

Occupational Health and Safety in the Biofuels Industry:

The Case Study of Small Scale Biodiesel Plants in Gauteng Province, South African

Sebonkile C. Thaba, Charles Mbohwa, and Anup Pradhan, *Member, IAENG*

Abstract—The main aim of the study is to investigate the occurrence of the health and safety in the small scale biodiesel industries Gauteng Province, South Africa. This study show case the importance of occupational health and safety in South Africa small scale biodiesel plant. Many large companies do not only comply with the rules and regulations of the health and safety campaigns, but also take their worker to continuous trainings concerning the health and safety. With smaller producers of biodiesel, they do not have the resources that major producers do have for addressing compliance with Occupational Safety and Health Administration workplace safety standards. The study was conducted in South Africa by visiting 35 plants that are situated in four different provinces namely Mpumalanga, Western Cape, Gauteng and Kwa-Zulu Natal Province. The study used questionnaires, interviews and observations to collect data on the biofuel plants. The findings were the results of the methods used to gather data.

Index Terms— small scale, biodiesel plants, Small Micro and Median Enterprises (SMME's), occupational health and safety, biofuels

I. INTRODUCTION

For centuries, occupational health and safety has been a very crucial topic. It is an important aspect as it ensures the health and safety of humans in the workplace; it ensures good use of by-products and waste products, that whatever the company is manufacturing is environmental friendly by not having any negative effects on the nearby communities as well as the omissions.

Occupational health and safety happens to be the business health route, the business that takes health and safety of all the stakeholders to consider how to get good returns due to the positive response of all constituencies of the business.

Manuscript received March 23, 2015; revised April 09, 2015. This work was supported in part ongoing research of life cycle assessment on biofuels in South Africa, in the Department of Quality and Operations Management. The authors like to acknowledge University of Johannesburg and National Research Funds (NRF) for financial and non-financial support. Biofuel Sector as a Potential Business Opportunity for Emerging Cooperatives: The Case Study of South African Cooperatives.

S.C Thaba is with the University of Johannesburg, Department of Quality and Operations Management, Johannesburg, RSA, (+27 73 2535 145; (e-mail: sebonkile.thaba@yahoo.com).

C. Mbohwa is with University of Johannesburg, Department of Quality and Operations Management, Fort Collins Johannesburg, RSA. (e-mail: cmbohwa@yahoo.com)

A. Pradhan is with the University of Johannesburg, Department of Quality and Operations Management, Johannesburg , RSA,(e-mail: anup.pradh@gmail.com).

The constituencies of the business are its employers, employees, customers, and government. According to National Renewable Energy Laboratory [1], the main advantage in using biodiesel is that it produces no by-products containing sulfur [2]. There are significant safety considerations when operating small-scale processors of biodiesel as fuel quality and by-product disposal need to be closely monitored to assure engines are not damaged, and regulations are met. Most of the manufacturing companies have waste materials and by-products, that is, the materials that are left overs or produced during the production process that the company no longer need. Such products can be hazardous to the public if they are dumped anywhere in the environments and some can pollute the environment, air and the oceans [3]. The removal of glycerol by-product and waste water generated from biodiesel production can cause environmental harm, unless approved right procedures are followed, and most importantly, plant owners pay close attention to the quality of the biodiesel produced. Proper storage is essential to avoid costly engine problems or excessive emissions in use.

The aim of this study was to investigate the failure of occupational health and safety acts in the small scale biodiesel plants in South Africa [4]. Safety awareness is however critical when running a biodiesel plant of any kind because of the corrosive and poisonous nature of the chemicals involved. The occupational health and safety's been taken very serious by big companies that employ thousands of people. Even at the entrance, all the signs ensuring occupational health and safety should be visible. The challenge still remains with small business; most do not make the health and safety a number one aspect. The small business tend to be more worried about producing and selling to cover all the cost of the business, such as paying employees, buying materials and all other things that are needed if the business is to be successful [3]. While small scale biodiesel production carries inherent risks, their obvious goal should be to minimize mistakes as it is also important to know how to respond appropriately to a mistake and the best approaches to prevent serious accidents.

A. The Importance of Biofuels in South Africa

Biofuels are one of the renewable energy fuels, that in future, have to completely replace fossil oil, this is one of the aspects the whole world would like to see working, as it will be coming with a lot of benefit. The advantages of

using a biodiesel include renewability, domestic origin, environmental benefits in terms of biodegradability and reduction of most regulated exhaust emissions, safer handling due to higher flash point, inherent lubricity and possesses a positive energy balance. For the whole world is about reduction in greenhouse gas emissions, is an answer to global warming and an environmental friendly aspect [5]. The use of renewable sources for biodiesel plants helps to increase not only job generation and incomes, but also promoting energy self-sufficiency in rural areas [6]. Fossil oil as non-renewable fuel it tends to be very expensive comparing to having biofuels as alternative fuels. For developing country adding to the above benefits, it looks at biofuels as a way of solving many social illness faced currently. It becomes an answer to reduce unemployment, alleviate poverty beside this specifically in South Africa, to help bring about removing inequality that was caused by apartheid system. The majority of farming contracts for farming the initiated feedstock for the production of biofuels have been awarded to small scale black owned farmers in the Eastern Cape as opposed to large scale farmers in an effort to bridge the gap between the first and second economies of South Africa [4]. Contrary to developed countries, the main driver for the development of a biofuels industry in South Africa is not only the economic threat of unpredictably increasing oil prices and a mitigation agenda for anthropogenic climate change, but the need to create a link between the country's 1st and 2nd economies. Governments wants to promote economic development by inviting those who were neglected by South African past laws to play a role in developing the south African economy [7] specifically, in areas of the country that did not have market access for their produce, most of which are in the former homeland area.

B. Current states of Biofuels in South Africa

Biofuels is a term used to describe renewable fuels that are derived from plants and animal fats. There are two main types: (i) Biofuels namely ethanol (resulting primarily from sugar cane, corn or maize) and (ii) biodiesel (resulting primarily from rapeseed oil, sunflower oil, palm oil, soya oil and animal fats) of biofuels. Currently South Africa is only producing biodiesel in a very small scale as for ethanol is still in the planning process by government, academics, producers and investors. The huge plants for biodiesel that government is looking at in order to meet the target estimated in 2007 [8] states that the biofuel strategy for 5 year pilot is to achieve a 2% penetration level of biofuels in the national liquid fuel supply. Hence construction is however under way of two huge biodiesel plants in the Eastern Cape, one using raw soybean and other canola oil as feedstock, these two plants 500 thousand hectares (ha) has been targeted for farming of oilseed that will assist with producing 400 liters per annum [4]. For now biodiesel is mainly produced by small enterprises, and their only feedstock used is vegetable oil. These small plants like any other small, micro, medium enterprises (SMMEs) are facing many challenges. The biodiesel specifically major concerns for these entrepreneurs are feedstock (virgin oils too expensive), uptake (no mandatory blending) and meeting specs required by petrochemical industries [9]. This is because government and other investor are concentration on coming with major projects that will mainly use virgin

feedstock and not used vegetable, while not caring for the only current method of producing biofuel in South Africa. Due to this, there is also a lack of health and safety implementation in the plants for manufacturing biodiesel. As many small business are having a challenge when it comes to complying with the occupational health and safety act. The same challenges experienced in the small scale biodiesel plants

II. LITERATURE REVIEW

A. Used Vegetable Oil as The Potential Feedstock for Small Scale Biodiesel Industries

The demand for vegetable oils has increased rapidly in the past decade, increasing demand for used vegetable oil, particularly in emerging countries, the development of the biofuels industry around the world [10]. The used vegetable oil is demanded by many small scale biofuel plants to produce the biodiesel, used cooking or frying oils are of increasing interest as inexpensive feedstock for biodiesel production [5]. This small scale biodiesel plants collect used vegetable oils as their feedstock from the food outlets restaurants. Biodiesel is generally defined by many scholars as mono-alkyl esters of vegetable oils or animal fats, largely competitive with petro diesel fuel. Defines biodiesel as a renewable fuel produced when agricultural feedstock's such as vegetable oils, rendered animal fats, and used cooking oils are reacted with alcohol in the presence of a catalyst to form fatty acid esters, glycerine, and soap in a process known as *transesterification* [11]. In South Africa, only used vegetable oil is currently used as a feedstock for producing biodiesel. There are many small scale biodiesel plants that are operating in home back yards and small towns, [4]. South African biodiesel industry is mostly small scale using waste vegetable oil collected from food outlets as feedstock. This is the only biofuel production that is currently used in South Africa.

B. Biofuels Industries as Unlocking Opportunities for SMMEs

These biodiesel plants are adding to the overall SMMEs that are creating employment and alleviating poverty in South Africa. SMMEs encompass a very broad range of firms, from established traditional family businesses employing over a hundred people (medium-sized enterprises) [12]. Currently, South Africa has more than 200 small scale biodiesel plants that produce biodiesel from waste vegetable oils [9]. These small plants have been operating for more than ten years now employees' less than five employees. Out of 200 plants with two to five employees, one can tell how many people are involved there so their safety and health is of utmost important. Occupational health and safety in the workplace is very important. All the companies that have employed workers should comply with the occupational health and safety policies. According to the Act no 85 of 1993, strive to provide health and safety of persons at work and for the health and safety of persons in connection with the use of plant and machinery; the protection of persons other than persons at work against hazards to health and safety arising out of or in connection with the activities of persons at work; to establish an advisory council for occupational

health and safety. No matter how big or small the business is, it is very important for all kind of business to comply with this act. The biodiesel plants in South Africa many are in small scales and do not really concern themselves with the health and safety, as they cannot afford the programmers or trainings for their workers concerning the health and safety. The numerous but smaller producers of biofuels did not have the resources that major producers do for addressing compliance with Occupational Safety and Health Administration workplace safety standards [13]. The major course is finance and lack of knowledge. since the business are not that profitable ,plant managers are more concern with the income they have to just run the essential cost of the business which if they have not being paid the business cannot run. No matter the situation they need to know and understand that occupational health and safety is an act that protects all people within the workplace and need to be taken serious as it involves the life of the person and it can affect the business negatively. The biodiesel plants are the only operating biofuels production in South Africa, as many plants that needs to be established are still in a planning stage. Currently these plants are producing biodiesel by using the used vegetable oil from restaurants outlets.

C. The Importance of Occupational Health and Safety in the Biodiesel Industries

It is very crucial for South Africa to produce biofuels that will replace the use of the fossil fuels. The main advantages of producing and using biodiesel come from the fact that foreign oil imports can be reduced, using the current installed distribution networks and the current engine technologies [6]. The biodiesel plants in South Africa even though are small they are playing a role in providing a biodiesel to farmers at a very affordable price and creation of employment, even before development of biodiesel plants , many food outlets did not know where to throw used cooking oil. the use of renewable sources for this biofuel industry helps to increase not only job generation and incomes, but also promoting energy self-sufficiency in rural areas [Small scale biodiesel plants needs to consider the health and safety procedures, while they are doing a good cause for the environmental friendly, need to also think of their own health and safety [6]. using waste materials for processing of energy like used oils, poorly designed and managed reuse technologies may generate toxic emissions such as *dibenzo-p-dioxins*, *dibenzo-p-furans* and PCBs and excessive exposures can increase risks of cancer, and reproductive/ immune disorders for workers and people who live close to industrial facilities [13]. Even though the biodiesel plants are too small, there is needed to take procumbent measures concerning the health and safety measures. Potential hazards of biodiesel production include the use of large quantities of methanol, use of caustic chemicals as catalysts, physical hazards, and potential exposure to aldehydes [11]. Methanol is the more preferred alcohol in South Africa since it a by-product of the coal to liquids process and is therefore abundant and affordable in South Africa [11]. It has to be mostly used be the as in advantageous in terms of cost of producing or processing.

III. FINDING AND DISCUSSIONS

The biodiesel plants in South Africa are producing; up to or less than 3000 liters of biodiesel per annum. Some are restricted by the renewable energy regulation as producing more than 3000 liters; the companies will have to pay a certain amount of tax. Others plants can only produce as little as 1000 liters per year as the plants are very small and the feedstock is also too little. With the perceptions that are experienced by the biodiesel producers from the public on biodiesel, the plants are mostly selling to farmers and other manufactures that are in green initiatives that are using the biodiesel on their automotive machines. Many organizations interested in renewable, domestic energy have switched from petroleum diesel to biodiesel blends for use in transportation and heavy-duty equipment.

A. Lack of Occupational Health and Safey Measures

Most of biodiesel plants are very small employing less than five employees. Most of the signs that represent the occupational health and safety are not visible, while there are many flammable chemicals in the biodiesel plants. The biodiesel industry recognizes its most significant hazard as methanol as it is highly flammable, and exposures can cause a wide range of deleterious health effects. Methanol is easily absorbed by all routes of exposure [11]. It is very important to put flammable sign at the main entrance and also put signs such as no smoking in the work stations. So that they make the people to be aware of before they can actually enter the premises. The workers do not have the month and nose cover, there is a certain smell that is due to used oil and other chemicals, which can have after effect to the people that are is plants most of the hours of every day. The properties of methanol make a particular hazardous chemical both physical and chemical [11]. Workers are not having any kind of protection for both mouth and nose happen to breath the this toxic chemicals all hours of heir working days.

B. Lack Personal Protection Equipment (PPE) and Exposion to Helath Hazards

Workers wear very dirty working clothes that are greasy due to the oils that they work with on daily basis, as they are flammable chemicals such as methanol within the working place, it if very dangerous if ever be a small light of fire such as cigarettes. Most workers in different plants work without proper personal protection equipment (PPE) such as protective gloves, an apron, and eye protection and to not inhale any vapors. Other plants are mobile were huge containers are been utilized for the production of biodiesel. The plants are always experiencing running water available. There are no signs of workspace ventilation. These can be dangerous to children or pets surrounded in the area as the water just takes any directions because there are no sledges for waste water.

C. No special space to dispose waste products

The space where the biodiesel is been produced need to be cleaned most of the time, one find the place very greasy

with the by products and waste products from the used vegetable all. All the waste that are left behind with cleaning the used vegetable oil, are mostly just left in the containers unattended, this is due to the fact that they are shortage of workers. One finds that they are only few workers, who cannot do all the work. Biodiesel plants collect their used oil from the restaurants outlets, which is both good for the environment and the food restaurants outlet, used oil is not through just anywhere and dirty the environment . While the food restaurants outlets are getting income from their waste products. But the biodiesel plant with their waste products they do not have a buyer and no specific space to dump their waste products. They happen to produce a lot of glycerin which is just there and have no market for it.

D. Low Quality of The Biodiesel

Most biodiesel plants are using the batch method to produce their biodiesel plants according to all biodiesel plants in South Africa, except for only three that are batch type processors, batch processes are preferred because they are inexpensive and easy to design, assemble and maintain but can produce the poor biodiesel plants [4]. The use of low or poor biodiesel quality can result in vehicle damage, including filter plugging, fuel injector failure, and repair costs that would not be covered by the manufacturer’s warranty [2]. The plants owner’s states that in most of the time they are unable to test their biodiesel to see if produced biodiesel meets the specs. One of the major challenges faced by small scale biodiesel plants is meeting specs required by petrochemical industries [9]. It shows that most of the biodiesel in South Africa do not take their biodiesel for specs requirements.

IV. RESULTS AND ANALYSIS

The questionnaire on the questions that are related to occupational health and safety was having, three categories namely managers, supervisors and occupational health and safety. The question was out from the questionnaires of the ongoing research; these questions on occupational health and safety were sequent following each other on the questionnaire list. Out of 450 overall response of the study, 12% was the response from questions related to occupational health and safety (see Fig. 1).

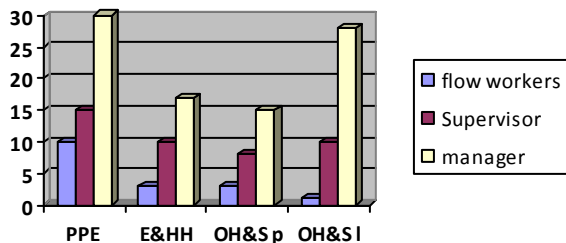


Fig. 1. Results of the survey

The first question that was asking about the availability of the PPE, the response was only 55, the following question was on precautions of explosion to health hazards and only 20 responded. The other question was on finding out if there

are any programs that address the occupational health and safety. There were 26 responses for this question, the last question was finding out if the plants are having a leader who is responsible for occupational health and safety. Out of this question there were 39 responses. With all their response the higher response was from the managers followed by the supervisor , it shows the people who were not that comfortable in answering these question was floor workers, even though they are the ones most affected by injuries and health hazarders. The response of the overall study was 450, out of these responses the questions that are related to occupational health and safety only 55 people were able to respond to the question. Showing that within the biodiesel plants there is still lots of negligence in terms of ensuring safety. Some of the safety methods are not that costly, while other training is paid by government if ever the companies train their people. The Services Sector Education and Training Authority (SSETA, 2014) is one of the 21 SETAs re-licensed by the Minister of Higher Education and Training and is responsible for skills development in the services sector [16].

V. RECOMENDATIONS

South Africa has many agencies that are employed to assist the development of small business enterprises. It must also concern these agencies to see if the people who are employed in the small business are safe in their workplaces. It is also the responsibility of the agencies to run programs that will teach the small business of the importance of the occupational health and safety. The agencies should encourage these small business owners to take the teaching to their work places.

Small businesses can also be required to be certificated with the health and safety policy once they have employed workers in their business. They can acquire the certificate by being trained by the agencies that support the small businesses enterprises. The owners of the business can also be taught on how to work with Service Education Training Authority (SETA) to train their employees without costing their businesses.

It will be very important for government to do an annual report on the health and safety of the biofuel industries. Like many developed countries were they are records of all the hazards due to lack of the health and safety practice in the work places. The case studies of the injuries and the death that are causes by the chemicals, raw materials (such oilseeds, used vegetable oil and animal fats), biodiesel equipment and the environment need to be issued. To show the employers of the biodiesel plants the importance of taking the health and safety precautions in to consideration at all time.

Results of practicing and not practicing occupational health and safety need to be disclosed by organizations that support the SMMEs, the department of labor and non-governmental organizations that are interested on occupational health and safety to all the biofuel industries that are operating in South Africa.

VI. CONCLUSION

SMME's remains the pillars of poverty alleviation and employment creation. Employers many people with little or no education, trying to make a living for themselves and their families. It is very important for organization to assist in the implementation of occupational health and safety in the small manufacturing businesses. Many deaths and health threatening diseases are caused by the results of being exposed to safety and health hazardous from the work places. Most of this incidents are not been investigated as they are happening to the poor people. Many people are being employed by this small manufactures, it's then the responsibility of agencies that support the SMME's and department of labor to pay attention in to such challenges. More research needs to be done on the biodiesel industries to ensure more safety measures that are needed. The research to focus on the chemicals used and how they can affect the users negatively and in tern of the business to check the poor performance that can be causes by the lack of occupational health and safety. This will be ensuring the safety and health of all that are affected by the biodiesel manufacturing industries.

VII. ACKNOWLEDGMENT

Authors would like to acknowledge both University of Johannesburg and National Research Funds for the financial support.

REFERENCES

- [1] NREL, Science Proects in Renewable Energy and Energy Efficiency: A guide for Secondary School Teachers, National Renewable Energy Laboratory (NREL), 2007, pp 106-193 Available Via: http://www.nrel.gov/education/pdfs/educational_resources/high_school/re_ee_projects.pdf
- [2] Z. Wen, S. A. Bantz, C. G. Bachmann, C. Brodrick and L. A. Schweitzer, Small-Scale Biodiesel Production: Safety, Fuel Quality, and Waste Disposal Considerations, Virginia Tech, 2009, pp 442-885, Available Via: http://pubs.ext.vt.edu/442/442-885/442-885_pdf.pdf
- [3] Extension. Safety in Small-Scale Biodiesel Production, American Research -based Learning Network, 2013, Available via: <http://www.extension.org/pages/29265/safety-in-small-scale-biodiesel-production#.VJOEFsDA> Last Accessed 26/12/2014
- [4] C Mbohwa, and A. Mudiwakure, The Status Of the Used Vegetable Oil Production in South Africa, Proceedings of the World Congress on Engineering London, U.K. 2013. Vol.1 pp 3 -5
- [5] G. Knothe, and K. R. Steidley, A comparison of used cooking oils: A very heterogeneous feedstock for biodiesel, Biosource Technology, Elsevier, 2009, Vol. 100, pp 5796-5801
- [6] L.E. Rincón, J.J Jaramillo, and C.A. Cardona, Comparison of feedstocks and technologies for biodiesel production: An environmental and techno-economic evaluation, Renewable Energy, Elsevier, 2014, Vol. 69, pp 479-487
- [7] T. Letete, and H. Von Blottnitz, (2012) Biofuel Policies in South Africa: A critical analysis, Bioenergy for Sustainable Development In Africa, Springer pp 191-199
- [8] DME, Biofuels Industrial Strategy of the Republic of South Africa, Department of Minerals and Energy (DME), 2007, Available via: http://www.energy.gov.za/files/esources/renewables/biofuels_indus_strat.pdf%282%29.pdf
- [9] W.H. Van Zyl, and B.A. Prior, South African Biofuels, IEA Taskgroup 39 Progress Report, Chair of Energy Research: Biofuels, department of Microbiology, Stellenbosch University, 2009.
- [10] IEA Bioenergy, A Global Overview of Vegetable Oils, with Reference To Biodiesel, 2009.
- [11] B. F. Law, T. Pearce, and Siegel, P.D. Case Study, Journal of Occupational and Environmental Hygiene, Taylor and Francis, 2011, Vol.8 no.7 pp. 68-72.
- [12] A. Berry, M. von Blottnitz R. Cassim, A. Kesper, B. Rajaratnam, and D. E. van Seventer, The Economics of SMMEs in South Africa, Trade and Industry Policy Strategy, 2002, Available Via: <http://www.tips.org.za/files/506.pdf>, Last Accessed 18/12/2014
- [13] WHO, Health in the green economy: Co-benefits to health of climate change mitigation, 2014, Available Via: http://www.who.int/hia/green_economy/hgebrief_occ.pdf, Last Accessed 18/12/2014.
- [14] Act no 85 of 1993, Department of Labour, Occupational Health and Safety Act, April (2014), available via: <http://www.labour.gov.za/DOL/downloads/legislation/acts/occupational-health-and-safety/a85-93.pdf> , last accessed 10/12/2014
- [15] Services Sector Education and Training Authority (SSETA), 2010, Available Via: <http://www.serviceseta.org.za/Pages/home.aspx>