SUCRO-CHEMICALS*

by

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They say the sun has shone for 5 billion years and is expected to continue for another 5 billion years, and that there was once a time when the only source of energy on earth was the sun. At that time, man had not yet discovered how to create fire and put it to use. All the food he ate was in its natural state. All his transportation was by foot.

Each day the sun sent to earth more energy than the earth could use. Most of this energy was captured by plants. Some of these plants fell to earth, became part of it and were slowly transformed and stored as frozen energy -- oil, gas and coal.

Before the appearance of man and the discovery of fire, an enormous storehouse of energy was laid down to earth from dead organic material. After millions of years, man discovered these underground vaults and in the relatively short period of two hundred years or so, man has withdrawn so much of the stored energy that it has now reached the point of scarcity.

Today earth can no longer make fossil fuel because we no longer allow plant material to accumulate. During the last one hundred years or so we have withdrawn fossil fuel like mad. And this has brought about the most serious economic problem that has faced our civilization in recent years. To solve this problem, the terms are quite clear and definite – we have to find practical and economic substitutes for fossilized fuels.

Fossilized fuels are of great value to the modern world because they are not only a direct source of energy but are also used as a feedstock for the petrochemical industry, whose products have become a modern day necessity. This dual purpose has put a premium on the world's reserves of petroleum. Its flexibility which is satisfying all sorts of market requirements has made countries with petroleum surpluses financially secure.

There are very few alternative proven sources of energy and feedstock that can replace dual-purpose fossilized fuels commericially. For energy there is, of course, hydro-electric power, with its limited resources, nuclear energy, with its well-known hazards, and geothermal energy, also with limited resources.

The oldest known fuel is wood from trees, and wood has been used as a dual-purpose feed in such processes as the production of methanol and turpentine. The further uses of wood as a chemical feedstock are being investigated and developed,

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but wood has its drawbacks because cellulose makes up the bulk (ca 70%) of its composition and cellulose is difficult to break down. Also, wood is bulky to transport.

In this connection, the Philippine National Alcohol Commission is negotiating the UNIDO to set up a pilot plant for the production of ethanol from wood waste using the enzymatic process developed by Gulf Oil in the U.S. A pilot plant for producing ethanol directly from wood using acid hydrolysis is also being tested at New York University. These processes are all promising but it will take a lot of time and effort to make them commercially viable.

Of all the products produced by growing plants and at present commercially exploited, the most useful as dual-purpose feed are the products from the fermentation of sugars extracted either directly from vegetation or by the enzyme or acid pre-treatment of starches.

When we talk about sucro-chemicals, we of course, think of sugar as the base feedstock and the product of its fermentation, ethanol, as the "building block" raw materials.

The increased production of ethanol, by itself, is one of the programs being undertaken by the government and of which I have been put in charge as Executive Director of the PNAC.

Our target is to produce sufficient ethanol to enable us to use a fuel mixture of 80% gasoline and 20% ethanol throughout the country by 1985. This mixture has been found practical in Brazil where today one can no longer purchase pure gasoline for transportation use. The ethanol must be anhydrous, i.e. 99.6% purity, to mix with gasoline without phase separation. Increasing the ethanol percentage in the mixture beyond 20% could cause phase separation as well as reduce the power of the engine in use.

The alcohol presently produced by our distilleries is only 95% pure. Increasing the purity to 99.5% requires the addition of a dehydrating column and involves increased processing costs. A challenge to the investors amongst you would be to develop an economical process of blending 95% alcohol with gasoline without phase separation.

A source of sugar for fermentation into ethanol, we are fortunate in this country to have the soil and climate to produce various agricultural crops that are highly suitable. First and foremost, of course, is sugarcane, the industry of which is well developed. Then there are many other possibilities, such as, cassava, sweet potato, sweet sorghum, corn, nipa, coconut, etc.

The estimated annual yields of ethanol of the well-known crops are as follows:

Crop	Per Ton Harvested (Liters)	Per Hectare (Liters)
Sugarcane	60	3,600
Cassava	1700	3,400
Sweet Sorghum	70	2,000
Potatoes	130	1,800
Corn	300	700

Molasses, a by-product of sugar manufacture, produces 270 liters of ethanol per ton. Nipa and coconut palms are higher yielding than even sugarcane, but the problem is that the collection of sap is too laborious.

In view of its relatively high yield, and the advanced state of development of the industry, we are giving first priority to sugarcane as the basic feedstock for the alcohol program. A most important reason, of course, concerns energy balance. Sugarcane not only yields sugar but also bagasse, which can supply all the fuel required for the process with an estimated 30% in excess. With other crops, there is the possibility of using wood or wood-wastes, but this involves higher collection and transportation costs.

We realize the immensity of the alcogas program and its huge requirements, not only in terms of plant but land area and infrastructure. For example, to meet our 1985 requirements, we shall need an additional 160,000 hectares of sugarcane and/or cassava plantations.

What will happen after we have hopefully reached the first target of 20% blend of ethanol with gasoline. We propose to continue developing the ethanol industry for two purposes.

First is for use as a complete fuel replacement for gasoline. By then we should have developed engines which would operate on pure ethanol, as they have done in Brazil. We have already existing devices, the Alco-tipid of Commodore Protacio, and the dual-feed device of Mr. Concepcion, which enable the use of higher percentages of ethanol in motorcars.

Our second target is the chemical industry which we feel will turn more towards ethanol as its building block.

The products that can be synthesized from ethanol are as follows:

1. By oxidation, we obtain acetaldehyde and acetic acid which find use in the production of acetates and dye stuffs.

2. By hydration, we obtain acetone which is used as a solvent and in perspex manufacture.

3. By dehydration, we get ethylene for plastics and synthetic textiles and also ether is used as solvent and anesthetic.

4. By halogenation, we obtain chloroform for plastics and refrigerants, and also ethyl chloride, an anti-knock compound.

5. By esterification, we get acetates used as solvents and in synthetic textiles.

6. By ammonolysis, we obtain diethanylamine for insecticides.

7. By dehydrogenation combined with dehydration, we obtain butadiene for synthetic rubber.

These processes are all well-known and proven licensed processes. The use of ethanol as the building block will depend on its economics. The following figures show the ethanol requirements of final chemical products on a ton per ton basis.

Ethylene	1.71
LDPE	1.77
Acetaldehyde	1.16
Acetic Acid	0.89
Ethyl Acetate	1.22

VCM	0.78
PVC	0.78
Butadiene	2.47
Acetic Anhydride	0.92

These chemicals that may be substituted by sucro-chemicals are at present generally manufactured from petroleum and natural gas. There are no serious technological problems expected in switching the industry from petro-based to sugar-based chemicals. The deciding factor will be the economics.

In summary, the costs of oil-based products in recent years have escalated much faster than those of agricultural crops. It is reasonable to assume that this trend will continue.

The economic advantages of renewable agricultural-based feedstocks are obvious. With appropriate technology, the production of fuels and chemicals from agricultural crops is an acceptable means of utilizing the power of the sun through the process of photosynthesis and provides a positive balance of energy. Furthermore, increased coverage of our earth by green plants and trees will unquestionably reduce our ecological problems and contribute to the survival of mankind in this modern world.

The manufacture of chemicals based on petroleum and natural gas as raw materials generates much fewer jobs and employs much smaller work forces than those required to plant, grow and harvest an equivalent quantity of crops. The benefits to our country from a shift to sucro-chemicals will not only be in terms of improved ecology and increased domestic employment but also in the tremendous savings in foreign exchange presently required to meet our petroleum import requirements.

In the vast and complex undertaking that I have described, no profession will have a bigger involvement than that of chemical engineering, and I am sure our country will once again need the full support of its chemical engineers in this huge development program.