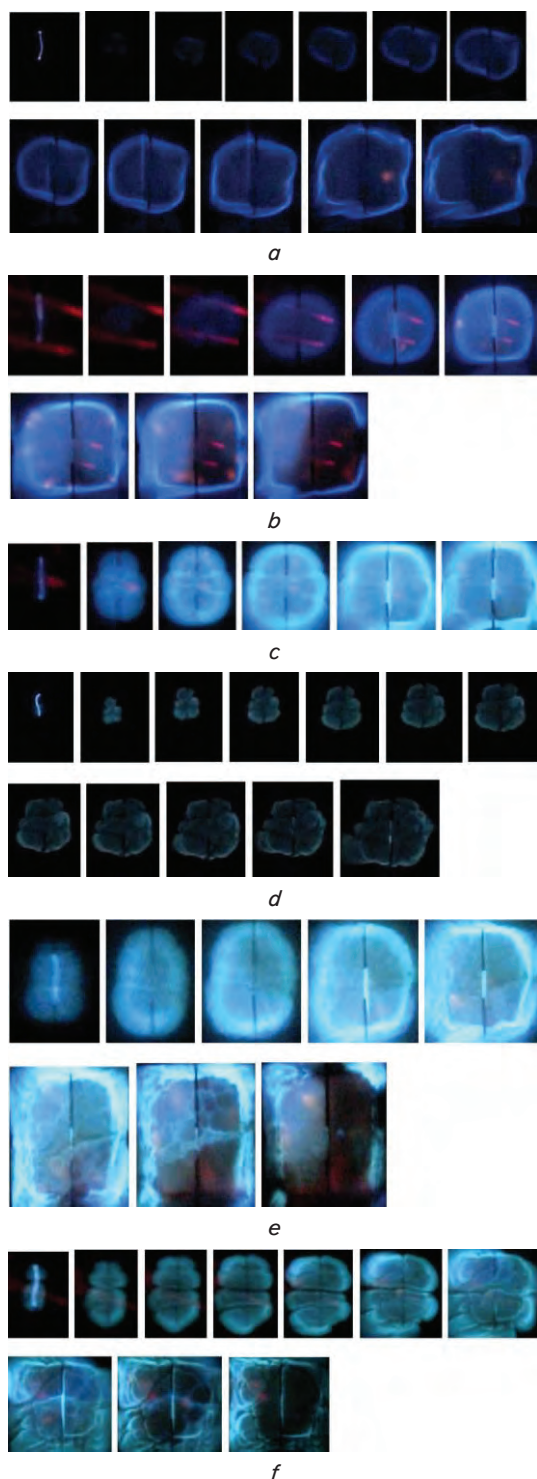


Fig. 2. Flame of premix coconut oil with the addition of bio-additive: *a* – mixed with activated carbon without magnetic field, *b* – mixed with eucalyptus oil without magnetic field, *c* – mixed with clove oil without magnetic field, *d* – mixed with activated carbon with magnetic field, *e* – mixed with eucalyptus oil with magnetic field, *f* – mixed with clove oil with magnetic field

Fig. 4 shows the role of a magnetic field against a pre-mixed combustion process of a cotton oil blended bio-additive (activated carbon, eucalyptus oil and clove oil). Without a magnetic field, flame propagates forming an equivalent radius.

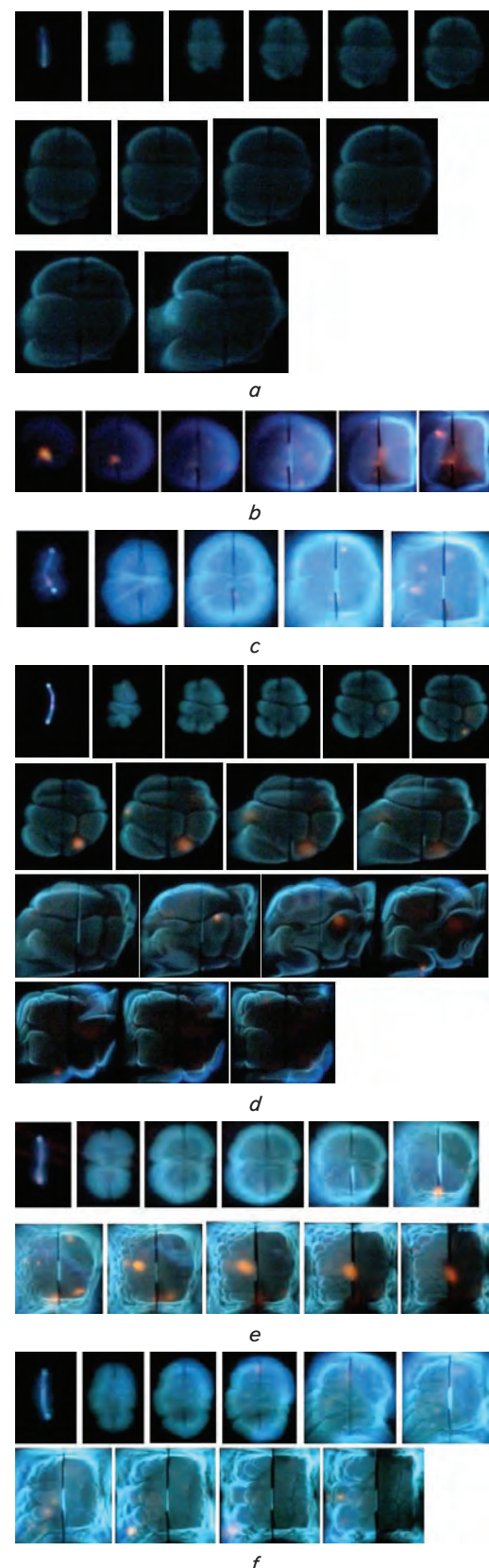


Fig. 3. Flame of premix castor oil with the addition of bio-additive: *a* – mixed with activated carbon without magnetic field, *b* – mixed with eucalyptus oil without magnetic field, *c* – mixed with clove oil without magnetic field, *d* – mixed with activated carbon with magnetic field, *e* – mixed with eucalyptus oil with magnetic field, *f* – mixed with clove oil with magnetic field

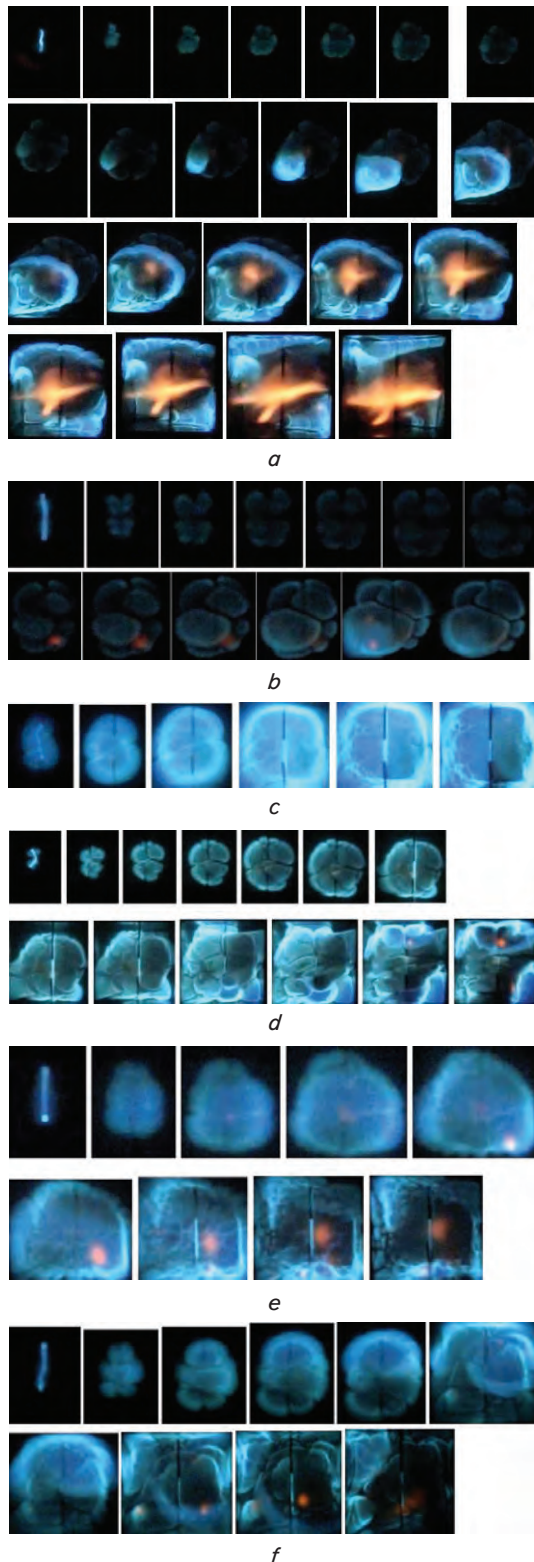


Fig. 4. Flame of premix cotton oil with the addition of bio-additive: *a* – mixed with activated carbon without magnetic field, *b* – mixed with eucalyptus oil without magnetic field, *c* – mixed with clove oil without magnetic field, *d* – mixed with activated carbon with magnetic field, *e* – mixed with eucalyptus oil with magnetic field, *f* – mixed with clove oil with magnetic field

Cotton Oil Flame – the brightest blue Eucalyptus oil, cotton oil – clove oil is a little dim, and the dimmest is a flame

of cotton-activated carbon oil. Cotton Oil Flame – eucalyptus Oil is very bright as it is composed of nonpolar long and saturated chain fats reacting with 1,8-cineol (eucalyptus) causes stronger and more reactive bonds [23, 24]. The more diminished long-chain saturated fats and more and more unsaturated fats in cotton oil, the dimmer the flames as they are less reactive. At the oil-activated cotton-carbon flame and the cotton, oil-eucalyptus oil, red spots are seen at the centre of the fire ball. It is glycerol that is difficult to burn because it is very wet [1]. Glycerol is hygroscopic and the water content in cotton oil is the highest (0.36 %). With the provision of a magnetic field fire becomes brighter that indicates that the magnetic field makes a spin electron becomes more energetic while the proton spin is transformed from to ortho so that the bond between the atoms in the oil cotton-carbo active and oil Cotton-white wood oil is stretchable and the combustion reaction becomes more intense. Red Flame in cotton oil-clove oil is precisely the opposite, at the time of combustion without the magnetic field does not appear to be visible when given a magnet. This suggests that the burning reaction of cotton-oil clove oil without a magnetic field is weaker than carbon cotton oil burning and cotton oil – eucalyptus Oil is indicated by a more dim flame (Fig. 4, *a-c*). The granting of the magnetic field strengthens the combustion reaction so that combustion heat is sufficient to burn the wet glycerol (Fig. 4, *d-f*).

5. 2. Mechanism of magnetic field influence on the vegetable oil combustion with the bio-additives addition

The direction of the magnetic field style line affects the vegetable oil flame (coconut oil, castor oil and cotton oil) blended bio-additives (activated carbon, eucalyptus oil and clove oil). Magnetic fields can accelerate the electron spin and spin of the proton so that the vegetable oil becomes more reactive as seen (Fig. 2–4) from a flame that becomes brighter. While from (Fig. 5) on the area centred cylinder in the direction of the terrain style line to fire from the N-N pole and away from the fire to the pole S-S (Fig. 5, *a*). Consequently, in this area, the fire encountered a distortion (Fig. 5, *b*). In this case, the reactants exist outside of the fire and the product is inside the (near centre) flame.

In areas where magnetic fields lead to fire, paramagnetic oxygen is pushed to the fire so that the reactants become poor. The heat carried by the diamagnetic product of H₂O in the fire is also pushed slightly out through the fire due to the direction of magnetic style lines so that the flame remains lit well. In areas where the magnetic style line is shunning the fire, oxygen exits the flame so the mixture becomes rich while the heat carried by H₂O is also away from the fire into the product. Consequently, fire is difficult to burn due to heat and oxygen deficiency. When the fire increasingly propagates outside and enters the area where the magnetic style line makes the field vortex, then the flame begins to spin (Fig. 5, *c*). This occurs because of radical, paramagnetic oxygen, and the diamagnetic heat-burning products of H₂O are stirring by the vortex of magnetic field motion as seen in the flame image in the fifth-order with the magnetic field. The fire area ignited strongly on the opposite terrain line and the weak flame lit on the terrain line area approaching and nearly extinguished on the area of the magnetic field-style line being moved away. As the flames propagate increasingly out, the fire goes into areas where the opposing magnetic force lines give the stronger influence so that only the fires in the areas between the N-S poles are getting brighter (Fig. 5, *d-e*). This occurs due to paramagnetic oxygen and the product of H₂O that

carries the diamagnetic heat is moving the cross-flow so that Lewis number approaches unity. At Poles around the pole S and around the N pole oxygen movement and heat source movement (H₂O) are interconnected so that the combustion reaction is very weak.

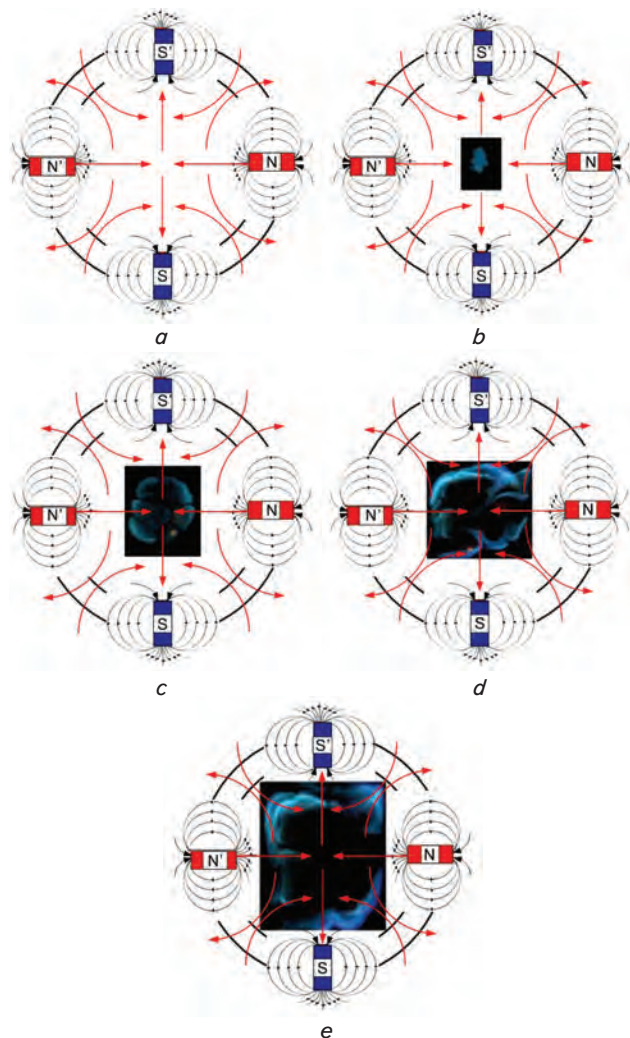


Fig. 5. Magnetic polar line simulation: *a* – starting point, *b* – ignition, *c*–*e* – development of flame under magnetic fields

5. 3. Graphical analysis

Fig. 6, *a* shows a trend in the development of a radius of fire indicating the speed of flame propagated coconut oil mixed bio-additive (activated carbon, eucalyptus oil, and clove oil) without magnetic field. The flame of coconut oil – clove oil vines faster which means it is more reactive. This corresponds to the bright flame of coconut oil as shown in Fig. 2, *a*–*c*. Then coconut oil-a slower eucalyptus oil that means less reactive than coconut-activated carbon oil so that the flame light is dimmer. The speed of flame propagation of coconut-activated carbon is the slowest which means it is least reactive compared to the mixture of bio-additives (Fig. 2, *a*–*c*). With the introduction of magnetic fields (Fig. 2, *d*–*f*), the flame propagation of coconut-activated carbon is the least whereas the flame of coconut oil-the eucalyptus oil is accelerated and the coconut oil-clove oil is slowed mainly in the early combustion process. The flame of coconut oil-activated carbon is slower than the mixture of oil.

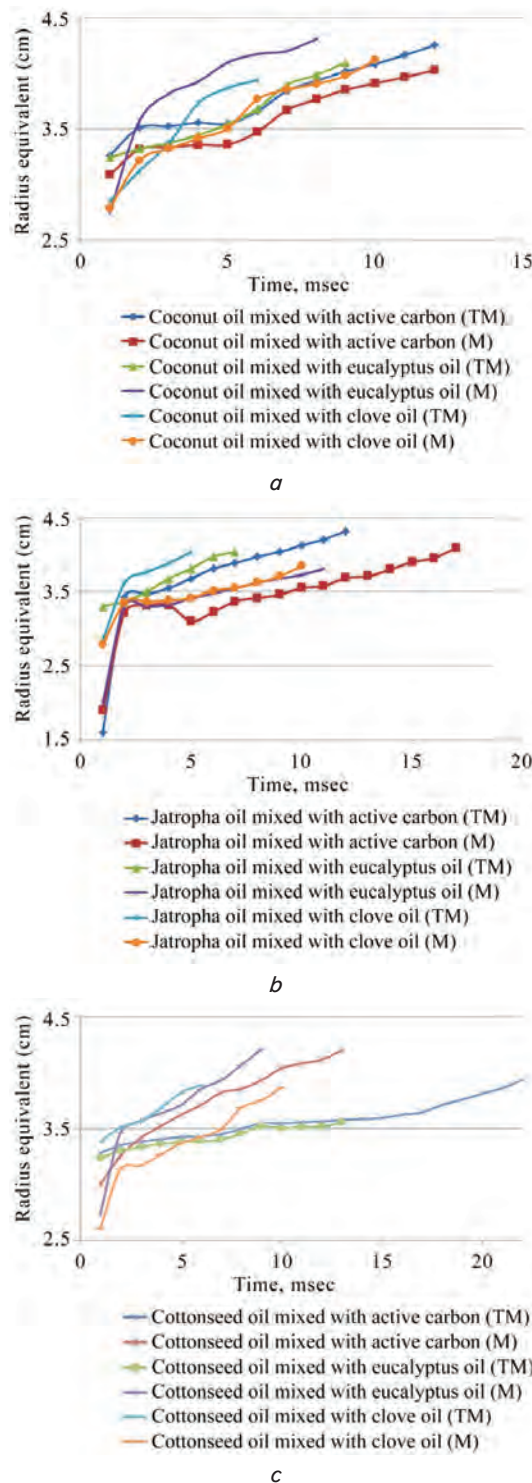


Fig. 6. Image graph of a flame on the equivalent radius: *a* – coconut oil; *b* – castor oil; *c* – cotton oil; blended bio-additives (activated carbon, eucalyptus oil and clove oil) without magnets with magnetic fields

Fig. 6, *b* shows the development trend of the flame radius indicating the speed of the flame propagated oil range of mixed bio-additives (activated carbon, eucalyptus oil, and clove oil) without a magnetic field. The three radiated flame mixtures of the mixture are more rapidly adopted when compared to magnetic field administration. Successive castor oil – oil of the next clove oil distance – eucalyptus Oil, followed by castor

oil – activated carbon at the latest (Fig. 3, *a–c*). This is due to the enormous carbon bonds binding to the long chain of non-polar dominant Castor oil. Consequently, the saturated chain ties cannot move freely so that the carbon-distance oil flame is slower than the oil-and A mixture of castor oil – a clove oil that is in dominance eugenol (43.66 %). With the introduction of magnetic fields (Fig. 3), the third-range flame of oil variation propagates much longer when compared to without a magnetic field. This phenomenon generally caused the characteristics of the castor oil to have a long chain of saturation with non-polar dominant properties and the presence of barriers to the area of the terrain line away from the N-S pole (Fig. 5). As the flames propagate further away from the Poles, the fire to the centre gives the weaker influence so that the flames become dim (Fig. 3, *d–f*). At poles around the pole S and around the N pole oxygen movement and heat source movement (H₂O) are interconnected so that the combustion reaction is very weak.

Fig. 6, *c* shows the development trend of the flame radius indicating the speed of the flame propagated oil of cotton blended bio-additives (activated carbon, eucalyptus oil, and clove oil) without magnets. The cotton oil flame that has been mixed before, all three of fire is slower when compared to given a magnetic field. Cotton Oil Flame – eucalyptus Oil is faster, followed by a cotton oil – clove oil and the slowest cotton-activated carbon oil. Cotton oil is a resemblance to castor oil which is to have a long chain of saturated but the nature of polity of cotton oil makes the flame vines faster than castor oil if given a magnetic field (Fig. 4).

In general, all three vegetable oils and three bio-additive blends, the flame light of all oils becomes brighter if given a magnetic field (Fig. 2–4) which means the combustion reaction becomes more intense (Fig. 6). Due to the combustion speed depends on the mass transport of the reactants and hot transports, the slowing of fire propagation generally occurs in the burning reaction of coconut-activated carbon oil that further inhibits the movement of the fatty acid chain ties. That magnetic field controls heat transport and the mass transport of reactants is stronger. Stronger flame control by a magnetic field in all three aromatic oil blends makes a small cellular-cellular fire. The reason for stronger control over the mass of reactants is explained in more detail from the following Fig. 7.

5. 4. Analysis of carbon bond structures

Fig. 7–9 shows the interaction of some of the most dominant fatty acid molecules in coconut oil, castor oil and cotton oil blended bio-additives (activated carbon, eucalyptus oil and clove oil) which are estimated using Hyperchem software. The dominant fatty acids in coconut oil are lauric acid, oleic acid and myristic acid. At the dominant fatty acid, range oil is linoleic acid and oleic acid. In the dominant fatty acid cotton oil is linoleic acid, palmitic acid and oleic acid. While the dominant in activated carbon is 77.7 % carbon, the white wood oil 1.8-Cineol (Eucalyptus) has the highest composition of 63.8 % and clove oil in the dominance of eugenol 43.66 %. It is seen that in physics the dominant fatty acid collection of fatty acids in each of these vegetable oils forms an interaction that inaccurately the equilibrium and the different energy geometry.

In Fig. 7, coconut oil has been mixed with bio-additives (activated carbon, eucalyptus oil and clove oil). Coconut oil-activated carbon reacts to form the lowest equilibrium geometry and kinetic energy. This means that the molecules in coconut oil move slower and are less energized because carbon bonds are very strong. This is the reason why the burning reaction to coconut-carbon active oil is the slowest and most dim (Fig. 2). Then coconut oil-clove oil is brighter, followed by coconut oil-the brightest eucalyptus oil light in its flames, as well as the flames (Fig. 6, *a*). The reason is that if an equilibrium is a geometry value and its energy kinetics is low then the fire is dim and vice versa if high geometry equilibrium then the energy kinetics is high due to the fire caused the brightest.

For castor oil mixed with activated carbon, eucalyptus oil and clove oil in Fig. 8, the dominant fatty acid molecules have an interaction that causes the equilibrium of its molecular geometry to be more tightly and lower total energy kinetic. This means that the fatty acid molecules in the activated carbon-range oil are somewhat less free-moving and somewhat less energetic, medium-oil-white wood molecules of its most tightly-bonded molecules when compared to the bonding of oil molecules distance-clove oil. Consequently, the reaction of the combustion becomes faster and the light of the fire is brighter than the active carbon-castor oil and clove oil-castor oil (Fig. 3).

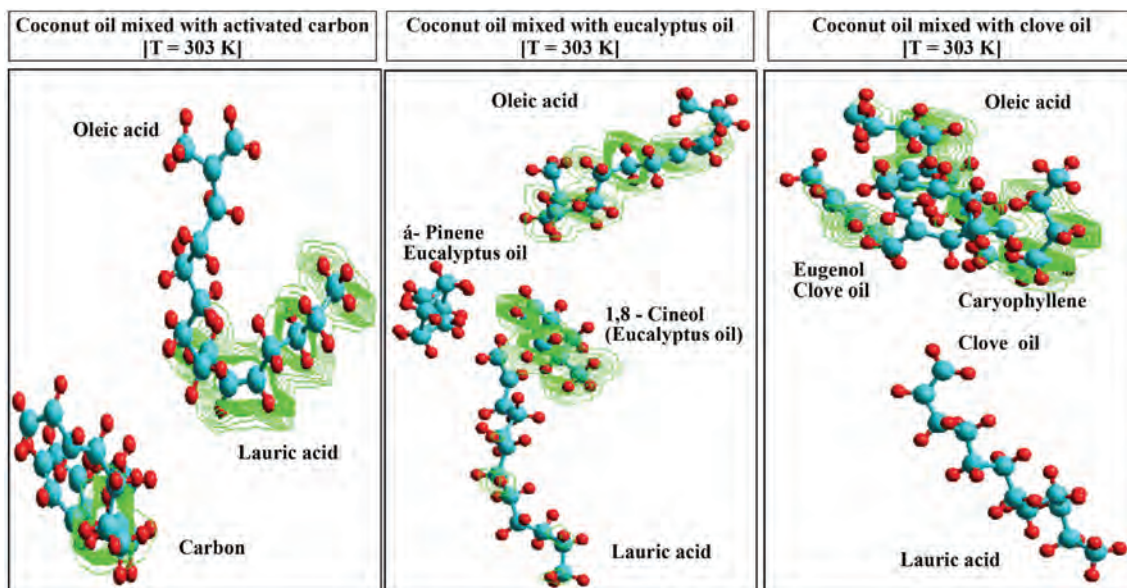


Fig. 7. Reaction energy of fatty acid coconut oil mixture with activated carbon, eucalyptus oil, and clove oil

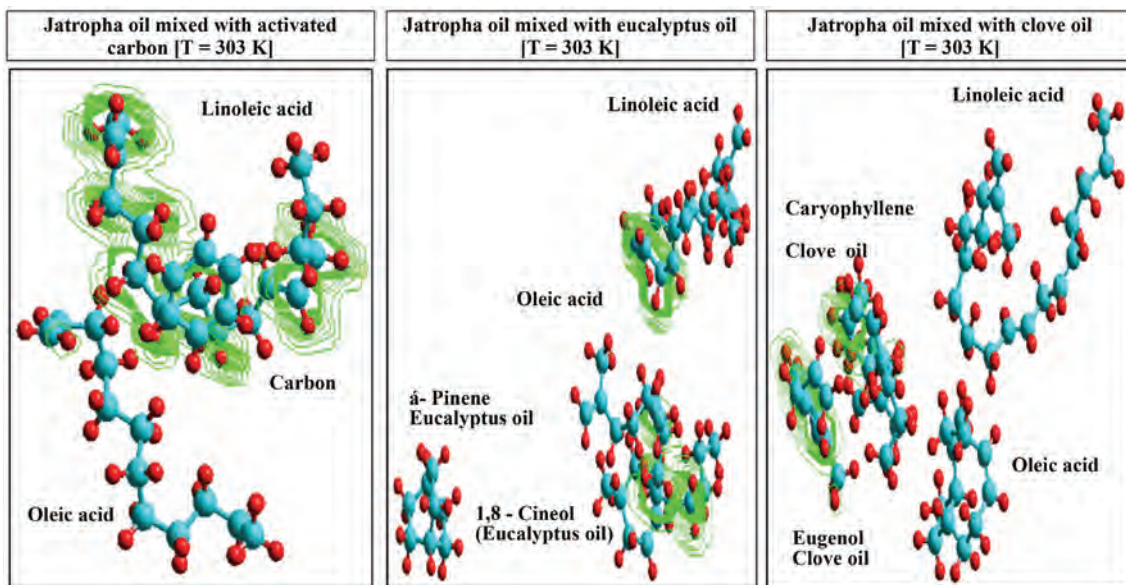


Fig. 8. Reaction energy of fatty acid jatropha oil mixture with activated carbon, eucalyptus oil, and clove oil

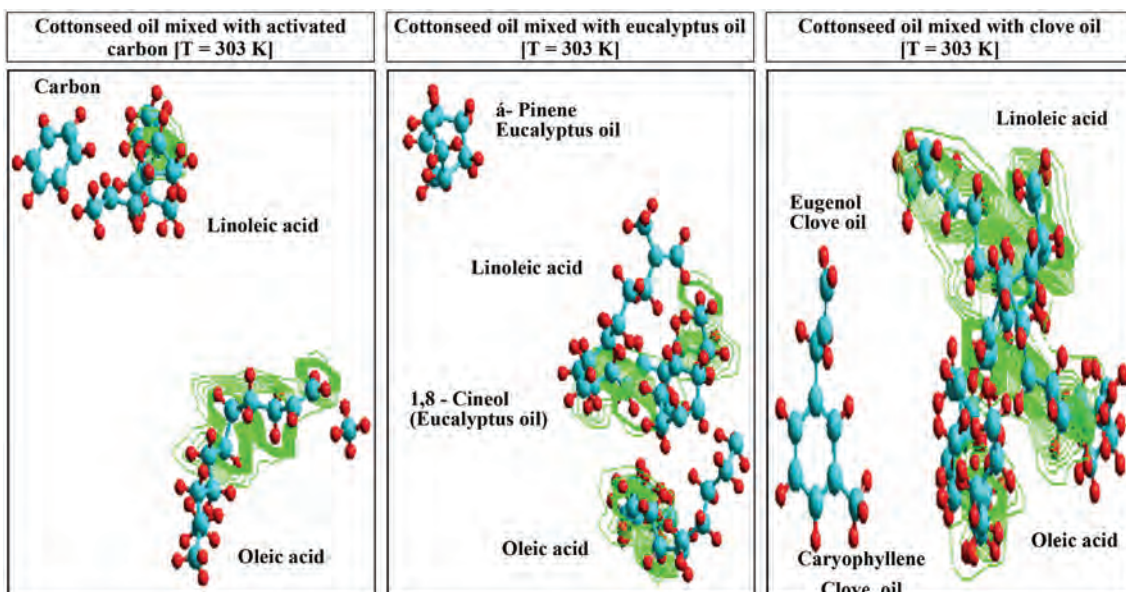


Fig. 9. Reaction energy of fatty acid cottonseed oil mixture with activated carbon, eucalyptus oil, and clove oil

Fig. 9 shows the reaction energy of fatty acid cottonseed oil mixture with activated carbon, eucalyptus oil, and clove oil.

In Fig. 9, all three bio-additive variants (activated carbon, eucalyptus oil and clove oil) that have been mixed with cotton oil forming fatty acid molecules have an equilibrium of its molecules geometry increasingly tightly also very strong.

Its carbon bonds cause fatty acids and molecules not capable of moving freely. Equilibrium geometry is increasingly tightly as well as with higher kinetic energy than castor oil. This indicates that the burning reaction of cotton-activated carbon is weaker so that it is less reactivated than the burning of cotton oil – the eucalyptus oil indicated by a more dim flame (Fig. 4).

The cotton oil flame-the brightest clove oil because it has an equilibrium of the geometry and high-kinetic energy.

6. Discussion of the influence of bio-additive and magnetic field exposure on vegetable oil

The effect of adding bio-additives and exposure to magnetic fields is evaluated from the characteristics of the flame color, propagation speed, and equivalent radius. This analysis begins with an understanding of the vegetable oil content used, namely coconut oil, castor oil, and cottonseed oil. Vegetable oil is triglyceride, consisting of glycerol and three types of fatty acids. Each type of oil has its own dominant fatty acid content. The dominant fatty acids in coconut oil are lauric acid, oleic acid, myristic acid. In castor oil and cotton oil are linoleic acid and palmitic acid. The material used as a bio-additive also has a dominant molecular content which later plays a role in the combustion process. Bio additives used are activated carbon, eucalyptus oil, and clove oil. The dominant element in activated carbon is carbon at 77.7%. Eucalyptus oil has a dominant element 1,8-cineol (eucalyptus),

with a level of 63.8 %. Clove oil is dominated by eugenol with 43.66 % content.

Without a magnetic field, flame propagates to form an equivalent carbon radius. All vegetable oils when mixed with activated carbon become the faintest flame and form a cellular. The brightest flame comes from a mixture of eucalyptus oil. By giving the magnetic field, flame to be brighter, indicating that the magnetic field makes the spin electrons and protons become more energetic so that the combustion reaction becomes more intense. However, the magnetic field induction resistance occurs in all three vegetable oils, the fire has decreased propagation speed. The three types of vegetable oils show different propagation rates. This difference is due to differences in the number of reactants in each oil. Without a magnetic field, all types of bio-additive mixture oils generally experience slowing of flame propagation, except for cotton oil mixed with clove oil, which actually becomes faster. Because the speed of combustion depends on the reactant mass transport and heat, slowing the propagation of flame appears dominant in the combustion reaction of a mixture of coconut oil with activated carbon, because the movement of the fatty acid chain bonds inhibits.

The rate of flame propagation is influenced by the length of the carbon chain and the degree of polarity of the chain. The more polar a bond is, the easier it is to be affected by a magnetic field so that it is more easily broken. This speeds up the combustion process. On the other hand, the longer the bond, the less responsive to the magnetic field, and the slower it burns.

Mixing vegetable oils and bio-additives also results in different geometrical balances. If the geometrical balance of the mixture is more tenuous, the kinetic energy is lower, the molecules are less free to move. This slows the combustion reaction.

The research results showed that the mixture which showed the best response in the combustion process with the influence of the magnetic field was between cotton oil and clove oil. The characteristics of cotton oil and clove oil additive can be used as a reference to improve the process of vegetable oils combustion.

7. Conclusions

1. The bright colour of the dimly-lit flame of a vegetable oil depends on the polar and non-polar properties of the fatty acid compounds and the composition, on the other hand, a cellular-cellular flame formed on the growth of the equivalent radius.

2. The polarity of fatty acids affects the process of ignition and evaporation of vegetable oils but with the provision of different magnetic fields of carbon bonding behaviour. The polarity of fatty acids tends to weaken the style of inter-molecules that withstand evaporation and affect the mobile fire premixed.

3. Trend graphs of polar groups, however different on non-polar dominant distance oil cause slowing down then keep returning quickly its flames. The effect of linoleic saturated fat and oleic acid occurs slightly slower evaporate. However, the role of eucalyptus can accelerate at the end of the fire propagation process if given a magnetic field.

4. The magnetic field affects the evaporation rate, visible in the freely moving molecules to form the equilibrium energy spin protons and electron as well as induction of oxygen and H₂O as a determinant of the premixed combustion of vegetable oil.

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