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Chemistry-based socio-scientific issues (SSis) as a learning context: an exploration study of biofuels

Chemistry-based socio-scientific issues (SSis) as a learning context: an exploration study of biofuels

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Abstract. This study aimed to explore chemical content in socio-scientific issues (SSIs) of biofuels as a context in chemistry learning. Based on the purpose, an exploratory research design was used in this study. The selection of issues based on five criteria that include (1) authenticity, (2) relevance, (3) results that have not been determined by social consensus, (4) topics that allow open discussion, and (5) issues related to the chemistry concept. In this qualitative method, content analysis data with the coding technique was done to classify themes in chemical content related to biofuels as social-scientific issues. This research showed that energy sources from biofuels become as examples of potential socio-scientific issues in chemistry learning. This issue is addressed by the nine chemical concepts contained in the senior high school curriculum. Finally, for the future, as a context, this potential issue can be used as a driving factor in chemistry learning with the socio-scientific issues approach.
Keywords: *chemical literacy, context, socio-scientific issues*

1. Introduction

Living in the flow of globalization that continues to develop, brings everyone to the face of several complex problems, such as air pollution, water, soil, and global climate change [1]. Education is considered to be one of the main factors that can be used to change some of the globalization effects from negative to positive and turns threats into opportunities [2]. Education that focuses on the young generation to be responsible citizens of the environment and the communities in which they live [3], is a fascinating solution in the education system in this globalization era. The roles like that can be realized by making chemistry into something more relevant for students [4]. This is because almost all aspects of our lives are related to chemistry [5], [6]; thus a good understanding of chemistry is needed in this modern era. Chemistry and chemical technology contribute to the quality of life in various fields such as health, nutrition, agriculture, transportation, material production, energy, and industrial development [7]. But unfortunately, in senior high school education, chemistry is only considered as a collection of facts that are isolated and have a lack of relevance to student life [8]. This fact underlies the emergence of various efforts to make chemistry more interests and be preferred by students with making chemistry learning to be something more meaningful. These principles form the basis for the development of context-based learning [8], [9], [10].

Context-based learning design emphasizes application examples, daily life experiences, laboratory experiments, and specific problem-solving tasks that are structured into learning material to show the relationship between concepts and context. Educational topics adopted from everyday life and society are used not only to arouse students' interest in studying chemistry but also enable students to recognize the importance of chemistry in understanding scientific phenomena and technological problems [8]. According to Broman and Parchman [11], the topic is a broad area that connects with everyday life, such as health, food, and fuel, while the context is the setting where the topic is displayed such as, personal, social or professional. Meanwhile, Gilbert [8], proposed four context models which include context as a direct application of the concept (a), context as a reciprocal relationship between concept and application (b), the context provided by personal mental activity (c), and then context as social circumstances (d). Among these models, the fourth model is considered as the most effective model for overcoming various problems faced in education today. The context was chosen because it is more closely related to students' interests and is, therefore considered relevant to them [12]. This fourth model can be introduced to students through the use of socio-scientific issues in chemistry learning [4], [7]. Chemistry learning approaches based on socio-scientific issues characterized by the use of socially relevant, current, authentic and controversial issues that exist in society [13]. The use of these issues is intended to prepare young people to actively participate in developing social discourse and decision making [14]. In Indonesia, the use of socio-scientific issues in learning chemistry seems to be very little researched and analyzed. Rahayu [15] revealed several examples related to socio-scientific issues that have been developed and can be applied to the High School Curriculum including alcohol, monosodium glutamate (MSG), sodium benzoate, acidification, acid rain, and dichlorodiphenyltrichloroethane (DDT). Besides these issues, the use of biofuels as a renewable energy source is also one of the most potential issues in learning chemistry, because the use of biofuels as fuel is very attached to the daily lives of students. But unfortunately, there has not been found an implementation of the use of biofuels as socio-scientific issues in the study of chemistry, while in other countries this has been widely studied [16], [17], and this makes the use of biofuels as socio-scientific issues in the study of chemistry is interesting to explore.

The existence of these issues during the learning process can contribute to an individual's understanding of relevant aspects from a science education [4], and can also encourage student scientific literacy [18]. Scientific literacy is an aspect that is considered as necessary, especially in the world of education. Schwartz, Ben-Zvi and Hofstein [19] through interviews with teachers and chemical scientists found the view that both teachers and chemical scientists view literacy as necessary. In general, Holbrook and Rannikmae [20], revealed that there are two different points of view regarding scientific literacy, namely, (a) those that advocate a central role for the knowledge of science; and (b) those who see scientific literacy referring to a society of usefulness. The first group is widespread among teachers today, while the second group includes a long-term view and sees scientific literacy as a requirement to be able to adapt to the challenges of a rapidly changing world, thus recognizing the need for reasoning skills in a social context. Another view is also explained by Roberts [21], where he suggests two different visions of scientific literacy. The Vision I is more traditional like science learning in general, which focuses on all learning content and concepts for the use of the concept application whereas Vision II focuses on providing students with an understanding of the benefits of chemical scientific knowledge in life and society by starting science learning from meaningful contexts. Further Eilks, Sjöström, and Zuin [22], describe scientific literacy into three visions. Vision I and II focus on developing knowledge of individual content and how it is applied in everyday life and the context of Science-Technology-Society, while Vision III aims at developing critical skills actively to shape future societies sustainably.

Chemical literacy is a part of scientific literacy, and this is what is meant by Eilks, Sjöström, and Zuin [22]. They more interpret chemical literacy as what is described in scientific literacy Vision III, which aims to develop critical skills so that they can actively form a sustainable society. This critical attitude is needed to promote an understanding of individual responsibility to take appropriate action. Chemical literacy has several domains, namely general scientific ideas, characteristics of chemistry, chemistry in context, high-order learning skills, and affective aspects. From those domains, we can see a person has the ability of chemical literacy if he has several categories in each of the existing domains. We look at the criteria for the ability of chemical literacy in the domain of chemistry in context, high-order learning skills, and affective aspects in line with the learning objectives of socio-scientific issues, among others are a chemically literate person who uses his/her understanding of chemistry in his daily life, as a consumer of new products and new technologies, in decision-making, and in participating in a social debate regarding chemistry-related issues; a chemically literate person understands the relations between innovations in chemistry and sociological and cultural processes (the importance of applications such as medicines, fertilizers, and polymers), a chemically literate person can raise a question, and look for information and relate to it when needed, he/she can analyze the loss/benefit in any debate, a chemically literate person has an impartial and realistic view of chemistry and its applications. Moreover, he/she expresses interest in chemical issues, especially in non-formal frameworks (such as a television program and a consumer debate) [19], [23]. The Increasing literacy capabilities that have been described previously, are in line with the goals of the country listed in the Minister of Education Regulation No. 23 of 2015. Therefore, serious efforts need to be made for the realization of these educational goals because teachers generally still do not emphasize the use of context in learning chemistry [24], [25]. Thus, an analytical framework of biofuels as socio-scientific issues, as well as a description of the related chemical content, needs to be done as a guide for teachers. This research is necessary because by knowing the chemical content in socio-scientific issues that have been identified, teachers and preservice teachers can make it as a reference for the use of socio-scientific issues as a context in learning chemistry in the classroom.

2. Research method

This research is qualitative in the design of exploratory research. This design is considered most appropriate, given the several limited studies on the analysis of biofuels as local socio-scientific issues related to the chemistry concept in Indonesia. An exploratory design is best used when a problem is not well understood in the literature or is unexamined in a particular way [26]. This research is intended to explore chemical content in socio-scientific issues (SSIs) of biofuels as a context in chemistry learning. The selection of biofuels as socio-scientific issues is based on an analysis of the news that is spread in various electronic media in Indonesia. Consideration of the chosen issue is based on five criteria suggested by Marks and Eilks [13] which include (1) authenticity, (2) relevance,

(3) results that have not been determined by social consensus, (4) topics that allow open discussion, and (5) issue related to the chemistry concept. Content analysis data with the coding technique was done to classify themes in chemical content related to biofuels as social-scientific issues. Qualitative research using content analysis focuses on the characteristics of language as communication by paying attention to the content or contextual meaning of the text. Text data might be in print or electronically which can be obtained from printed media such as articles and books [27]. After the data was analyzed, a judgment was conducted through focus group discussion to ensure the truth of the data that had been analyzed. Authors and two experts discuss in the focus group discussion, dissent is resolved by way of negotiation. From these series of processes, we found nine themes of chemical content related to biofuels as socio-scientific issues, which include mixtures, covalent bonds (petroleum and biofuels), intermolecular force, stoichiometry, the separation of fossil fuels and biofuels, chemical reactions (hydrocarbons and carbon compounds), thermochemistry, the impact of combustion of carbon compounds, and carbon compounds.

3. Results and Discussion

3.1 Energy sources from biofuels are examples of the potential of socio-scientific issues in chemistry learning

Energy is one material that is quite important in chemistry learning. This is as revealed by Shwartz, Ben-Zvi and Hofstein [19] that most chemistry teachers consider energy to be an essential chemical concept for students among several other concepts. Furthermore, the use of energy which is quite relevant among students includes the use of fossil fuel and biofuel energy in their vehicles. The use of vehicle case contexts in automotive engineering, which includes Hydrocarbon Chemistry and Petroleum (HCP) which is quite in line with the issues of fossil fuels and biofuels has been carried out [28]. In that research, the researcher emphasizes more on the integration between chemistry and automotive lessons based on the basic competency curriculum and integrated with the vehicle context and has not emphasized aspects of the use of socio-scientific issues related to fossil fuels and biofuels. In line with the criteria of the problem that can be used as issues in the socio-scientific issues-based approach that has been described previously, so researcher used the same path to analyze energy sources from biofuels as examples of socio-scientific issues in chemistry learning. Biofuels are renewable fuels derived from biological raw materials, which include bioethanol (equivalent to gasoline), and biodiesel (which is equivalent to diesel) [29]. Biofuel is a liquid or gas fuel made from plants or agricultural waste. The term biofuel is generally used for liquid fuels in the transportation sector. Plants such as corn, sugar cane, and soybeans are some of the raw materials for producing biofuels. Although it looks useful to use plant material as a source of renewable energy, the use of residues and other biomass as a source of biofuel raw materials raises many concerns about environmental issues, including those related to food crisis and destruction of vital soil resources [30]. In Indonesia, using biofuels as renewable raw materials has begun to be encouraged by the government, which is pushing for the use of biodiesel to replace fossil fuels in vehicles. The main raw material derived from palm oil is considered as one of the plants that contain the most efficient oils [31], besides its availability which is quite abundant in Indonesia so that it is expected to be able to boost the community's economy. On the other hand, oil palm expansion is the main driver for peat deforestation and drainage which results in huge CO_2 emissions [32]. On the other hand, Jatropha plants which are also potentially used as raw materials for biodiesel are currently less than the existing oil palm plants. If the jatropha or other plants are chosen, it will impact the land clearing and threaten forest preservation. The existence of debates and unresolved solutions makes biofuels as one of the potential socio-scientific issues in the study of chemistry.

Besides identifying the socio-scientific issues that can be used in chemistry learning, analysis of scientific content that related to socio-scientific issues raised needs to be done, because knowledge of chemical content and contextual understanding of chemistry are prerequisites needed for students to participate in evaluating information contained in scientific and social discourse related to the application of chemical technology and the effects of a chemical-related phenomenon on the environment and society [33]. The relationship between the issues raised and the concept of chemistry is also significant to be known by the teacher because the teacher has a vital role in the success of the learning process. Several characteristics must be possessed by the teacher when applying socio-scientific issues in the classroom, including that the teacher must know scientific content related to the issues raised, and be aware of the social considerations associated with the issues [34]. Through the available socio-scientific issues students get the opportunity to investigate socio-scientific issues that are personally relevant through the activities of discussing, debating or making arguments to resolve the problem [13], [15]. Furthermore, the issues raised must be issues that are present in various media sources such as newspaper articles, advertisements, news on television, and so on so that they can provoke questions and discussions. The selected problem is a problem that allows the emergence of differences of opinion by various parties. Inappropriate issues are problems that only allow partial solutions or which will be deemed unacceptable for scientific, ethical, or sociological reasons by the majority of classes, teachers or parents [13]. Through the issues, students are expected to find solutions and solve existing problems in socio-scientific issues raised through their chemical knowledge. Thus knowledge of chemical content is a prerequisite needed to participate in evaluating information in the scientific discourse they obtain [33]. Analysis of the potential use of energy sources from biofuels as socio-scientific can be seen in Table 1.

Table 1. Analysis of energy sources from biofuels and examples of potential socio-scientific issues.

Socio-scientific Issues (SSIs)	Indonesia emergency fuel (fuel oil): should the government determine certain agricultural commodities as a source of raw materials for producing biofuels and provide land for planting these commodities, to encourage the use of alternative energy sources?
Viewpoint	Indonesia is a country with a considerable amount of motor vehicle usage, and it is always increasing every year. A large number of vehicles is not in line with the amount of fuel oil available. The Agency for the Assessment and Application of Technology (BPPT) said that currently, Indonesia is experiencing an energy emergency. The crisis experienced by the Indonesian state has made the government try to find alternative energy sources. Biofuels is one alternative energy that is being rife in recent times by various groups. The Indonesian government itself has criticized the dependence of the community in using fossil fuels and stressed the need to accelerate the use of one form of biofuel, namely biodiesel, to be applied in Indonesia. The use of biofuel itself is still being debated; some institutions that focus on environmental issues oppose the use of biofuels as fuel. The reason is that the source of the commodity used as raw material for biofuels is food so that it can disrupt the availability of food for the Indonesian people. Another cause is the use of biofuels can trigger land clearing by destroying the environment, which aims to minimize production costs; this can undoubtedly disrupt ecosystems and animals in the environment. To support the smooth use of biofuels as an alternative energy source, do you agree that the government must determine certain agricultural commodities as sources of raw materials

	for producing biofuels and can provide land for growing these commodities?
The scope of chemical knowledge	Covalent bonds (petroleum and biofuel), intermolecular forces, chemical reactions (hydrocarbons and carbon compounds), Impacts of carbon compounds, thermochemistry, carbon compounds, separation of fossil fuels and biofuels, mixtures and, stoichiometry.

From Table 1 it is known that socio-scientific issues biofuels can be discussed with nine themes related to chemical methods which include covalent bonds (petroleum and biofuel), intermolecular forces, chemical reactions (hydrocarbons and carbon compounds), impacts of carbon compounds, thermochemistry, carbon compounds, separation of fossil fuels and biofuels, mixtures and, stoichiometry. These materials are the basic material taught at the high school level in Indonesia. The relationship between the socio-scientific issues identified with chemical content in high school indicates that biofuels as a socio-scientific issue are potential issues to use in learning chemistry at high schools in Indonesia.

3.2 Elaboration of chemistry concept

Based on the analysis of Table 1, it is known that for the theme of sources from biofuels issues, we can relate to the nine chemical concepts spread in each class at the High School Level. The concept of chemistry related to socio-scientific issues raised will make students feel that what they have learned is relevant to their lives. This relationship from the issues will be able to build chemical linkages at the macroscopic, microscopic, and symbolic levels. A complete description of the chemical content associated with the issues of energy sources from biofuels at all high school chemistry levels for all related chemical concepts is shown in Table 2.

Table 2. Explanation of chemical concepts in the high school curriculum-2013 in Indonesia.

Basic competencies	Concept	Elaboration of the chemical concept
3.1 Explaining the scientific method, the nature of Chemistry, safety and security in the laboratory, and the role of chemistry in life	Mixtures	Understanding the concept of mixtures on fossil fuels and biofuels **(Dimension: Technology, environment, economy)**
3.5 Comparing ionic bonds, covalent bonds, coordination covalent bonds, and metal bonds and their relation to the nature of substances	Covalent Bonds (petroleum and biofuels)	Understanding the covalent bonds found in the constituent compounds of fossil fuels and biofuels, and their relationship to the properties of these substances **(Dimension: Technology)**
3.7 Linking interactions between ions, atoms and molecules with the physical properties of substances	Intermolecular force	Understanding the effect of intermolecular forces on the physical properties of substances in the constituent compounds of fossil fuels and biofuels **(Dimension: Technology)**
3.10 Applying the fundamental laws of chemistry, the concept of relative molecular mass, chemical equations, the concept of moles, and the content of substances to complete chemical calculations	Stoichiometry	Applying the concept of stoichiometry in reactions involves the constituent compounds of fossil fuels and biofuels **(Dimension: Technology)**
3.2 Explaining the process of forming petroleum fractions, separation techniques and their uses	The separation of fossil fuels and biofuels	Understanding the basic principles contained in the separation of fossil fuels and biofuels such as multilevel distillation and others **(Dimension: Technology, environment)**
3.3 Identifying perfect and imperfect hydrocarbon combustion reactions and	Chemical reactions (hydrocarbons and	Understanding the hydrocarbon reaction patterns in fossil fuel and biofuel compounds and carbon products and

Basic competencies	Concept	Elaboration of the chemical concept
nature of combustion substances (CO2, CO, carbon particulates)	carbon compounds)	particulates produced during the combustion reaction **(Dimension: Environmental, social, economy)**
3.5 Explaining the type of reaction enthalpy, Hess's law and the concept of bond energy	Thermochemistry	Understanding the basic concepts of thermochemistry contained in the combustion reaction of fossil fuels and biofuels, as well as the relationship of bond energy with the amount of energy produced from the combustion process **(Dimension: Lingkungan, economy)**
4.3 Develop ideas on how to overcome the effects of burning carbon compounds on the environment and health	Impact of combustion of carbon compounds	Analyzing the different effects of fossil fuel and biofuel combustion reactions on the environment **(Dimension: Environment, economy)**
3.9 Analyzing the structure, nomenclature, properties, synthesis, and usefulness of carbon compounds	Carbon compounds	Understanding the functional groups contained in the constituent compounds of fossil fuels and biofuels, properties, synthesis, and chemical reaction in those compounds. **(Dimension: Technology, environment)**

3.2.1 Mixtures on fossil fuels, biofuel and the separation of fossil fuels and biofuels

Fossil fuels and biofuels that we use every day are not found directly in a pure state in nature but in mixed form. A mixture is a combination of two or more pure substances that do not occur through chemical reactions, but only happen through physical mixing so that the properties of the original pure substance do not change in the mixture. Mixtures can be broken down into pure substances making up through physical methods [35]. The components are mixed randomly without any visible barrier between the components. Gasoline which results from refining petroleum has an octane rate of around 70% [36], so to increase the octane number additives such as TEL (Tetra Ethyl Lead) and MTBE (Methyl Tertiary Butyl Ether) are added. While bioethanol and biodiesel that we encounter are also a mixture. Some types of biofuel that have been produced are Bio Premium which is a mixture of 5% ethanol and 95 premium, and biodiesel (B20) which is a mixture of diesel and 20% biodiesel [35].

Petroleum is a major source of alkane fractions, some of which we use as vehicle fuels and oil and gas stoves. Separation of petroleum into its fractions is done through distillation techniques, namely separation techniques based on differences in boiling points [37]. Similar to petroleum, to get pure bioethanol, usually ethanol from glucose fermentation is distilled to separate it from other undesirable components. In transesterification, the separation of biodiesel from glycerol can be done with different densities.

3.2.2 Covalent bonds (petroleum and biofuels and carbon compounds)

Most fuels such as petroleum and biofuels are carbon compounds as their main constituent components. In carbon compounds, carbon atoms are usually coupled with each other and also with other atoms such as hydrogen atoms and oxygen atoms. Besides, some carbon compounds also contain nitrogen and sulfur atoms. The C atoms in the carbon compound form chemical bonds. The bond between C and hydrogen atoms in the compound is formed through the sharing (sharing) of electrons. The C atom is surrounded by eight electrons that form covalent bonds. The bond, called the covalent bond because it occurs through the sharing (sharing) of electrons [38]. The fact that electrons in many molecules are arranged so that each atom (except hydrogen) shares 8 electrons is called the octet rule. This covalent compound is composed of molecules that contain covalent bonds.

3.2.3 Intermolecular force and carbon compounds

Covalent compounds generally boil and melt at low temperatures. The conditions can occur because of the physical properties in covalent compounds, such as boiling points and melting points which are affected by the attraction between the molecules [39]. Both petroleum and biofuel consist of covalent compositions. van der Waals' force is a general term used to determine the attraction between molecules. There are two types of forces, namely van der Waals, the weak London Dispersion force and the stronger dipole-dipole force. The attraction force that occurs between molecules in petroleum is London dispersion forces which are weak [38].

Meanwhile, the intermolecular forces in ethanol are different from the intermolecular forces on hydrocarbons. Ethanol molecules are held together by particular hydrogen bonds, the presence of hydrogen bonds in ethanol compounds because ethanol contains alcohol groups. These bonds are generally stronger than ordinary dipoles and dispersion forces, but weaker than actual covalent and ionic bonds. Hydrogen bonds occur between polar molecules that contain O-H groups, N-H and F-H. But besides hydrogen bonding, on the non-polar side of hydrocarbons on ethanol, intermolecular forces as London forces can occur. The biodiesel contains an ester functional group, namely carboxylic (COOH) which is polar. However, the effects of long carbon chains make the non-polar character in biodiesel dominate [40].

3.2.4 Chemical reactions (hydrocarbons and carbon compounds, and stoichiometry)

Chemical reactions occur when molecules change their chemical composition. There are five general types of reactions: single displacement, double displacement, decomposition, synthesis, and combustion reactions [41]. Energy from fossil fuels and biofuels is released through a process called combustion. Energy from fossil fuels and biofuels is released through combustion reactions. The following are some of the combustion reactions that exist in biofuels and compounds in petroleum [38].

$$2\ C_8H_{18}\,(l)\ +25\ O_2\,(g) \longrightarrow 16\ CO_2 + 18\ H_2O \text{ (combustion reaction in octane)}$$

$$C_{19}H_{36}O_2\,(l)\ +27\ O_2\,(g) \longrightarrow 19\ CO_2 + 18\ H_2O \text{ (combustion reaction on biodiesel)}$$

$$C_2H_5OH\,(l) + 3\ O_2\,(g) \longrightarrow 2CO2\,(g) + 3H_2O\,(g) \text{ (combustion reaction in bioethanol)}$$

After balancing chemical equation, it is possible to analyze the relationship between what is put in and what comes out of the reaction. The coefficient for a balanced equation shows the mole relationship between the molecules involved in the reaction. The coefficient for a balanced equation shows the mole relationship between the molecules involved in the reaction. From the example of the combustion of octane and biodiesel combustion. We can see that two octane molecules will produce 16 moles of carbon dioxide. The number of moles of carbon dioxide produced is eight times greater than the number of moles of octane burned.

In comparison, biodiesel fuels are larger molecules and produce 19 moles of carbon dioxide. Not only can we do this calculation by looking at the relationship of molecules to molecules between products and reactants, but it is also more practical to discuss this reaction in terms of mass. Octane has a molar mass of 114.23 g/mol, and a molar mass of carbon dioxide is 44.01 g/mol. For example, if 500 grams of octane fuel is burned, it is possible to calculate the mass of carbon dioxide to be produced using its stoichiometric relationship; 500 grams of octane will release 1,540 grams of CO_2 into the atmosphere. The molar mass of biodiesel is 296.50 g/mol so that it is more than twice as heavy as octane. Using the same example, 500 grams of biodiesel fuel will release 1,410 grams of carbon dioxide. Because biodiesel is a larger molecule, 500 grams of biodiesel contains fewer moles than 500 grams of octane. As a result, combustion of biodiesel produces less carbon dioxide than gasoline with the same mass of octane [42].

3.2.5 Thermochemistry

Fuel generally comes from carbon compounds, which are made up of atoms which are bound together through covalent bonds. A Chemical reaction involves breaking and forming these bonds. Energy will be needed to break the bond. Conversely, the formation of chemical bonds, will release energy [35]. Bond energy is the amount of energy that must be absorbed to break certain chemical bonds. Values are expressed in kJ/mol of the broken bond. The concept of bond energy is used to determine the energy produced from the fuel combustion reaction [38]. In practice ethanol cannot be used purely in your vehicle's engine, because some vehicle engines are not designed for the process of burning ethanol purely; therefore the vehicle engine can run with "gasohol" which is a mixture of gasoline and ethanol [35]. With the increasing ethanol mixture, the gas mileage will be reduced. That's is because ethanol releases a lower amount of energy per amount burned than hydrocarbons found in gasoline. That fact can be seen from the following chemical equation:

$$C_2H_5OH\ (l) + 3\ O_2\ (g) \longrightarrow 2\ CO_2\ (g) + 3\ H_2O\ (g) + 1240\ kJ$$

$$C_8H_{18}\ (l) + \frac{25}{2}\ O_2\ (g) \longrightarrow 8\ CO2\ (g) + 9\ H2O\ (g) + 5060\ kJ$$

Based on these equations, it can be seen that per gram, the value for ethanol (C_2H_5OH) is 26.8 kJ/g and it is 44.4 kJ/g for C_8H_{18} (n-octane). Ethanol releases less energy because it contains oxygen. As a fuel, ethanol has been partially oxidized, or "burned" [42]. In countries like America, the use of "gasohol" has been applied with a percentage of 10% and 15% ethanol while the rest is gasoline. In Indonesia, Pertamina has adopted the use of ethanol in fuel, namely bio premium.

3.2.6. Impact of combustion of carbon compounds

During this time, the use of fossil fuels produces CO_2 and SO_2 particles that affect the environment. CO_2 plays a role in the environment because it can cause the greenhouse effect. Like fossil fuels, all biofuels release CO_2 when burned, but biofuels must release lower amounts of CO_2 into the atmosphere than fossil fuels. Plants that are currently used to make biofuels initially absorb CO_2 from the atmosphere as they grow. Based on the principles of the First Thermodynamic Law, whether as the fuel was burned or not, these plants will release the same amount of CO_2 back into the biosphere after they die. Conversely, fossil fuels keep their carbon "locked" underground if it is not extracted and burned as fuel. Therefore, when fossil fuels are burned, an increase in CO_2 emissions to the atmosphere. Biofuel is said to be more environmentally friendly compared to fossil fuels because CO_2 produced by motorized vehicles will then be reused by biofuel-producing plants as raw material for photosynthesis [38]. While other particles such as sulfur dioxide (SO_2) are released into the air by fossil fuel power plants, vehicles, and oil refineries. These particles can cause acid rain. H_2SO_4 falls to the surface of the earth along with drops of water so that there is rain (acid rain). Acid rain can cause corrosion and damage to vegetation. On the other hand, the use of one type of biofuel that is biodiesel can reduce the formation of acid rain because burning in biodiesel produces 8% less sulfur dioxide which is the cause of acid rain.

Both of the results show that the issues of energy sources from biofuels has the potential to be an appropriate issues for teaching chemical concepts related to mixtures, covalent bonds (petroleum and biofuels), intermolecular force, stoichiometry, the separation of fossil fuels and biofuels, chemical reactions (hydrocarbons and carbon compounds), thermochemistry, impact of combustion of carbon compounds, and carbon compounds**.** Besides being able to positively influence the cognitive and metacognitive aspects of students, the application of the socio-scientific issues approach to chemistry learning is also expected to affect the affective aspects which include ethical, social, economic, and environmental dimensions [43], [44], so they will be able to contribute to solving problems that exist in the community with various points of view.

4. Conclusion

The complexity of problems in an increasingly social world requires students to provide contributions to society through the knowledge of chemistry that is owned by students. Chemistry is no longer only seen as a subject that is not relevant to their real life. Through the use of context in learning chemistry, students are expected to understand better the learning they are doing. Some literature has mentioned that the context in the form of socio-scientific issues can encourage the improvement of students' chemical literacy abilities, this is because what they learn relates to issues that are relevant to their lives. Energy sources from biofuels become examples of potential socio-scientific issues in chemistry learning. Based on the analysis of the relationship of issues with chemical concepts that existed in curriculum-2013 in Indonesia, the issues had links with nine concepts in chemistry including mixtures, covalent bonds (petroleum and biofuels), intermolecular forces, stoichiometry, the separation of fossil fuels and biofuels, chemical reactions (hydrocarbons and carbon compounds), thermochemistry, impact of combustion of carbon compounds, and carbon compounds. Besides, these issues could be discussed through technological, economic, social and environmental perspectives. Finally, for the future, as a context, this potential issue can be used as a driving factor in chemistry learning with the socio-scientific issues approach.

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