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EXPERIENCES OF SMALL-SCALE, BATCH BIODIESEL PRODUCERS IN SOUTH AFRICA: CHALLENGES AND SUCCESS FACTORS
ISKUSTVA PROIZVOĐAČA U MALOSERIJSKOJ PROIZVODNJI BIODIZELA U JUŽNOJ AFRICI: IZAZOVI I FAKTORI USPEHA

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ABSTRACT

The biodiesel industry in South Africa is still on the developmental phase thus this study gives a general outlook on the current position of small-scale biodiesel producers. This study reports on the experiences of various small-scale batch biodiesel producers in South Africa and provides a reference framework for new entrants into the industry. Snowball sampling was used to identify and illustrate the current scenario of South African small-scale batch processing biodiesel producers who were voluntarily interviewed on issues relating to technology systems employed, capital investment, production costs, management and operation of the plant and biodiesel quality testing methods. This paper further reports on the challenges in small-scale biodiesel production. It was found that the present economical as well as the legislative environment is not conducive to the profitable production of biodiesel. Using literature and the interviews, deductions and recommendations were made for elevating the South African biodiesel industry. The future outlook of this investigation is that once the recommended success factors are implemented, this would assist to further develop the biodiesel industry and spur the market for biodiesel uptake.

***Key words**: Biodiesel, Renewable Energy, Small-Scale Production, South Africa.*

REZIME

Industrija biodizela u Južnoj Africi je i dalje u fazi razvoja tako da ovo istraživanje pruža jedan opšti prikaz trenutne situacije proizvođača u maloserijskoj proizvodnji biodizela. Ovo istraživanje opisuje iskustva različitih proizvođača u maloserijskoj proizvodnji biodizela u Južnoj Africi i pruža referentni okvir za one koji tek ulaze u ovu proizvodnju. Koristila se tehnika „snežne grudve" da bi se odredio i ilustrovao trenutni razvoj događaja za južnoafričke proizvođače u maloserijskoj proizvodnji koji se bave preradom biodizela, koji su dobrovoljno dali izjave o temama vezanim za tehnološke sisteme koje koriste, kapitalne investicije, troškove proizvodnje, upravljanje i rukovanje postrojenjem i metodama za testiranje kvaliteta biodizela. Ovaj rad zatim govori o izazovima u maloserijskoj proizvodnji biodizela. Utvrđeno je da sadašnje ekonomsko kao i zakonsko okruženje ne vodi ka profitabilnoj proizvodnji biodizela. Pomoću literature i intervjua, došlo se do zaključaka i preporuka za unapređenje industrije biodizela u Južnoj Africi. Prognoze za budućnost su da će implementiranje faktora uspeha pomoći daljem razvoju industrije biodizela i dati podsticaj tržištu za prihvatanje biodizela.

***Ključne reči**: biodizel, obnovljiva energija, maloserijska proizvodnja, Južna Afrika.*

INTRODUCTION

The current global liquid energy market is dominated by fossil fuel consumption. However the rising world fuel prices, increased demand for energy and concerns about global warming are the key factors driving the global trends towards renewable energy resources (*Rosegrant et al., 2008*). Biodiesel is a renewable liquid fuel with the potential to compensate conventional fossil based diesel in the liquid fuel matrix. Biodiesel has a potential to reduce dependence on foreign energy supplies and mitigating greenhouse gas emissions (*Tareen et al., 2000*).

Biodiesel has the potential to create jobs throughout the value chain, from feedstock production to processing and manufacture, up to distribution and retail of the biodiesel product (*Visagie and Prasad, 2006*). The main driver for developing a biodiesel industry as outlined in the South African Biofuels Industrial Strategy released in 2007 is to use biodiesel production to stimulate agricultural production and to generate employment opportunities especially in previously disadvantaged areas (*Wilson et al., 2005*).

The SANS 1935:2004 is the South African National Standard for automotive biodiesel fuel. Therein biodiesel is defined as "fuel comprised of methyl esters of long chain fatty acids derived from vegetable oils". The technical information from the publications of the European Committee for Standardization was used when developing this standard (*SANS, 1935*). The identified feedstock seed oils suitable as feedstock for South African biodiesel production are soya, sunflower and canola. Jatropha excluded because it is an alien species thus further research is required to determine its suitability in South Africa particularly for water use efficiency (*DME, 2007*). According to *Hoekman* (*2009*), waste oil can be used as a cheaper alternative to virgin oil, however in order to secure sufficient volumes of biodiesel production it would be necessary to develop designated energy crops for sustainable feedstock supply.

The challenges associated with the South African biodiesel industry which is still on the developmental phase include technological immaturity and unpredictable government energy policies. This restricts support and investment from financial institutions thus hindering entrepreneurship in renewable energy projects (*Amigum, 2008*). The high initial investment required to build large scale plants and to obtain sufficient volumes of feedstock are the major obstacles in establishing continuous plants. Batch operations are more popular for small-scale production due to their feasibility. The shortcoming of batch production is that it tends to create quality and homogeneity problems in the final biodiesel product (*Bender, 1999*).

The South African biodiesel industry is still in the developmental stages (*DME, 2007*). This survey study was conducted

during 2009 and 2010 whereby South African small-scale batch biodiesel producers were interviewed. The aim of the investigation was to collate information based on the activities and experiences of the producers. This study is relevant in this critical phase of development as it gives an understanding of the biofuel production environment. In addition, the challenges and success factors related to small scale batch biodiesel production are highlighted and recommendations are made for the future development of the South African biodiesel industry.

MATERIAL AND METHOD

A snowball sampling method was used to identify the small scale batch biodiesel producers and in order to form the sample of interviewees. A questionnaire was developed with the aim of capturing the experiences of South African small-scale batch biodiesel producers. It was developed such that a broad overview of the experiences and outlook of the respondents could be captured. With the intention to get better understanding of the situation, the interviews were conducted in person nevertheless in order to promote honesty and openness, the identities of the producers were not to be published. An excel spreadsheet was used for data capturing. Basic statistical analysis was then done to establish the general viewpoint of the producers and to determine ballpark figures related to biodiesel production. Based on their responses, deductions were made to determine the challenges and success factors in biodiesel production. Information was gathered regarding (i) compliance to regulations, (ii) the type and quality of feedstock, (iii) the type of technology systems employed, (iv) capital investment, (v) methods of biodiesel quality testing, and (vi) anticipated challenges

Compliance to Legislation for Biodiesel Production Licensing

The guidelines on biofuels licensing were released in 2007 by the South African Department of Energy which stipulates the various legislations for the licensing criteria to manufacture biofuels. These were listed in the questionnaire and the respondents were asked to indicate whether they comply with the legislation or not. The outcome of compliance and non-compliance for each regulation was then computed from the sample.

Utilisation of Plant Capacity

The annual design capacity of the biodiesel equipment was compared with the actual volumes of biodiesel produced by each respondent as calculated over a particular year cycle. The South African Revenue Services by the authority of the National Treasury stated in 2003 that a tax exemption will be allowed for biodiesel production below the threshold volumes of 300 000 ℓ per annum, this was used as a baseline for comparison.

Utilisation of Biodiesel Produced

The use of biodiesel was categorised into three options where producers were asked to choose from namely (i) own use, (ii) selling biodiesel to other companies or consumers, or (iii) both selling as well as own use.

Anticipated Challenges

Anticipated challenges for new entrants in the biodiesel industry were listed. The respondents were asked to rate the challenges on a scale of 1 to 6 according to difficulty, where 1 is not a challenge up to 6 being extremely challenging. The mean value and mode were then computed.

RESULTS AND DISCUSSION

From the snowball sampling method seventeen credible small-scale, batch biodiesel producers were indentified thus used as a sample for this study. The outcome obtained from their responses to the questionnaire were analysed and are presented and discussed in this section.

Compliance to Legislation for Biodiesel Production Licensing

Table 1 presents the regulations to be adhered to in order to meet the licensing criteria thereby showing the outcome regarding the regulations that the respondents comply with. It was found that 84% of the producers had registered with the receiver of revenue. This may be encouraged by the tax exemption for small scale producers. The rest of the regulation were not well adhered to and the majority of producers were operating their enterprises without the necessary permits. This non-compliance may be due to a lack of a central administrative body that regulates and enforces compliance.

Table 1. Compliance to regulations and legislation

Regulation Requirements for Registration and Licensing	Number of compliant respondents	Total number of respondents	Percentage (%)
S.A. Revenue Services (SARS) registration	14	17	82.4
Site license	9	17	52.9
Electrical Certificate of Compliance	6	17	35.3
Environmental Impact Assessment	5	17	29.4
Hazardous area classification	3	17	17.6

Utilisation of Plant Capacity

When comparing the production capacity of the biodiesel equipment against the actual amount of biodiesel produced over a year cycle, it was found that all the plants were underutilised. The primary reason that was given by the respondents is that they were still on the production pilot phase. Consequently experimental trial runs were being conducted to test the equipment. Thereafter, once operation systems for the technologies are set up, the production would be expanded however remaining within the threshold volume for non-commercial producers.

Biodiesel Production and Process Technologies

The biodiesel equipment employed by the sample of producers varied and may be categorised as back yard self made products, off-shelf components that were assembled and also equipment that was imported. Due to this discrepancy, quotes were requested from three reputable South African biodiesel equipment suppliers in order to determine ball park figures for the cost of equipment for 200 l, 400 l, 1500 l, 4000 l, 8000 l batch sizes. The quotations were then classified as “low-tech” and “high-

tech" which indicates the quality of material and the sophistication of the technology. The equipment classified as low tech, comprised of plastic components with basic functionality without automation usually used for small volumes. From the three low-tech quotes, the average price for the smallest batch unit of 200 l was R 39 581.00. The equipment classified as high-tech, comprised of durable stainless steel components using automation to run the system usually for large volumes. From the three high-tech quotes, the average cost of the smallest batch unit of 150 l was R 302 500.00.

When evaluating the processes used for biodiesel production, the outcome was that settling was the method preferred by all respondents for glycerol separation and some used it in conjunction with gravitation and centrifuge. Fourteen out of seventeen respondents used pump circulation rather than a stirrer for mixing the reactants. When washing biodiesel, a trend was noticed whereby producers were moving away from water wash toward resin flow bins. The common reason given by respondents was that this method was less messy and it reduced problems of post water treatment and disposal. Only three respondents out of this sample executed methanol recovery. The high electricity cost is the limiting factor.

Biodiesel Quality Testing

When determining the quality of biodiesel produced, 24% of the respondents indicated that they only conduct basic visual tests such as clarity and cloud point tests, rather than taking the samples for laboratory testing. The two main reasons highlighted were, (i) it was assumed that the visual tests were easy to conduct and adequate for determining biodiesel quality (ii) the cost of laboratory testing was too high. The South African Bureau of Standards charges approximately R 8 000.00 per sample to conduct biodiesel tests in line with the SANS 1935 specifications. There are other independent laboratories which charge a lesser price to conduct a portion of the parameter tests in line with the SANS 1935. However, these independent laboratories are not accredited. Nonetheless, small-scale producers rely on them to get an indication of the biodiesel quality.

From the test results that were submitted by the producers who had taken their samples for laboratory testing, it was found that the sample tests were conducted in a random manner. There was no consistent test record for samples of each batch produced. It was deduced that most of the laboratory tests were conducted in the initial trial phases though once improved results are achieved from the system, then fewer laboratory tests were conducted. It should be highlighted that the full parameter specifications must be tested according to SANS 1935 for each batch produced.

Utilisation of the Biodiesel Fuel Produced

Small-scale biodiesel producers who register as non-commercial producers under the threshold volume of 300 000 l per annum are restricted to own use. The biodiesel produced is not to be transferred to other users by sale or in kind. It was found that 42% of the producers in the sample were limiting the biodiesel to own use while overall a cumulative 58% of producers were either selling the biodiesel or using it for both own use and selling as illustrated in Figure 1.

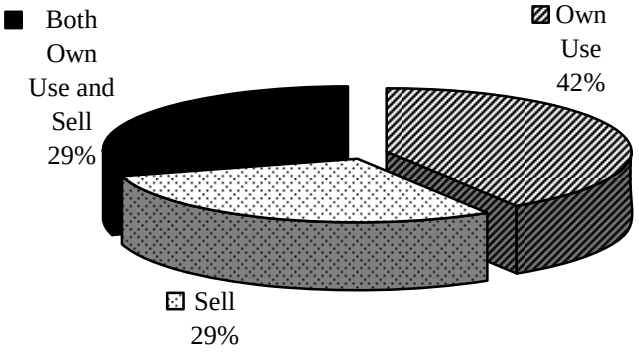

Fig. 1. Utilisation of biodiesel fuel produced

Outlook on the Future of the South African Biodiesel Industry

The producers were asked to explain their plans for the future of their enterprises and indicate whether they will expand, downscale or to stay the same. The result was 53% percent of the respondents wanted to expand their enterprises. From their various reasons, it was deduced that they were optimistic about the future of the South African biodiesel industry. They wanted to be market ready once South Africa's biofuels strategy and policies are implemented. On the contrary, 29% of the producers planned to downscale their operations. This was attributable to a lack of incentives during this developmental phase. The remainder of the producers intend to maintain their current size of operation while they wait to see how the industry develops.

Anticipated Challenges

Acquiring feedstock was rated 5.4, thus the toughest challenge that a new producer entering the South African biodiesel market may encounter. The rest of the challenges were rated as minor to moderate see Figure 2. Without feedstock one can not run a biodiesel enterprise.

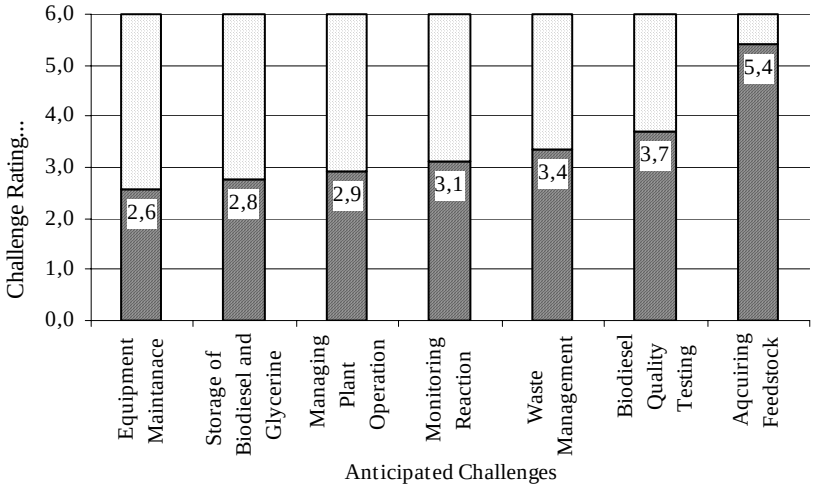

Fig. 2. Rating the anticipated challenges

CONCLUSION

The global drivers towards biodiesel as an alternative renewable fuel are energy security concerns, promoting renewable energy initiatives and to allay climate change. The key driver for biofuels in South Africa is job creation, rural development and agricultural upliftment. The South African government aims to

promote the use of underutilized land especially in the former homelands for biodiesel feedstock production. Biodiesel gives the opportunity to diversify farming operations and has a potential to serve as an income stream on each stage of the biodiesel production value chain. Adequate and reliable supply of feedstock is an important aspect of the production process in order produce the required volumes of biodiesel. The cost of virgin oil as feedstock for biodiesel production is limiting as compared to the gain from using virgin oil in the food and beverage industry. Waste vegetable oil is mostly used as a cheaper feedstock. It is challenging to reach quality specifications when using waste oil as input. The overall capital and production costs to start up biodiesel production operation are high. This is aggravated when there is no support from investors or banking institutions. Thus it is essential for government to facilitate funding schemes with funding institutions and to put policies and legislation that promote advancement of the biodiesel industry. These efforts would assist to create a biodiesel market and demand for the biodiesel product as consumer uptake and awareness would be encouraged. It would be of benefit to create awareness programs to provide support to small-scale biodiesel producers on technical guidance, to dispel any misconceptions, highlight the benefits and raise interest into biodiesel production and use. It is required that a law enforcement and quality monitoring strategy be implemented. This would ensure that correct procedures are followed in establishing biodiesel production operations and that the biodiesel quality produced is of an acceptable standard.

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