FEASIBILITY STUDY ON THE ESTABLISHMENT OF THE POWDERED ACTIVATED CARBON PLANTS IN THE REPUBLIC OF THE PHILIPPINES

(SUMMARY)

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JAPAN INTERNATIONAL COOPERATION AGENCY

I. Introduction

1. Background of Feasibility Study

Various measures are being adopted in the Philippines today for the preservation and effective utilization of forest reserves.

In concert with these measures, forestration is being advanced actively and regulations relating to felling of trees are being enacted. In addition, exports of timber as felled is controlled in order to promote exports of processed timber.

Under the existing situation of active enforcement of these measures, it has become vitally important for the Philippines, in order to promote development of the domestic forestry industry, to encourage efficient utilization of sawdust that is being cast away by sawmills without being utilized, and of logging waste and residues that are being left to rot wastefully in the mountains.

From the standpoint of effective utilization of these untapped timber resources, joint basic research is being advanced these several years between the Government Industrial Development Laboratory, Hokkaido that is a governmental research institute of the Japanese Government and the National Institute of Science and Technology that is a research institute of the Philippine Government, with the aim of developing technologies for producing powdered activated carbon from tropical wood. Findings of basic research have corroborated that several kinds of tropical wood are pormising for use as the raw materials for manufacturing powdered activated carbon.

Against this backdrop, the Philippine Government requested the Japanese Government to extend technical cooperation for sounding out the feasibility of commercializing the manufacture of powdered activated carbon on the basis of the rsults of these basic research activities.

In response to this request, the Japanese Government entrusted the work of extending technical cooperation to Japan International Cooperation Agency.

The Japan International Cooperation Agency dispatched a preliminary survey team to the Philippines in March 1983, where deliberations were held to define the scope of work to be conducted in connection with basic items when carrying out the feasibility study. Based on these deliberations, an agreement was reached between the Agency and NIST on "Implementing

Arrangement for Technical Cooperation between Japan International Cooperation Agency and National Institute of Science and Technology for Feasibility Study on the Establishment of the Powdered Activated Carbon Plants" (hereinafter referred to as I/A), and both parties affixed their signatures to this agreement.

2. Objective of Feasibility Study

The objective of this feasibility study is to make a feasibility study (hereinafter referred to as F/S) on the establishment of powdered activated carbon plants using tropical wood and waste available in the Philippines as the raw materials, based on the aforementioned I/A and Minutes of Meeting on I/A.

3. Scope of the Study

The scope of the study is described in detail in the I/A and Minutes of Meeting, and the principal items are summarized as follows:

a) Review and analysis of the background of the project
b) Market study
c) Study on raw materials
d) Study on the plant site
e) Drafting the conceptual design of the plant
f) Financial analysis
g) Economic and social evaluation

Also, regarding the tests on the manufacture of powdered activated carbon which are conducted in the compounds of NIST in parallel with the feasibility study, close liaison is to be maintained with the Test Team and the performances of the product evaluated in order to feed back these results on the selecton of raw material and plant site.

II. Activated Carbon Manufacturing Industry in the Philippines

1. Background and Present Status of Activated Carbon Manufacturing Industry

In this respect, the Philippines is blessed with abundant raw materials such as coconut shell, timber and sawdust, which provide advantageous conditions for the activated carbon industry. However, the existing situation is that only coconut shell is being utilized as the raw material for manufacturing coconut shell activated carbon, which belongs to the category of granular activated carbon. Timber and sawdust, which are also usable for producing powdered activated carbon, have not been utilized so far for the manufacture of activated carbon.

In the Philippines coconut shell activated carbon is being manufactured as described above and the larger portion of it is being exported.

Excepting for coconut shell activated carbon, no other form of activated carbon is being manufactured in the Philippines, so the entire volume of coal-based granular activated carbon as well as wood-based powdered activated carbon necessary for industries in the country is being imported.

Coconut shell activated carbon came to be manufactured in the Philippines in the early 1970s with the cooperation of Japanese activated carbon manufacturers, and today four plants are in operation. The aggregate registered production capacity of these plants runs up to 12,480 tons/yr. Incidentally, a new plant has been constructed recently in Atimonan (Quezon Province).

2. Import of Activated Carbon

In 1981 and 1982 a quantity of about 1,300 tons of activated carbon was imported annually. The main exporting countries were Japan, Netherland, Belgium, United States and Taiwan. The activated carbon from the United States consisted almost of coal-based granular activated carbon and that from Europe and Japan consisted of coal-based granular activated carbon and wood-based powdered activated carbon.

Since the Philippine economic situation was stable in 1981 and 1982, the above-mentioned import of activated carbon in both years is considered to reflect the correct market of activated carbon in the Philippines.

III. Forestry in the Philippines

1. Forest Resources

Of a total of 30,000,000 hectares of the whole land of the Philippines, the forest lands occupy 16,629,000 hectares. The forest lands specified by land classification total 11,076,000 hectares. Dipterocarp forests occupy 8,600,000 hectares.

41% of these forests exist in Mindanao Island, 37% in Luzon Island, and 22% in Visayas Island.

The timber volume of these forests totals 796,000,000 m^3, the breakdown of which shows that dipterocarp forests occupy 662,000,000 m^3 (83.2%). Of the stock of forests, Mindanao possesses as much as about 50%, Luzon 30%, and Visayas 20%.

2. Timber Licenses

The leases given for the use of forest lands were 1,242, covering 790,192 hectares. Mindanao Island possesses most of the wood resources of the Philippines, and the largest number of licenses was granted to that island. Of the 186 timber license agreements, 105 were given to Mindanao, and of the 18 ordinary timber licenses, 10 were granted to this island.

3. Production of Log and Lumber

The production of log during 1982 was 4,500,000 m^3, of which 3,000,000 m^3 was produced in Mindanao island.

Of the cut timber lauan enjoyed an overwhelmingly largest volume.

A total lumber production during 1982 was 1,200,000 m^3 and Luzon put out 48% of lumber and Mindanao 44% and Visayas 8%.

4. Kinds of Woods Selected for Tests

The following five species were selected to study if they are useful or not as raw material for manufacturing powdered activated carbon:

Ipil-ipil (Leucaena leucocephala)
Coir Dust (Cocus nucifera)
Kakauate (Gliricida sepium)
Apitong (Dipterocarpus grandiflores blanco)
Falcata (Albizzia falcataria)

IV. Tests

1. Raw Materials

The raw materials put to test consisted of the following wood species. They are ipil-ipil, coir dust, kakauate, apitong, falcata, red lauan, white lauan, Davao sawdust, I.D.C. sawdust and E.A. sawdust.

Davao sawdust was derived primarily from white lauan, I.D.C. sawdust from red lauan and white lauan, while E.A. sawdust was a mixed sawdust derived from primarily apitong and red lauan.

2. Preparation of Raw Materials

There were some kinds of trees which were selected as the objects of tests and whose sawdust was difficult to obtain. In such cases lumbers were procured, crushed into sawdust form, then tested.

3. Drying

Some sawdust contained high moisture and were difficult to carbonize, and since it was also necessary to elucidate the influences of moisture on carbonization, samples of these sawdust were dried and put to carbonization tests.

4. Carbonization

Carbonization was carried out by using an open hearth type carbonization furnace that is being used popularly in Japan.

The furnace is a down-draft type self-combustion furnace having slow carbonization velocity, but it provides char of good quality for use as an activated carbon raw material since carbonization is accomplished at a low temperature. In addition, it features trouble-free and easy operation owing to its simple structure, making it a furnace that is matched to conditions in the Philippines.

The time required for completion of carbonization is normally four days.

5. Activation

Activation was carried out by the gas activation process.

The furnace used in this process was a circular fluidized bed type activation furnace.

Activation tests were conducted by changing the quantity of reactive gas, ratio between H_2O and O_2, quantity of char fed into the furnace, interior temperature of the furnace and char retension time in the furnace, and optimum activation reaction conditions were studied.

Broadly classified, the quality of activated carbon produced by activation under optimum conditions fell into three groups.

Displaying the most excellent quality were the group of activated carbon produced from Davao sawdust, white lauan and I.D.C. sawdust, which featured methylene blue value of 180 mℓ–200 mℓ at 25% yield on raw char. This was followed with activated carbon obtained from falcata, ipil-ipil, kakauate and E.A. sawdust, which displayed methylene blue value of 150–170 mℓ at 25% yield. Coir dust being characterized by a high ash content, activated carbon obtained from this raw material also contained much ash even after activation, thereby indicating a low adsorption ability unless ash was removed by refining.

Also, continuous operation of the activation furnace showed that no special problem was involved, and that good activated carbon could be manufactured with stability.

However, from the viewpoints of volume available and price, the use of sawdust wasted in sawmills is most economical.

6. Refining

Refining provided refined activated carbon conforming to the standards of the revised Pharmacopoeia Japonica whose standards are at present the most rigid among the standards applicable for activated carbon in Japan. By this, it was corroborated that powdered activated carbon can be manufactured that possesses adsorbability and purity which fully conform to the Japanese Standards for Food Additives as well as the Standards of Japan Water Works Association which is applicable to powdered activated carbon for city water.

7. Conclusion

It has been fully confirmed that virtually all kinds of activated carbon for principal applications can be manufactured, including activated carbon for decoloring of sugar, decoloring of amino acids, water purification and for refining of medical drugs, industrial chemicals and liquors such as sake.

V. Markets for Activated Carbon

1. Domestic Market

The market demands for activated carbon in the Philippines are being met by local coconut shell activated carbon, imported powdered activated carbon and imported coal-based granular activated carbon, and the annual volume of consumption of activated carbon runs up to about 1,300 tons.

The activated carbon market consists primarily of the food processing industry, especially the sugar refining, monosodium glutamate manufacturing industry, and edible oil industry. These industries consume nearly 90% of the total volume.

The activated carbon market in the Philippines in 1982 consisted of about 1,000 tons of granular activated carbon and about 300 tons of powdered activated carbon.

2. Export Market

Regarding the consumption in Japan in 1983, about 35,000 tons of granular activated carbon and about 20,000 tons of powdered activated carbon were consumed.

As for powdered activated carbon, a balance is being maintained at present between demand and supply. However, the price of powdered activated carbon shows all signs of rising in concert with the price of raw material sawdust. In fact, a substantial price increase was observed in 1984, and this trend will continue into the future. Accordingly, if a quality wood-based powdered activated carbon of low price is manufactured in some neighboring countries, it will be imported replacing highly priced Japanese powdered activated carbon.

In other neighboring countries, there are some small markets. Because of the situation described above, there is a possibility that the product of the present project finds its market also in Japan and neighboring countries.

3. Sales Plan and Selling Price of the Product of This Project

The domestic sales market is expected to be about 160 T/Y. However, in the sales plan, the domestic sales volume is assumed at 120 T/Y (25%* of annual output). The annual export sales volume is assumed to be 360 T/Y (75%* of annual output).

The product will have to be competitive on the domestic market with the imported powdered activated carbon, and on the Japanese market with the powdered activated carbon of same kind which is presently being imported.

For this reason, it will be necessary to set the product's ex-factory price at US$1,600/T for the domestic market, and at US$1,200/T for the export market (average US$1,300/T), as of prices of September 1984.

Therefore, taking price escalation into consideration the product's average ex-factory sales price at the time of commencement of sale in April 1987 is calculated at US$1,470/T.

Note: Please refer to "Production Capacity" in VI, 2.

VI. Manufacturing Process and Production Capacity

1. Manufacturing Process

It is preferable that the same processes that have been adopted for conducting basic research and manufacturing tests would be selected.

Therefore, when calculating the funds necessary for this project, the estimate was made on the assumption that the following processes would be adopted:

a) Carbonization . . . . Open hearth process
b) Activation . . . . Circular fluidized bed process

2. Production Capacity

In view of the size of the domestic market and of minimum economic scale of the plant, the optimum scale of the plant is recommended to be 40 T/M, or 480 T/Y.

3. Quantity of Raw Material and Utility

According to the results of tests it was found that 16 tons of sawdust (bone dry), 500 kWh of electricity and 20 m^3 of water are necessary for producing one ton of product through project.

VII. *Plant Site*

The study team studied the following seven regions with emphasis placed on their raw material situation:

(a) Cagayan de Oro and Butuan region (northern Mindanao)
(b) Davao region (southern Mindanao)
(c) Negros Island
(d) Isabela Province (northern Luzon)
(e) Metro Manila region
(f) Camarines Norte Province (southern Luzon)
(g) Laguna Province (central Luzon)

It was concluded that Davao City is the best plant site from the viewpoint of raw material procurement, availability of utilities, meteorological conditions, land procurement, transportation cost of product, etc.

VIII. Plant Construction and Operation

1. Required Area

Land:	about 10,000 m^2
Building area:	about 2,900 m^2

2. Civil Engineering Works

Civil engineering works for plant construction involve the preparation of plant construction site, construction of roads in the plant compounds, laying of water drainage channels, construction of peripheral water drainage ditches and the construction of plant fences and gates.

3. Construction Works

Construction works include the construction of the Carbonization Plant, Activation Plant, Office and Laboratory Building, etc.

4. **Ancillary Works**

Ancillary works include the construction and installation of power receiving facility, plant compound illumination facility, water supply facility, firefighting facility and telephone facility.

5. **Procurement of Machinery and Materials**

Machinery and equipment of the plant and the structural materials of plant buildings are to be imported from Japan.

6. **Construction Period**

The time required for plant construction is one year, including the time required for test run.

The plant is assumed to be completed by March 1987.

7. **Required Personnel**

Total required personnel for this plant is 56 personnel. Among them, five persons are for management staff, and the other 51 persons are comprised of 35 skilled workers and 16 unskilled workers.

8. **Operation**

The number of days of plant operation is assumed to be 300 days annually. The plant's operation rate in the initial year is 70%, and 100% in subsequent years.

IX. Required Fund

1. **Method of Estimation**

All the prices and costs were estimated in September, 1984.

Then, these prices and costs were escalated on an assumption that they will escalate with an annual escalation rate of 5% up to the time of completion of plant construction.

2. **Exchange Rate of Currency**

The following currency exchange rates are used in this study.

US$1 = ¥245 = ₱18

3. **Required Fund**

The total funds necessary up to the completion of plant construction in March 1987 are estimated to be US$1,823,548, of which foreign currency portion is US$1,316,481 and local portion US$507,067.

4. **Sources of Fund**

The foreign currency portion of funds is to be met by a long-term loan, and the local currency portion by equity. The conditions for borrowing long-term loan are assumed to be uniform repayment in ten years, and the interest rate 8% (Case A) or 12% (Case B). Short-term fund deficiency is assumed to be met by a short-term loan at an interest rate of 30% per annum.

X. Financial Evaluation

1. **Income Tax Rate**

The corporate income tax rate is as follows:

0 – ₱100,000	25%
Over ₱100,000	35%

2. **Tax Credit**

The following tax credits are offered to this project:

a) Tax credit on Net Value Earned
b) Tax credit on Net Local Content of Exports

3. Financial Analysis

Internal rates of return are as follows:

	Case A	Case B
IRR on investment (before tax)	15.27%	14.91%
IRR on investment (after tax)	13.58%	13.33%
IRR on equity (after tax)	21.26%	15.03%

As observed from the aspects of production cost, debt service coverage ratio, pay-out period, rate of return on investment, rate of return on equity, etc., this project is judged to be financially feasible.

4. Economic Analysis

The economic rate of return on investment is as follows:

EROI	20.85% (Case A)
EROI	20.68% (Case B)

The amount of foreign currency acquired through this project (amount of import substitute plus export revenues), after subtracting the interest and capital repaid on the long-term loan, will be as follows:

US$5,012,871 (Case A) (Value in 1987)
US$4,772,932 (Case B) (Value in 1987)

Carrying out this project will provide various kinds of indirect benefits in addition to the direct benefits.

XI. Conclusion

No technical problem is encountered in carrying out this project. As observed from the results of financial and economic analyses, the project is concluded to be feasible.

XII. Recommendations

1. In order for the product manufactured through this project to compete favorably with foreign products on export markets, it would be desirable for the product to be given further special promotional incentives from the aspects of taxation.

2. Since this project provides foreign currency by a small amount of investment and within a short period of time after commencement of plant operation, it will be desirable for the project to be carried out as early as possible.

3. More than half of the product manufactured through this project is to be exported. In order to expedite the sale of the product on the foreign market, a business tie-up with a foreign activated carbon manufacturer will be necessary. This will also have the effect of stabilizing the foundation of this project.

4. In order to operate the plant with stability, training of employees and guidance in plant operation will naturally be necessary. However, these operations will be very costly, and the expenses for long-term guidance may oppress the plant's financial conditions. Even when taking this factor into consideration, a tie-up with a foreign activated carbon manufacturer is considered to be advantageous.

5. The corporate body carrying out this project may be an official organization, a private corporation or its joint concern. However, as observed from the standpoint of early project execution and brisk corporate activity, the selection of a sawmill as the enforcing entity will be a desirable form. In this case, as it will be possible to utilize the various conveniences possessed by the sawmill, highly advantageous conditions can be obtained in connection with plant construction and operation including raw material procurement.

6. It is recommended that, in the commerical implementation of the project, NIST gives its assistance to the enterprise/investor/s as required.

7. It will be necessary for the plant management to constantly strive to acquire an ever wider scope of knowledge relating to the activated carbon industry as well as industries utilizing activated carbon as a means of expanding the sales market for the product.

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