Integrated Production of Bio-diesel Esters and Glycerol: Top Grade Glycerol As Key Factor of Economical Success in The Bio-diesel Cycle

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INTRODUCTION

It has been noted that, beginning from early 1991 till now a substantial number of transesterification plants have been in operation all over the world. Continental Europe has been particularly active in this field, due to the interest of the business itself but mainly due to the encouragement of Regional, National and EEC Authorities finally to search for a stable solution of the dramatic problems of pollution, a more rational use of city for fuels and a better performance of agricultural resources. The agreements of last GATT and consequence of new PAC has given a further impulse to this activity.

TRANSESTERIFICATION PLANT

From the technical and economic point of view with reference to the last three years at least ten units have started the production of methyl esters in Europe, using soya bean, rapeseed and sunflower oil as raw material.

Other ventures, based on same raw materials, took place in the United States. And an intensive activity of research and development based on palm oil began in the region of Far East, mainly due to the effort of Malaysian authorities through the Palm Oil Research Institute of Malaysia (PORIM). Some of such installations were obtained by modification of existing plants, originally designed for other processes and presently under utilised (typical case is the reactor of alkyd resins). Others are the design of new parts using processing know-how "home made" were built by individual companies. According to our knowledge, none has built a specific and working installation for bio-ester fuels at fully integrated cycle.

Looking at the actual scenario, we realise that the capacity of production of single units varies from 2,000 to 60,000 tonnes per year. However the practical results are different from unit to unit. At present, quite a number of such installations arealready or are going out of production for different reasons including:

- inability to meet the very strict specifications imposed by the EEC authorities to market the biodiesel. And it is also the same for other continents where the official specifications imposed on the biodiesel will be similar.
- not economic due to a non performing process.
- unable to reach the economic of scale, due to the installed capacity.
- and various other factors, including lack of raw materials at proper range of quality/price.

The existing installations are not equipped with a refining-section for glycerol, which is the "key factor" of economic performance.

KEY FACTOR OF SUCCESS

In the last few years we had various experiences in continental Europe, acting as consultants to solve specific problems. A certain activity has been carried out also in other continents, where this kind of business is about to start. Some of the key factors that are necessary for success are as follows;

- availability of local vegetable oil as surplus from edible use (certainly the case of palm oil in Malaysia and neighbouring countries).
- availability of a modern, specific and economic *know-how* of process.
- availability of an industrial plant of 50,000 tonnes/year - 100,000 tonnes/year capacity to maximize the economies of scale.
- capability to produce the fuel-ester at an production cost of about US$100/tonne over the raw material cost.
- capability to optimise the credit coming from crude glycerol as by product to give added value in the process economics.

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GLYCEROL PRODUCTION AND ITS ECONOMICS

In running up a transesterification plant to obtain an ester of correct specification and economics, there is a by-product of about 10% crude glycerol. The composition of this material varies according to the method of transesterification process. The traditional technologies for glycerol refining now available in the international market are able to process the mixtures of glycerol and water. By splitting and soap-lye this is the natural process of obtaining natural glycerol.

Crude glycerol from biodiesel is a fully new product that could not be processed according to the present technologies to obtain a product of Pharmaceutical Grade. This is because the crude glycerol produced from biodiesel technologies contains some peculiar impurities that need to be removed. This is why the producers of diesel esters are forced to sell their crude glycerol to the professional refiners. These refiners mix the biodiesel crude glycerol with traditional glycerol/water crude, then processing the blend in usual way to produce a second quality refined glycerol with great losses and high costs.

In some other cases the crude glycerol coming from a particular transesterification process is used in agriculture as organic fertilizer. Therefore the quotation of crude glycerol is low and according to our experience the refiners pay from a minimum of US$250/tonne to a maximum of US$750/tonne according to grade and impurities of crude. The value of crude is even lower, in the case of agricultural usage. Taking into consideration that the actual market price of refined glycerol (Pharmaceutical Grade) is around US $2,000/tonne, there is a difference of US$ 1,250 to 1,750/metric tonne of glycerol, corresponding to a credit of US$125 to 175/tonne of biodiesel which is lost by the producer. In the case of agricultural use the economic recovery is marginal which covers storage and transport costs.

Before entering the field of biodiesel esters it is best to consider the above mentioned factors. The profitability of the business, even in presence of 'set-aside' conditions for the vegetable oil (as in Europe now) is governed by the performance of the transesterification process and the capability of raising the value of the crude glycerol which is the by-product.

The existing and traditional transesterification plants are not equipped with a proper refining section of glycerol and therefore forced the sale of crude, giving the following economics:

Industrial cost of transesterification	US$180/tonne
Credit from sale of 10% crude glycerol	US$25 - 75/tonne
Net cost of Biodiesel production	US$155-105/tonne

The integrated process we would suggest would give the following economics:

Industrial cost of transesterification	US$100/tonne
Credit from sale of 10% refined glycerol	US$200/tonne
Industrial cost for 10% refined glycerol	US$18/tonne
Net cost of Biodiesel production	US$82/tonne

This means that in the first case the practical cost of one tonne of biodiesel for the producer is : cost of oil plus US$155/105. On the second case the practical cost of one tonne of biodiesel for the producer is the cost of oil minus US$82.

CONCLUSION

As a conclusion from the experiences made through the years of 1991 - 1994 in the production and use of biodiesel esters, it could be summarised that the following elements as already acquired :

- The new PAC established in Europe has been successful in reducing the production edible oils with a consequent improvement in market prices. It is estimated that an improvement of market price of about 20 - 25% has been achieved.
- There is a positive evidence that biodiesel can be used, alone or in mixture with The excess of oil produced derived from the 15% of 'set-aside' is easily absorbed by the industry in the production of biodiesel fuels. mineral based diesel, in traditional engines and/or in Central Heating Systems resulting a considerable improvement of the air pollution level.
- The market price of vegetable oils appointed to industrial use averages US$ 120 - 180/tonne

below the level of edible oil, due to the 'set-aside' subsidy. This level would be acceptable.

- Helps from EEC on different programmes to make the level of the industrial investment much lighter.
- The level of detaxation established by the EEC authorities makes the Bio-Diesel fuels competitive in price compared to the traditional petro-diesel for the final consumer. The community enjoys a lower level of pollution without any additional cost.
- This is only the substitution of less than 1% of the total consumption of petro-diesel used in Europe, due to the limited 'set-aside' areas.
- There is strong evidence that the real production cost of palm oil in Malaysia makes this raw material very attractive for the production of biodiesel.

The global scenario is then positive and we can conclude that:
in Europe, the policy of the community has been fair and useful to promote production and use of biodiesel. Once established that the EEC authorities have already made a substantial effort in giving financial help to investments, subsidy to set-aside areas and detaxation of resulting fuel, we cannot ask for a further improvement of actual conditions. We could eventually ask for an increase of areas and oil availability. But the price per unit of oil and biodiesel is already optimised.

In Malaysia, there are opportunities to start this business, thanks to the availability of palm oil at correct price and volume. The rock bottom price for palm oil to be used in local production of biodiesel must be competitive with the FOB price the local oil producers can obtain in the export market for industrial use.

A substantial help could come from an increase in the mineral oil price, sold at an average value of US$15 - 17/barrel in 1994 (we already saw the barrel at US$35!). But one would not invest his money in the hope of such a dramatic event, probably contributing to spoil the failing balance of world' s economies. Therefore one suggestion is not to hope for a further decrease of vegetable oil or for an increase of petro-diesel, but open to invest money on a pragmatic program of revenue and expenditure, based on the available technology.

An investment finalised to the production of biodiesel fuel at an industrial cost of US$100 - 150/tonne above the oil cost is risky and not giving a real revenue in short - medium terms. It is a difficult survival or even disappear, as the present experience shows.

An investment giving a production cost US$50-80/tonne of biodiesel below the oil cost is safe, profitable and with a very short pay-off, making one independent of local legislations, once a resonable level of detaxation in the final fuel is maintained.

Therefore, a positive attitude towards the European investments, based on rapeseed and sunflower, provided that the chosen technology offers a top grade biodiesel ester at a cost of US$50-8-/tonne below the vegetable oil price. Quantities will be of course limited, but the performing producers will enjoy a reasonable return. Presently our company is engaged in supplying the technical know-how and basic engineering and now entering an European Joint-Venture for direct production and sale. But we are much more optimistic about the situation in Malaysia where the production of palm oil is enormous in terms of volume and very interesting at level of price. If we consider that the region is affected by the same European problems in terms of pollution and petro-dollars expenditure, the biodiesel production and use can contribute substantially to an improvement of the agri-industrial economic balance. And furthermore this takes into consideration the increasing necessities of top grade glycerol coming from the rapid development of the entire Far East economy, including Australia and China.

We really believe that in a very short time the better level of industrialization will promote glycerol consumption "per head" similar to those already achieved in Europe and United States. The consumption of energy and glycerol "per head" gives a measure of the trend of development which is going to take place. Both items are strategic, with a strong involvement of economical factors. Malaysia enjoys a brilliant resource, the palm oil and is in a condition now to contribute, with an integrated strategy, to the independent creation of such two "fundamentals".