5.4.8 Heat Balance of Activation Furnace

The heat balance of the circular fluidized bed activation furnace described in Item 5.3.2 was analyzed by conducting surface temperature measurement, heat flow measurement and gas composition analysis.

In this test furnace, the retort was maintained at a high temperature of over 1,000°C by means of the heat generated by the combustion of raw material char, without using any fuel at time of its normal operation. Accoridngly, heat management is a vital factor for improving product yield, and also ninfluences the product's quality. Table 5A-1-24 shows the activation furnace's heat balance, and Fig. 5A-1-39 its heat balance diagram. According to Table 5A-1-24, the furnace's thermal efficiency is 84% showing that the furnace has high thermal efficiency.

Fig. 5A-1-40 shows the surface temperatures and heat flows measured at various points on the activation furnace. The heat flow was measured by means of Shotherm HFM Type made by Showa Denko K.K.

Table 5A-1-24 HEAT BALANCE OF ACTIVATION FURNACE

Thermal Input			Thermal Output		
Item	10^3 kcal/hr	%	Item	10^3 kcal/hr	%
Char combustion heat	115.5	83.3	Waste heat boiler recovery heat	35.3	25.4
Heat of activation steam	23.2	16.7	Hot water jacket	10.2	7.3
Circulating gas	(2.0)	(1.4)	furnace heat radiation	5.1	3.8
			Boiler heat radiation	1.5	1.1
			Collector part heat radiation	15.6	11.1
			Activated carbon heat	0.1	0.1
			Non-combusted CO heat	23.2	16.6
			Non-combusted H_2 heat	37.5	27.0
			Stack flue gas heat	10.2	7.6
			Circulating gas	(2.0)	(1.4)
	238.7	100		238.7	100

Fig. 5A-1-39 HEAT BALANCE OF ACTIVATION FURNACE

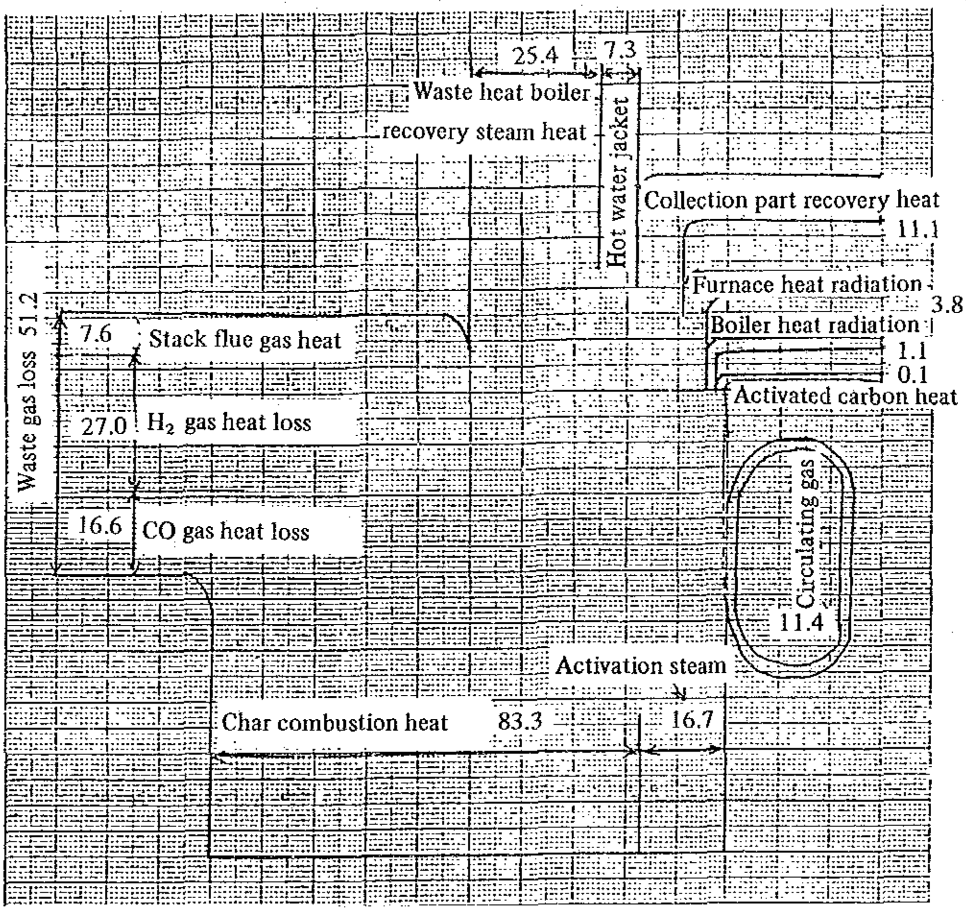
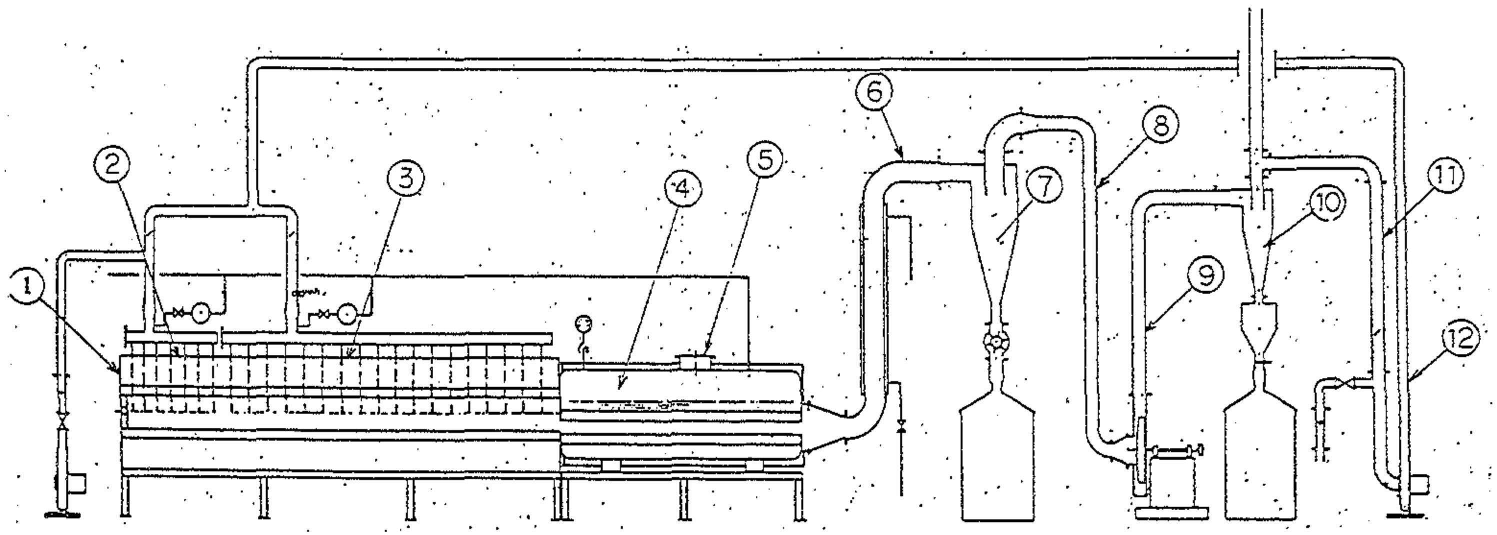


Fig. 5A-1-40 SURFACE TEMPERATURES AND HEAT FLOWS

Measured Point	1	2	3	4	5	6	7	8	9	10	11	12
Heat flow (kcal/m^2.hr)	589	370	428	281	1,130	1,788	1,614	984	890	645	416	330
Temperature (°C)	67	55	59	44	95	132	128	93	84	76	59	50



5.4.9 Crushing Test of Activated Carbon

Activated carbon was crushed by using a hammer type sample mill described in Item 5.3.3. Powdered activated carbon is normally used in liquid phase, primarily by the batch system. Accordingly, powdered activated carbon is demanded to feature great adsorption speed and ease of discrimination of filtered substances. Also, in order to accomplish refining (to be described later) efficiently, particle size adjustment will also be necessary.

Table 5A-1-25 shows an example of standards based on prescribed testing methods, and Table 5A-1-26 the results of the crushing test.

Table 5A-1-25

Screen Mesh	Screen Residue
100 mesh (149 μ)	Less than 5%
200 mesh (74 μ)	Less than 10%

Table 5A-1-26

Kind of activated carbon			Ipil-ipil	Davao white lauan	IDC sawdust	Davao sawdust	Davao sawdust
Activated carbon feed rate (kg/hr)			5.5	5.8	6.1	8.7	6.5
Load current A			3.3	3.4	3.4	4.6	3.4
Screen residue (%)	Before crushing	100 mesh	93.9	91.8	89.6	92.7	92.7
		200 mesh	99.4	96.5	96.7	97.1	97.1
	After crushing	100 mesh	1.4	1.8	1.2	3.2	1.5
		200 mesh	6.9	7.2	4.7	9.0	4.4

5.4.10 Refining of Activated Carbon

1) Results of Purity Analysis of Activated Carbon

Table 5A-1-27 shows the results of analysis of the purities of principal activated carbons. As indicated by the results of analysis of raw materials (Table 5A-1-8) and the results of analysis of char (Table 5A-1-13), the raw materials used in this test contained 3–5 times more ash than Japanese raw materials. As a result, the ash content was much higher in the activated carbons.

Table 5A-1-27

Kind of Raw Material	Sample No.	Ash, %	pH	Fe, %	Water Solubles, %
Davao sawdust	D-872	9.0	11.2	0.085	5.6
	D-874	10.4	11.0	0.180	4.5
	D-875	7.5	11.0	0.104	4.5
	D-8285	7.0	10.7	0.099	2.1
	D-953	11.7	10.4	0.095	1.4
IDC sawdust	I-8142	4.7	11.4	0.067	2.5
	I-8152	9.3	11.4	0.088	3.6
	I-8275	4.8	10.8	0.065	2.1
Falcata	F-8314	10.9	11.6	0.250	6.0
	F-8315	7.8	11.5	0.083	5.0
White lauan	W-8173	10.6	11.7	0.041	5.0
	W-8174	6.2	11.5	0.098	4.5
EA sawdust	E-8161	6.5	11.0	0.157	2.3
	E-8164	5.7	10.6	0.510	1.6
Coir dust	C-8204	16.5	11.1	0.590	4.5
	C-8205	22.7	11.2	1.040	5.6
Ipil-ipil	P-8222	20.3	11.4	0.250	8.2
	P-8224	18.1	11.1	0.180	5.6

2) Refining

Activated carbon was washed by the refining process described in Item 5.3.4. Table 5A-1-28 shows the results of purity analysis by the JWWA Effusion Method with respect to non-washed and washed activated carbons.

Table 5A-1-28 RESULTS OF ANALYSIS OF METALLIC IMPURITIES IN ACTIVATED CARBON PRODUCTS BY JWWA PROCEDURE USING AAS.

(Unit: ppm)

Sample Name	Washing	Ash, %	Ca	Mg	Zn	Fe	Mn	Cu	Ni	Pb	Cr	Cd
IDC	Before	7.3	16,283	1,060	38	778	251	7	3	5 (below)	5	28
	After	0.8	125	35	7	132	5	6	1 (below)	5 (below)	1	15 (below)
Davao	Before	10.1	18,830	2,092	52	774	73	9	5	5 (below)	5	37
	After	1.0	215	72	8	67	1	8	1 (below)	5 (below)	1	15 (below)

Meanwhile, Table 5A-1-29 shows the results of purity analysis when the samples were refined.

Table 5A-1-29

Kind of Raw Material	Sample No.	Ash, %	pH	Fe, %	Water Solubles, %
Davao sawdust	D-872	0.8	6.5	0.010	0.20
	D-874	0.9	6.0	0.022	0.14
	D-875	0.7	6.9	0.016	0.18
	D-8285	0.6	6.8	0.013	0.07
	D-953	0.9	6.2	0.008	0.09
IDC sawdust	I-8142	0.6	6.4	0.014	0.15
	I-8152	0.8	7.3	0.017	0.17
	I-8275	0.6	6.6	0.011	0.10
Falcata	F-8314	1.2	6.2	0.026	0.21
	F-8315	0.9	6.5	0.014	0.24
White lauan	W-8173	1.4	7.1	0.013	0.09
	W-8174	0.7	6.7	0.015	0.11
EA sawdust	E-8161	1.5	7.2	0.038	0.26
	E-8164	1.8	6.9	0.038	0.18
Coir dust	C-8204	5.1	6.1	0.085	0.21
	C-8205	8.7	6.9	0.108	0.28
Ipil-ipil	P-8222	1.9	6.3	0.045	0.24
	P-8224	1.3	7.0	0.031	0.23

3) Changes in Adsorbability by Refining

Table 5A-1-30 shows the methylene blue decolorizing power and iodine adsorbability of various samples of activated carbons before and after their refining. The properties of activated carbons of high ash content are improved by refining, and the adsorption speed is also increased.

Table 5A-1-30

Raw Materials	Sample No.	Before Refining		After Refining	
		M.B., ml/g	I_2, mg/g	M.B., ml/g	I_2, mg/g
Davao sawdust	D-872	200	1,056	220	1,117
	D-874	155	970	170	1,060
	D-875	190	1,047	210	1,110
	D-8285	185	1,038	200	1,079
IDC sawdust	I-8142	190	1,065	205	1,072
	I-8152	155	1,034	170	1,053
	I-8275	145	1,028	160	1,049
Falcata	F-8314	135	938	160	985
	F-8315	100	915	140	973
White lauan	W-8173	200	1,042	220	1,118
	W-8174	185	1,039	195	1,091
EA sawdust	E-8161	140	983	165	1,022
	E-8164	130	913	150	1,015
Coir dust	C-8204	90	851	130	931
	C-8205	90	876	135	986
Ipil-ipil	P-8222	150	933	200	1,060
	P-8224	135	904	190	1,030

4) Results of Analysis of Heavy Metals

Table 5A-1-31 shows the concentration of heavy metals by the JWWA Effusion Method and 1 N-HCl Effusion Method.

Table 5A-1-31 RESULTS AND DATA ON THE DETERMINATION OF METALLIC IMPURITIES PRESENT IN THE ACTIVATED CARBON SAMPLES BY JWWA AND IN HCl METHODS

(Unit: ppm)

Sample	Method	Ca	Fe	Zn	Pb	Cd
IDC - A	JWWA	19,600	< 1	0.55	< 1.5	0.34
	1 N-HCl	35,800	614	44.6	3.3	0.50
Davao - B	JWWA	25,300	< 1	0.85	1.7	0.55
	1 N-HCl	41,800	584	38.3	7.7	0.80

Table 5A-1-32 shows the measured heavy metal contents by processes, when Davao sawdust was used as the raw material.

Table 5A-1-32

(Unit: mg/kg)

Davao sawdust	Ash, %	Ca	Mg	Zn	Fe	Mn	Cu	Ni	Pb	Cr	Cd	As
Sawdust	1.1	1,875	165	4.5	60	5.5	1.7	< 1.2	< 5	< 0.5	< 15	–
Char	3.4	6,362	593	19.3	294	23.0	7.4	2.6	15	1.0	< 16	–
Activated carbon	5.4	18,830	2,092	51.9	774	73.0	8.8	5.0	< 8	5.0	37	0.2
Refined Product	1.0	215	72	8.0	68	1.3	8.0	< 1.2	< 5	1.2	< 15	< 0.2

Table 5A-1-33 shows the measured heavy metal contents of various kinds of char. The heavy metal contents were also measured for both Japanese chars made from coniferous trees and broad-leaved trees, and mutually compared.

Table 5A-1-33

(Unit: mg/kg-char)

Char Raw Material	Ash, %	Ca	Zn	Fe	Cu	Pb	Cr	Cd
Ipil-ipil	5.7	10,150	18	2,500	22	15	< 1	< 15
IDC sawdust	2.6	5,625	22	1,050	6	< 5	< 1	< 15
EA sawdust	5.2	3,950	10	1,050	5	< 5	9	< 15
White lauan	2.7	8,075	5	725	3	< 5	< 1	< 15
Falcata	3.5	9,700	27	1,022	< 1	32	< 1	< 15
Japanese coniferous woods	1.5	2,200	32	472	< 1	< 5	< 1	< 15
Japanese broad-leaved woods	1.0	890	12	135	< 1	< 5	< 1	< 15

The heavy metals contained in raw material timber undergo oxidation and reduction reactions in the carbonization and activation processes, but the gross volume does not undergo any notable change. On the other hand, the raw material's weight is decreased as through the combustion of volatile matter, with the result that the measured apparent heavy metal content values were increased gradually through carbonization and activation.

In the refining test, it was confirmed that purifying and removing ash and heavy metals contained in activated carbon by using mineral acids will permit manufacture of powdered activated carbon fully conforming to the standards relating to medicated chemicals which are demanded high purity levels. Also, the adsorbability of activated carbon was improved by refining. Table 5A-1-34 shows an example of results of analysis of high-grade activated carbon obtained in this test.

Table 5A-1-34

Raw Material	IDC sawdust	Davao sawdust	Unit
Methylene blue decolorizing power	220	240	ml/g
Iodine adsorbability	1,104	1,148	mg/g
ABS value	19	14	
Weight loss on drying	0.7	0.7	%
Ignition residue	0.8	0.9	%
Chlorides	0.01	0.01	%
Ferrous metal	0.009	0.006	%
pH	6.6	7.0	
Water soluble substances			
Arsenic	< 0.2	< 0.2	ppm
Screen residue (74 micron)	3.9	2.7	%

5.5 Summary

This test was conducted as part of the International Transfer of Industrial Technology (ITIT) that is being advanced by the Ministry of International Trade and Industry (MITI). Specifically, based on the results of basic research conducted jointly by the Government Industrial Development Laboratory, Hokkaido, and the National Institute of Science and Technology (NIST) of the Philippines on the manufacture of high-performance powdered activated carbon from tropical woods by installing a midget plant in the compounds of NIST, the aim is to acquire industrialization data relating to the manufacture of powdered activated carbon by using raw material wood and sawdust procured from various regions of the Philippines.

In order to attain this objective, 1/5 scale of an commercial activation furnace and a carbonization furnace, together with other related equipment, were installed in the compounds of NIST. Also, since the evaluation of activated carbon demands numerous analysis operations requiring expertise in connection with adsorbability and purity tests, NIST staffs received training in Japan.

Activated carbon is a product relying heavily on raw material supply, and roughly 16 tons (bone dry) of raw material sawdust are required for manufacturing 1,000 kg of activated carbon. Even the quantity of raw material used in this test exceeded 150 m^3, part of which was transported to NIST for studies all the way from Mindanao Island by means of a container ship.

The results of the test are summarized as follows:

1) Raw Material

The raw materials specified in the I.A. as well as other kinds of tree which were regarded as being promising were made the aims of the test. Kinds of tree which are being used for sawmilling were tested in the form of sawdust, while those not being used so much for sawing were crushed for testing.

All these raw materials commonly contained large quantities of ignition residue (ash) compared with Japanese timbers, and kinds of tree of high bulk densities tended to be characterized by slow activation. However, by adjusting activated material purifying and activation conditions, it was possible to use all these materials for manufacturing powdered activated carbon having qualities permitting them to be sold on the market.

Among these raw materials, lauan, in particular, was found to display excellent purity and adsorbability. In addition, since it is available as sawdust from sawmills, preparation of raw material is not needed, it is a highly useful material even from the aspects of economy.

2) Carbonization

A open hearth carbonization furnace was used for carbonization. Sawmills and waste sawdust storage yards are not necessarily located in industrial regions, and should rather be conceived as being situated in mountainous and other inconvenient regions. Therefore, a carbonization furnace suitable for these sites, or one that does not require much machinery and equipment or fuel and which can be operated without complicated control for operations, was selected.

The open hearth furnace is operated by self-burning method excepting at the time of its ignition, and electric power is virtually unnecessary. Slabs and charcoal are usable for its firing, so fuel will be self-sufficient. In this test, measuring instruments were installed specially in order to analyze carbonization conditions. Also, by using commercial scale after-burners for exhaust gas combustion, it may be self-combustible.

In carbonization tests using various kinds of tree, the raw material's moisture content and particle size were found to exert large influences, so proper measures were studied as by conducting drying tests by utilizing waste heat and by solar drying, as well as by conducting activation speed tests by mixing raw materials with wood shavings and chips of larger particle sizes. As a result, it was confirmed that the yield of char obtained by carbonization ran up to roughly 25% of the raw materials, and that the output of char per square meter of carbonization furnace can be adjusted to about 0.5 kg-char/m^2.hr. This value is as same as open hearth furnace operation results that in Japan.

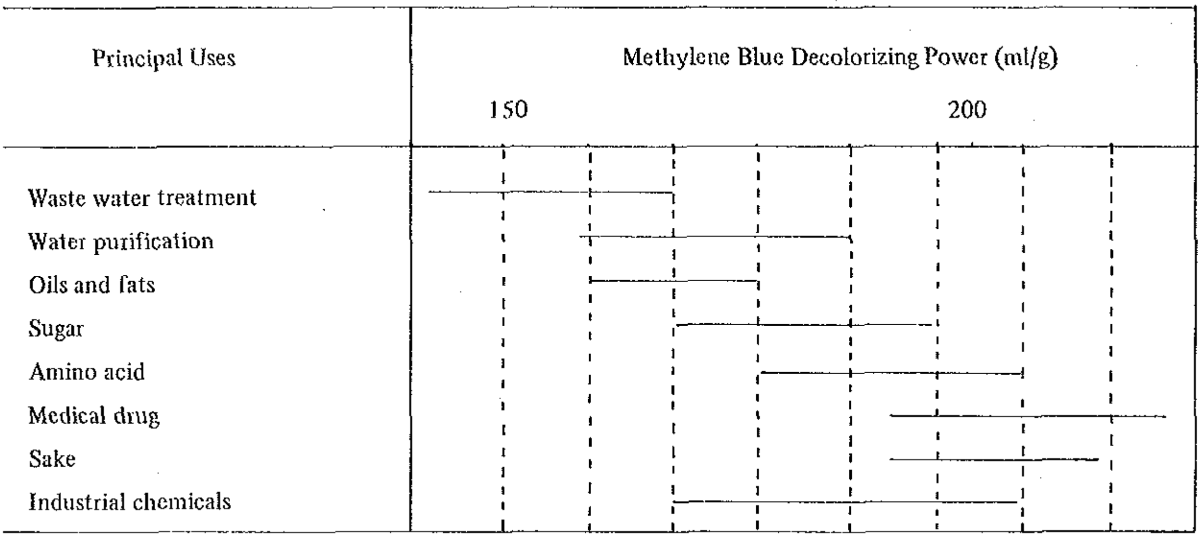
3) Activation

In the activation test, a circular fluidized bed activation furnace was used that enables ease of adjustment of activation gas composition, air feed rate, furnace temperature, activated carbon retension time in the furnace and other activation conditions. As a result, it was confirmed that the activation conditions can be set to optimized activation conditions which are fully matched to the properties of raw material char, or set to optimized activation conditions which are matched to the properties of the manufactured activated carbon and the number of times the furnace is to be used.

When using methylene blue decolorizing power as the indicator, the relationship shown in Table 5A-1-22 will be established between absorbability and yield. Lauan displayed the high values in both absorbability and yield, and its methylene blue decolorizing power was 180–200 ml/g at a yield of 25%. Powdered activated carbon is primarily used for liquid phase adsorption, and its methylene blue decolorizing power is generally adopted as the typical value of its performance.

Fig. 5A-1-41 shows for reference the principal uses of powdered activated carbon in Japan and the general absorbabilities of powdered activated carbon in these applications.

Fig. 5A-1-41



4) Refining

Refining, in broad sense, means that an activated carbon is to be washed by mineral acid. However, if necessary, there would be considerable various activated carbon refining methods such treatment as the neutralization of solid activated carbon, or the neutralization, dehydration and drying treatment of slurried activated carbon. In this refining test, laboratory scale refining tests were conducted with the thought that demands would be raised for high-grade powdered activated carbon in concert with the future progress of the Philippine economy, and in order to determine whether the manufactured powdered activated carbons would be capable of conforming to various country's National Standards when they are exported.

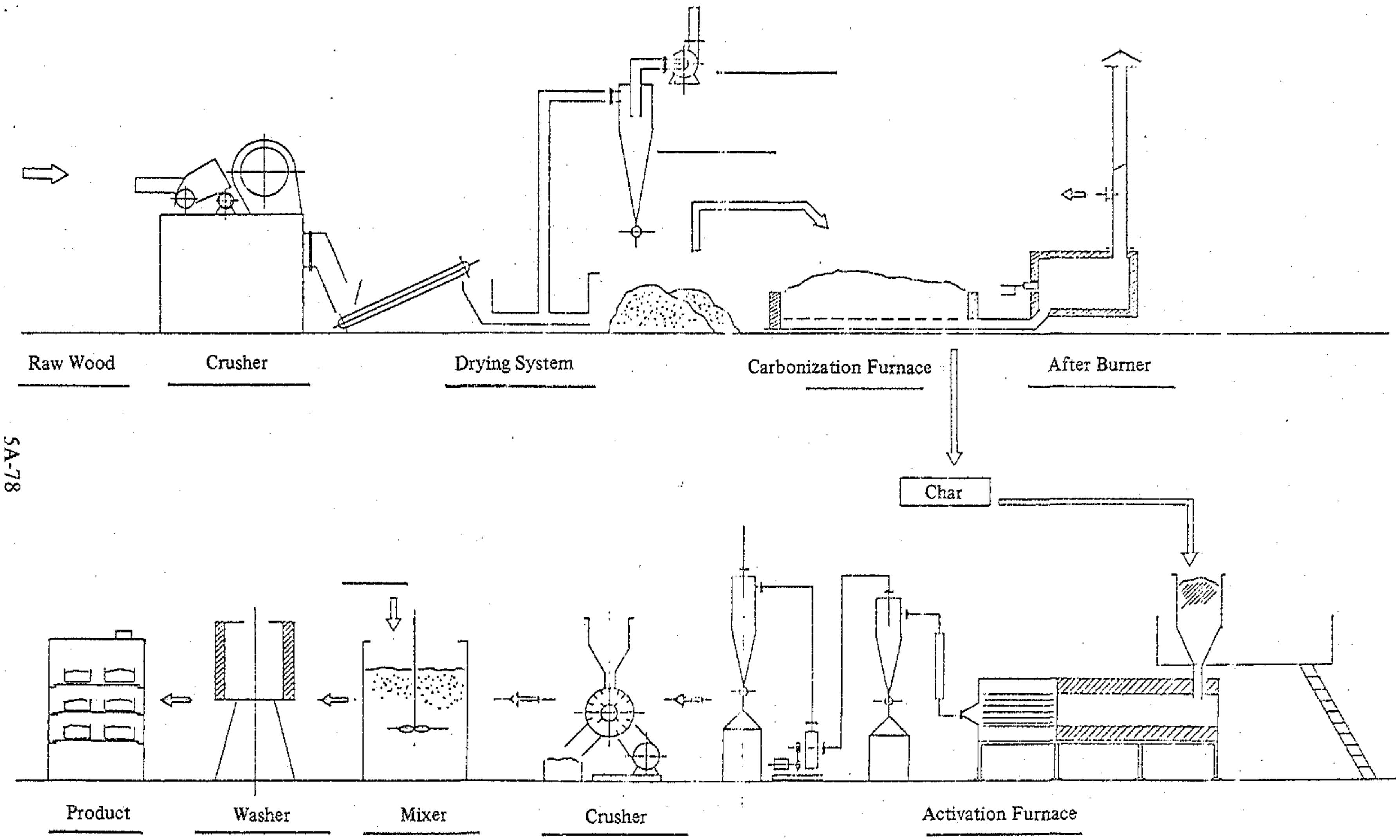
Test results confirmed that it is possible to manufacture powdered activated carbons which are comparable in properties to the high-grade powdered activated carbons presently being used in Japan, also that they are capable of conforming to various standards governing medicated charcoal and food additives, also of conforming to International Standards.

As mensioned above, it has been confirmed through the refining test that it is possible to manufacture powdered activated carbons from tropical waste wood and/or sawdust by means of a midget small scale plant, and that these activated carbons will possess excellent properties.

Appended herewith are the plant's process flowsheet, table of plant capacities, activation furnace material balance diagram, activation furnace layout, powdered activated carbon manufacturing process, electronic scan microscope with camera for raw material char and activated carbon, the results of measurement of surface areas, and the results of continuous plant operation.

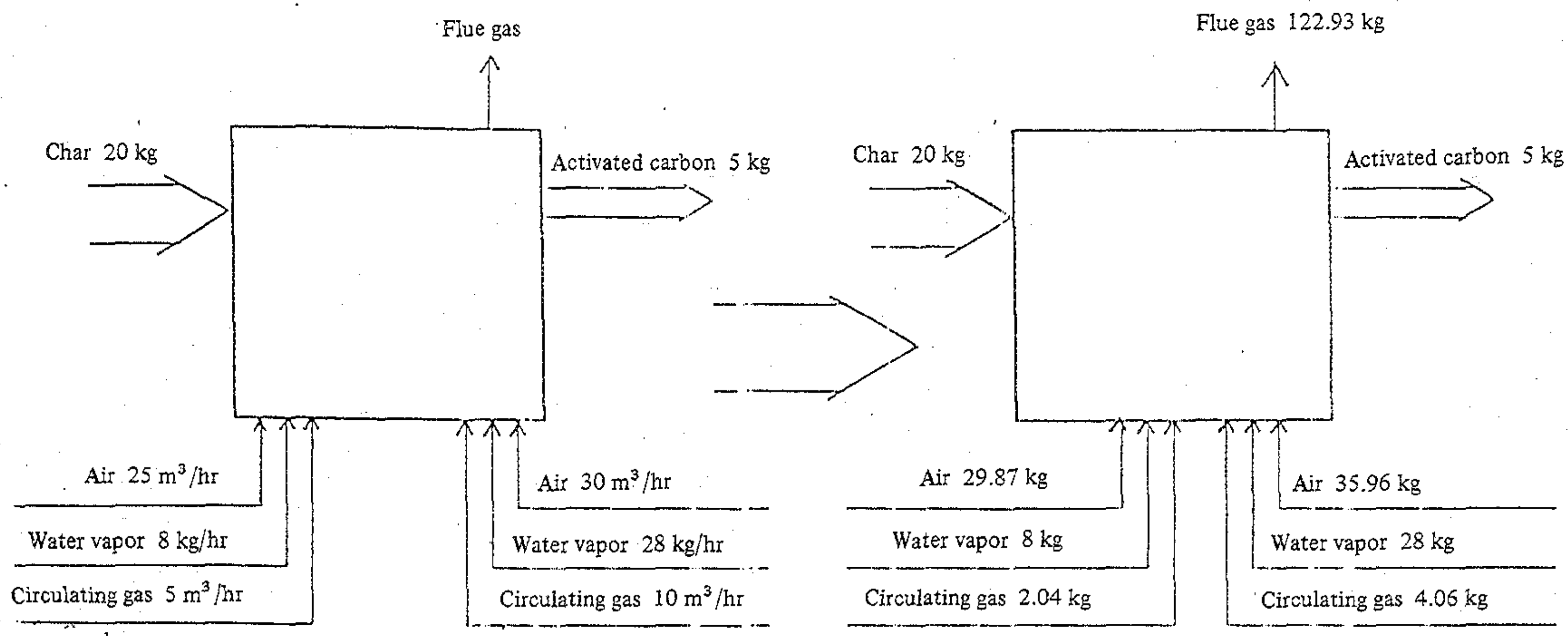
FLOW SHEET, MATERIAL BALANCE AND EQUIPMENT SPECIFICATIONS

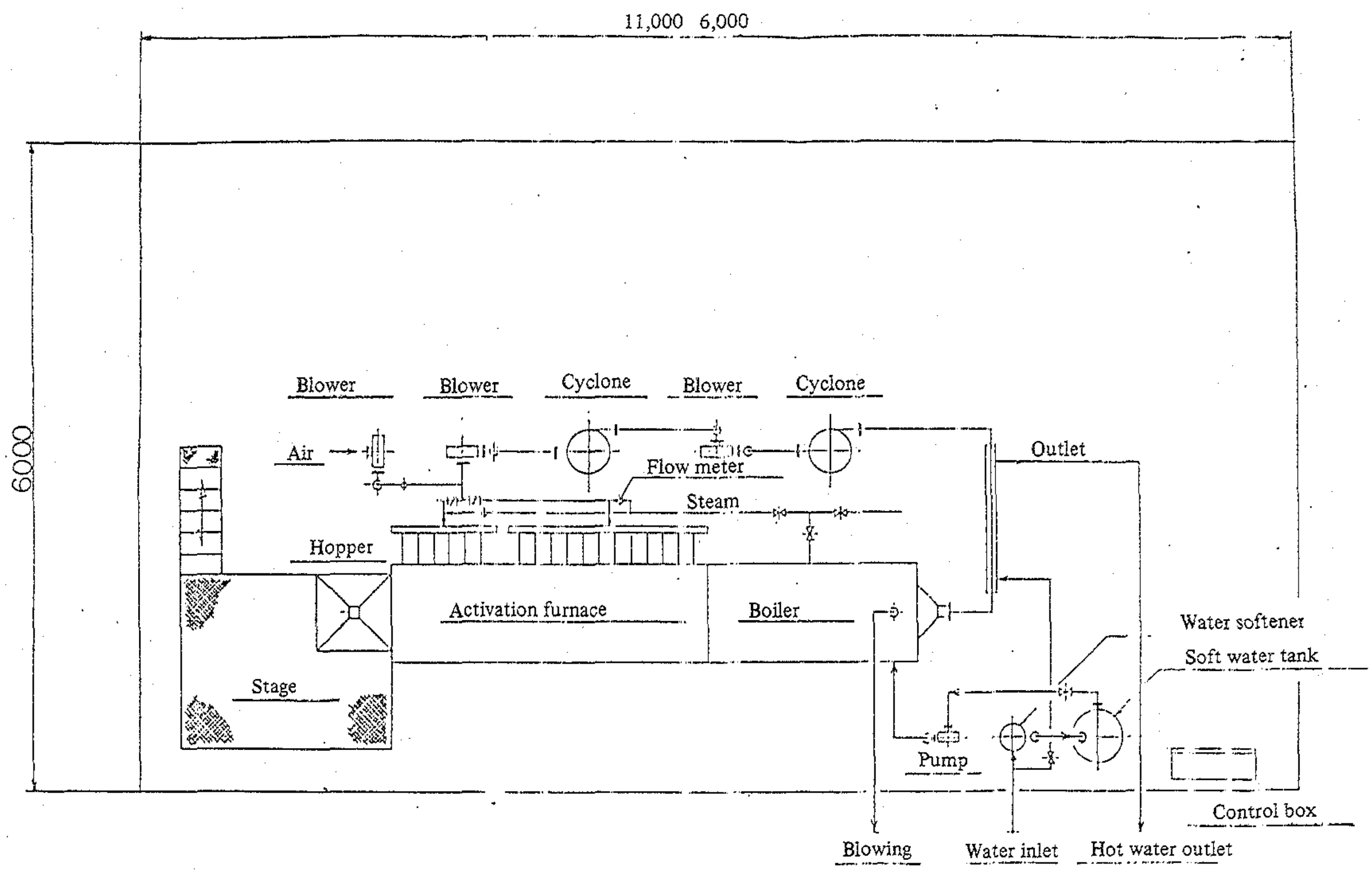
	Raw wood	Crusher	Dryer	Carbonization	Activation	Pulverization	Washing
Capacity		0.7 m^3/hr	100 kg/hr (40% moisture)	120 kg/day	5 kg/hr	5 kg/hr	0.5 kg/hr
Material balance		Bone dry sawdust 100 kg	Bone dry sawdust 100 kg	Bone dry charcoal 25 kg	6.25 kg	6.25 kg	6.0 kg
Name of equipment		Sawdust machine	Draft dryer	Open hearth furnace	Activation furnace	Grinding mill	
Specification		Akita wood (stump) MC-10 W500, L750, H950 cm 7.5 kW	Products of Hokuetsu Carbon Co. Air flow rate: 600 m^3/min Drying rate: 100 kg/hr	Downstream type W1.5, L2.7, H0.6 m 2 units	Circular fluidizing bed type	Hammer mill type	With acid treatment tank and setter Centrifugal dehydration and washing machine


Raw Wood
Crusher
Drying System
Carbonization Furnace
After Burner
Char
Product
Washer
Mixer
Crusher
Activation Furnace

FLOW SHEET

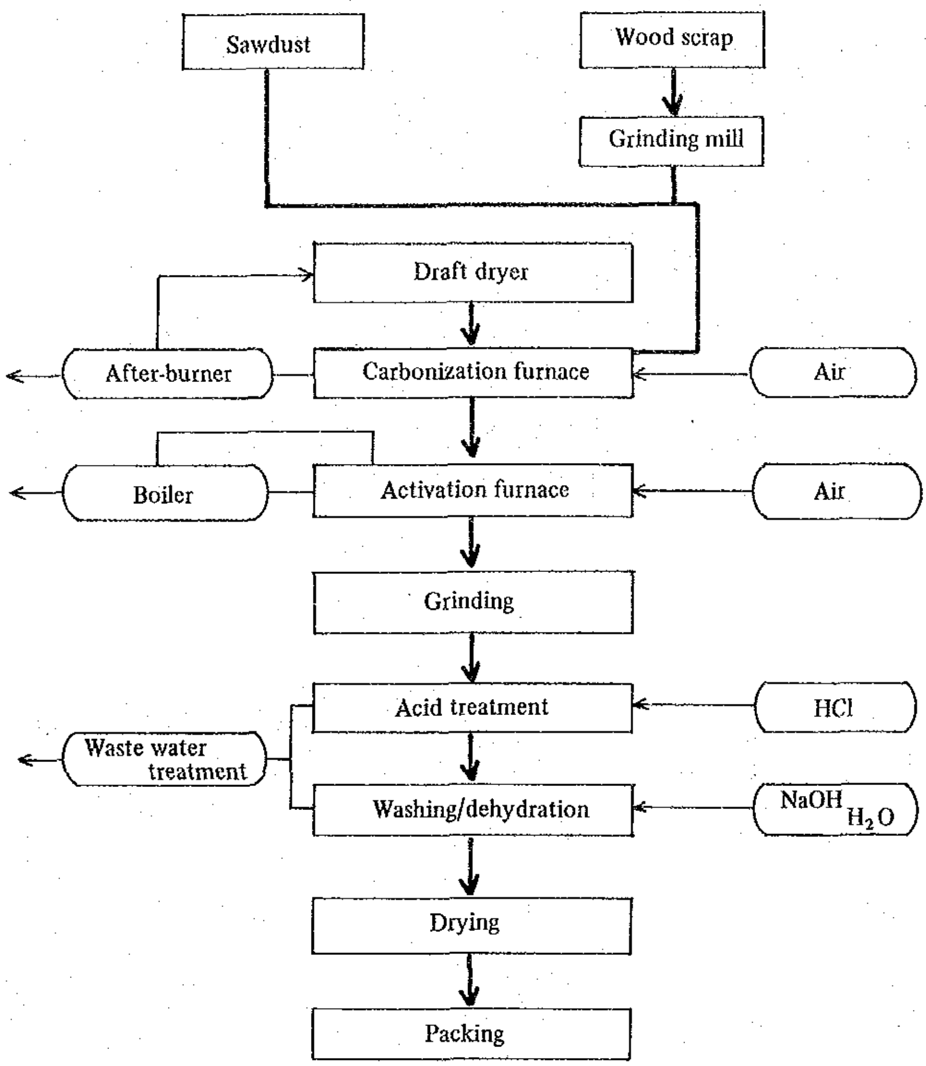
MATERIAL BALANCE OF CIRCULAR FLUIDIZING BED ACTIVATION FURNACE

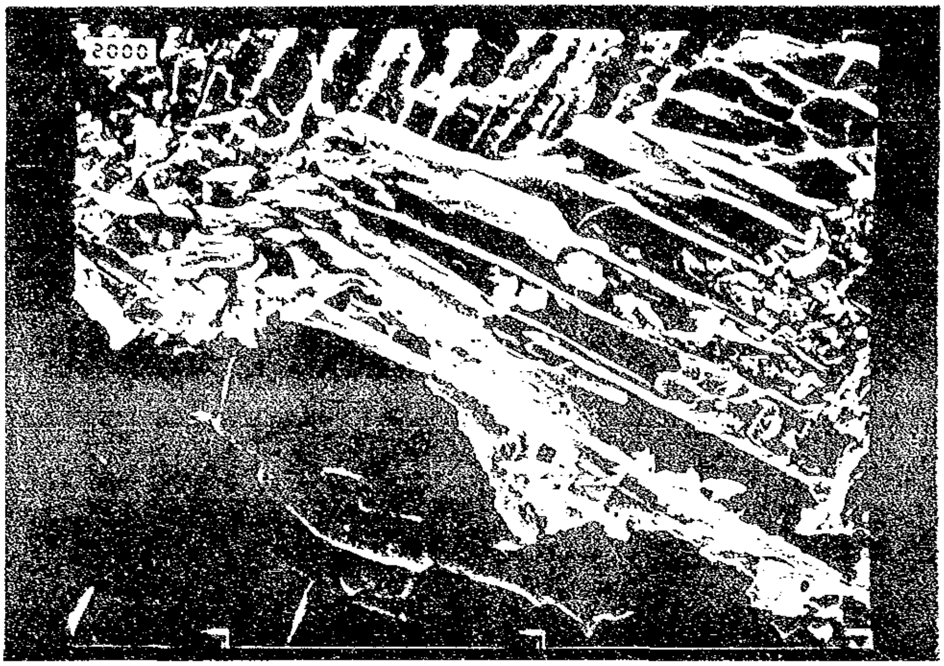



11,000 6,000
6000
Blower
Blower
Cyclone
Blower
Cyclone
Air
Flow meter
Steam
Outlet
Hopper
Activation furnace
Boiler
Stage
Water softener
Soft water tank
Pump
Control box
Blowing
Water inlet
Hot water outlet

LAYOUT

PROCESS FOR MANUFACTURE OF POWDERED ACTIVATED CARBON





Davao White Lauan – A.C.

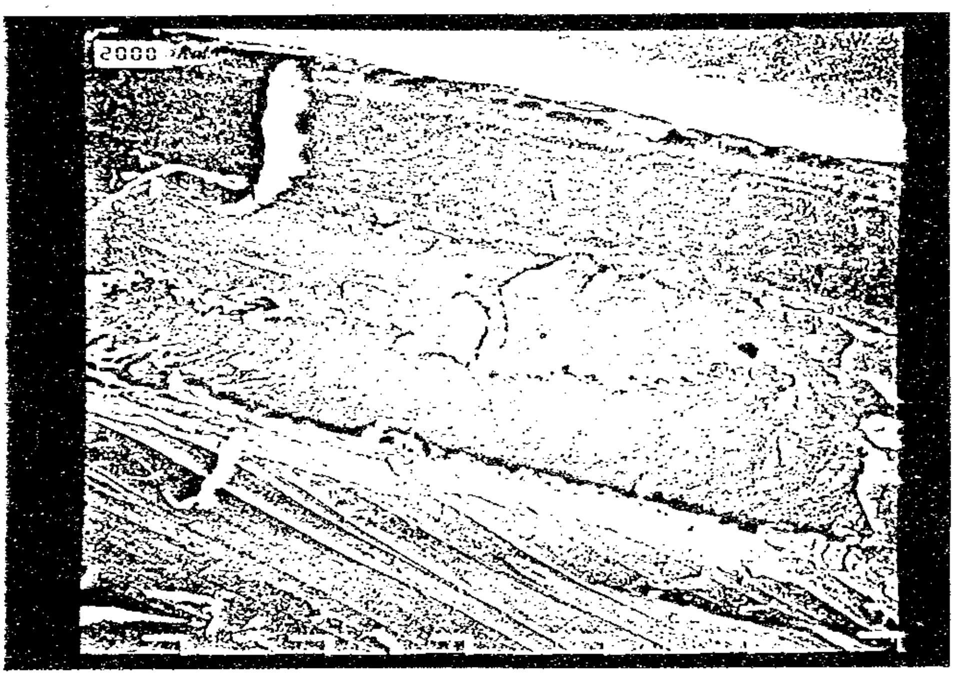
x 500

Davao White Lauan – A.C.

x 1,000

Davao White Lauan – A.C.

x 2,000



Davao White Lauan – Sawdust

x 2,000

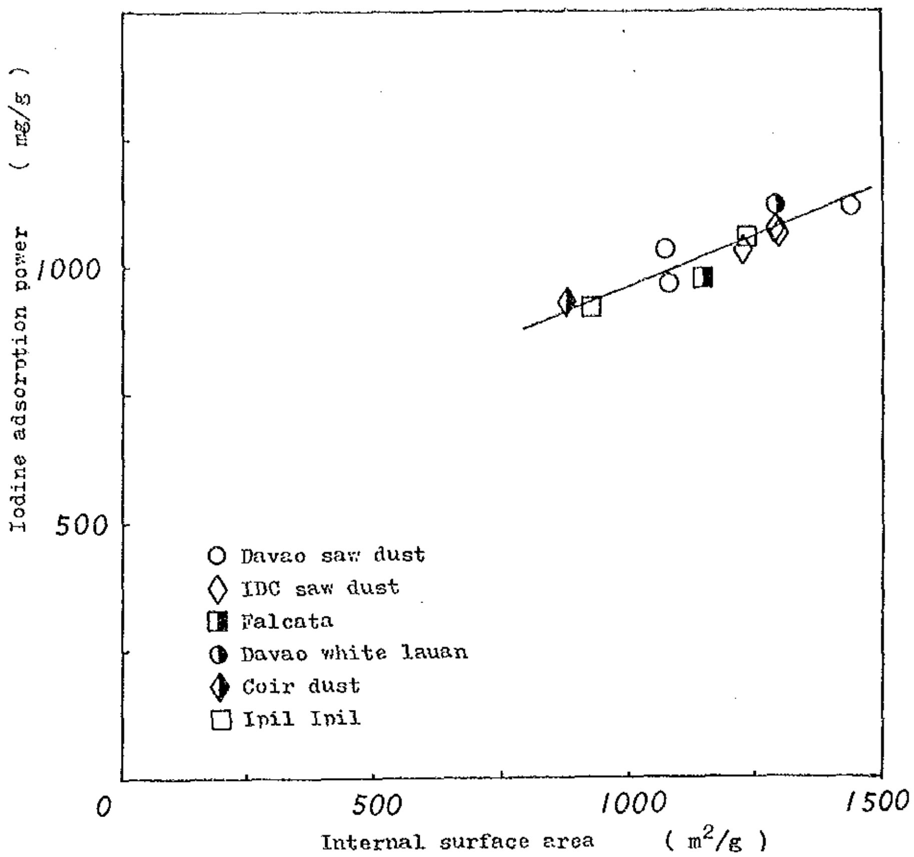
Davao White Lauan – Char

x 2,000

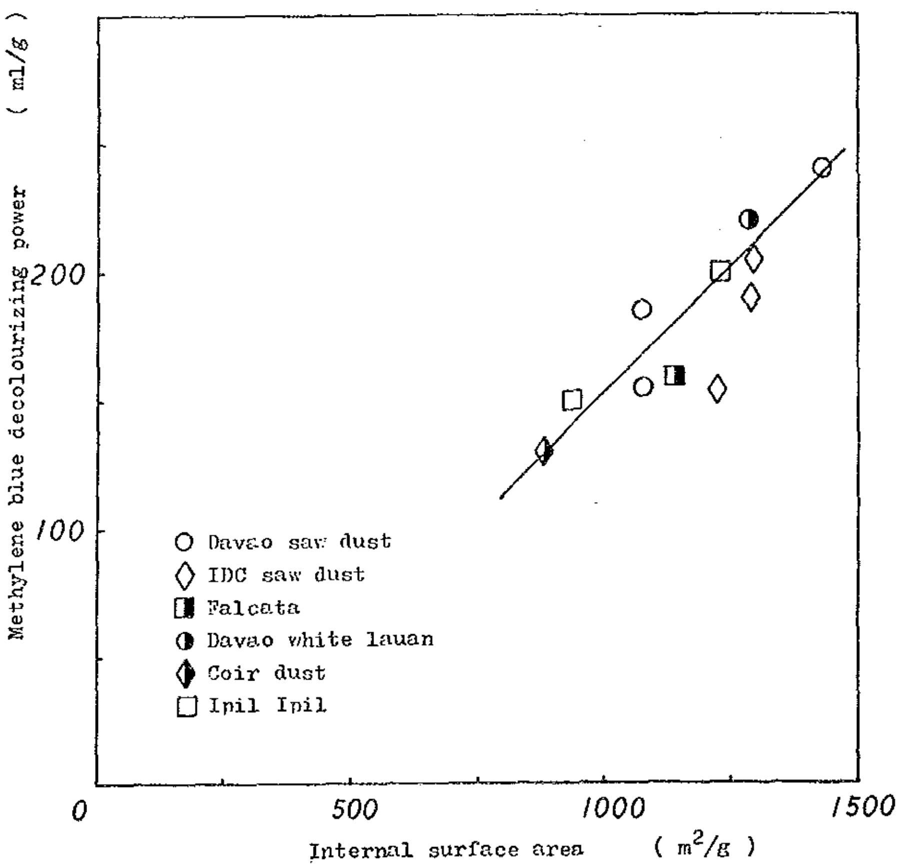
Davao White Lauan – Char

x 2,000

– Correlation between Internal surface area and Iodine adsorpton power –



– Correlation between Internal surface area and Methylene blue decolorizing power –



Appendix 6A-1 PRODUCTION AND CONSUMPTION OF SAWDUST IN JAPAN

1. Introduction

Sawdust is generated in the process of woodcutting and has a particle diameter of about 1–2 mm, although this will depend on the sawing machine, especially its sawtooth size and thickness. Its properties will also differ according to the specific kind of timber from which it is obtained.

The primary sources of generation of sawdust are saw mills where about 93% of the total quantity is generated, with the remaining several per cent generated by veneer plants, chip plants and furniture plants.

Saw mill are located in various parts of the country. With the recent development of industrial estate, there are today a total of 114 industrial estates, 72 in coastal regions and 42 in inland regions, and a total number of saw mills accounts 20,249 throughout the country.

These saw mills may be specialized in domestic timber, foreign timber, or may work with both domestic and foreign timber, with the result that sawdust obtained from these saw mills has varying properties.

Domestic timber derives mostly from cedar and cypress whose quality levels are generally excellent, whereas foreign timber derives from various kinds of trees such as tropical timber, northern timbers and American timbers, with the result that sawdust obtained from foreign timber naturally has its characteristic properties. Any kind of sawdust will be acceptable when used as a combustibles, but the specific kind of sawdust will exert a great influence when it is used in place of littering straw or for mushroom cultivation.

2. Sawdust Output

2.1 State of Timber Consumption

Sawdust output will be determined by the volume of timber consumption. Timber is demanded primarily for producing lumber, veneer boards and pulp, with the demand for lumbering accounting for about one-half of the total demand.

The demand for lumber, which had continued at a consumption level of roughly 100 million m^3/yr during 1965–1980, slumped after 1981 to about 90 million m^3/yr owing to the decrease in the construction of wooden housing units, a situation that dealt a severe blow to the lumber industry. As a natural consequence, sawdust output has also treaded a steady path of diminution.

The use of foreign timber increased after 1965, and has run up to more or less 65% of the total consumption volume in recent years. In 1983, for example, the total volume of imported timber of 34,500,000 m^3 consisted primarily of tropical timber (43.1%), followed with American timber (34.4%), Soviet timber (19.0%) and New Zealand timber (1.7%).

Tropical timber derives from broad-leaved trees and primarily consists of lauan, meranti and kapur timber, so sawdust obtained from tropical timber is characterized by properties which are distinct to lauan timber. Tropical timber is recently imported as lumber in increasing volumes.

Meanwhile, American timber consists largely of American pine and American hemlock-spruce, but some sawdust from those timbers are known as a cause of asthma. Canadian timber is being imported primarily as lumber product which hardly makes sawdust, and Soviet timber consists primarily of coniferous trees such as spruce and larch trees.

2.2 Lumber Industry and Sawdust Output

As pointed out earlier, roughly 93% of sawdust is generated by saw mills. About one-third of these mills exclusively handle domestic timber, with the remaining two-thirds of these mills handling foreign timber.

Sawdust obtained from broad-leaved trees is used for mushroom cultivation, but is available only in a limited volume. Tropical timber is used for producing 95% of veneer boards, but it is decreasing steadily. Sawdust production conforms to the ratios in which these timbers are being consumed. With domestic timber, cedar sawdust is produced in the largest volume, while in connection with foreign timber, the largest volume of sawdust derives from American timber.

2.3 Sawdust Generation Ratio and Output

The ratio of sawdust generation differs widely depending on where it is generated.

Here, the sawdust generation ratios revealed by a survey conducted by the Government Forest Experiment Station of the Ministry of Agriculture, Forestry and Fisheries shall be adopted, which gives the sawdust generations ratio of 93% for saw mills. The sawdust generation volumes of these sources are as compiled in Table 6A-1-1. The country's total output of sawdust in 1984 ran up to 4,454 x 10^3 cubic meters.

Table 6A-1-1 SAWDUST GENERATION VOLUMES AND UTILITIES

(Unit: 10^3 m^3)

Origin	Fuel	Ogalight	Manure	Chips	Littering	Mashroom	Burning	Others	Total
Sawmill	380	1,307	253		1,307	380		590	4,217
Plywood Mill	122			24.7				0.3	147
Plywood Mill (Chain-Saw)	75.2			13.5			1.2	0.6	90.5
Total	577.2	1,307	253	38.2	1,307	380	1.2	590.9	4,454.5

Source: Bureau of Forest

2.4 Sawdust Quality

Sawdust quality and particle size will differ widely depending on the specific type of timber from which it is produced, also on the sawing machine and place of generation. As a matter of fact, when handling large quantities of sawdust, there is a great probability of lumber scraps and tree bark getting mixed, so these substances may have to be removed depending on the specific purpose of use.

2.5 Measurement of Sawdust

Timber volume (m^3) is adopted as the unit for sawdust transaction on the market. Generally, "timber volume x 3.5 times" is the measurement employed for converting volume of timber into sawdust. About 15 m^3 of sawdust can be loaded on a 4-ton load truck.

2.5 Sawdust Distribution and Price

Regarding the channels for distribution of sawdust, the sawdust may be sold directly by sawmill to consumer, or transacted through sawdust trader or local sawdust association. Today, with the sawmill industry faced with a recessive economic mood and the available sawdust volume dwindling conspicuously, a competition is being waged among sawdust traders.

Sawdust prices vary widely depending on the place of origin, transaction conditions and quality. For "Ogalight" manufacture, for example, the mean unit purchase price from sawdust wholesalers is ¥1,020/m^3, the direct purchase price from sawmills ¥873/m^3 and from other sources ¥805/m^3. In the event a sawmill uses sawdust for Ogalight manufacture on its own, the in-company transfer price is ¥373/m^3.

Sawdust used in mushroom cultivation, which is limited to sawdust obtained from beech and quercus serrata, the purchasing price is about ¥5,000/m^3. As for sawdust used for littering the pens of domestic animals, the purchasing price is about ¥3,000 for sawdust obtained from imported coniferous and about ¥2,100 for sawdust obtained from domestic trees.

3. Utilization of Sawdust

Sawdust may be utilized as obtained, or after treatment. There are many uses for sawdust, including its use as a fuel and filling material, for littering of domestic animal pens, mushroom cultivation and soil improvement, also as an ingredient for producing compost and animal feed.

3.1 Use as Fuel

When using sawdust as a fuel, it may be used as obtained or may be treated and formed into fuel products such as Ogalight.

3.1.1 When Using as Fuel as Obtained

The calorific value of sawdust is the same as that of wood in general and runs up to an average of about 4,500 kcal/kg, but a wide difference exists between its high calorific value and low calorific value, influenced largely by its moisture. Therefore, when using sawdust as a fuel, preliminary drying will be very important, and decreasing its moisture of less than 15% will be desirable.

There are 214 plants engaged in the manufacture of Ogalight in Japan, with a total output of 245,000 tons/yr (1982).

Ogalight is a sawdust-based fuel developed in postwar Japan and accounts for 31% of total sawdust consumption. Having a high calorific value of about 4,100 kcal/kg, sawdust light is an excellent wooden fuel featuring great handling ease in addition to being a comparatively clean heat source. However, the lag in the development of combustion equipment has invited competition from other fuel sources such as oil and propane gas. Nevertheless, it enjoys a strong latent demand owing to its low price that is 60–70% that of oil fuels, despite its gradually rising price owing to sawdust shortage.

3.1.2 Sawdust Charcoal

Sawdust char is available in two forms, one of which is obtained in the form of carbonized sawdust, otherwise known as sowdust char. There are various types of carbonization furnaces such as open hearth type, horizontal cylindrical type, rotary kiln type and fluidizing bed type, but in Japan the open hearth type is employed almost exclusively and other types of carbonization furnaces are not in use today.

Sawdust char is characterized by low density and can be activated with ease. Char obtained from coniferous trees such as pine, cedar and cypress, in particular, lends itself to activation with ease and provide activated carbon of high quality that is ideal for use in product refining especially by the alcoholic beverage industry.

Today, the deficiency of coniferous tree sawdust has brought about a shortage of activated carbon for this purposes. But sawdust in general is being put to various uses, including the manufacture of briquette ignition agents, fireworks, snow thawing agents and for soil improvement.

Another from of sawdust charcoal is obtained by carbonizing pelletized products such as Ogalight and sawdust pellets. These products are being put to various uses in the same manner as charcoal, and are being accepted popularly due to their higher specific gravity than charcoal and great handling ease owing to their uniform shapes.

The output of sawdust char in Japan is estimated at roughly 27,000 tons/yr.

3.2 Sawdust for Mushroom Cultivation

Sawdust obtained from broad-leaved trees such as beech and quercus serrata is preferable for mushroom cultivation, and beech-tree sawdust is used for the cultivation of mushroom "Shiitake". The container cultivation method is being adopted popularly today for the cultivation of mushrooms.

The annual consumption of sawdust for mushroom cultivation runs up to about 380,000 tons annually.

3.3 Sawdust for Littering Domestic Animal Pens

Rice plant straw, long used as the material for littering the pens of domestic animals, has come to be replaced with sawdust in recent years. The volume ran up to 1,300,000 tons in 1981, accounting for one-third of the country's total output of sawdust.

Sawdust is being used by mass breeders of livestock such as cattle, hog and broilers, especially by beef cattle breeders, and sawdust has today become indispensable for beef cattle breeding.

The demand for sawdust for littering purposes is increasing steadily, and is being transacted at prices higher than those of sawdust for producing Ogalight as mentioned earlier.

3.4 Sawdust for Compost

Sawdust obtained from broad-leaved trees is preferable for the manufacture of compost, but coniferous tree sawdust is also being used. Compost is produced by mixing sawdust with organic and inorganic substances such as poultry excrement and rice bran, together with some fermentation accelerator.

3.5 Sawdust for Feed

Sawdust consists of numerous coarse fibers and is therefore unsuitable for use as feed as it is, but can be converted into feed by chemical treatment or by fermentation.

3.6 Chemical Treatment of Sawdust

There is an example of sawdust having been treated chemically for producing glucose for use as feed in Germany during World War I.

4. Manufacture of Sawdust

The popular utilization of sawdust in recent years has triggered a sharp shortage of sawdust, leading to the development of high-performance sawdust manufacturing machines. These machines are generally available in the screw saw type and disc plate type, but there is also another type in which a rotary cutter and crushing machine are used in combination.

Whatever the type of machine used, the manufacture of sawdust consumes a huge quantity of electricity, making sawdust very expensive. Therefore, it is not economical to use such sawdust of high cost, excepting for mushroom cultivation and for littering the pens of domestic animals.

5. Future Output and Utilization of Sawdust in Japan

Roughly 93% of sawdust is generated by sawmills. Therefore, sawdust output rests largely on the prosperity of the lumbering industry.

Japan's lumbering industry has a deep relation with the construction of wooden dwellings, and the sharp reduction in the number of wooden dwellings built in recent years has dealt a cruicial blow to the lumber industry, with the result that the number of sawmills has dwindled to 80% compared with when the industry was flourishing. Sawdust output has likewise decreased to 80% that at the height of prosperity.

Meanwhile, the prevailing trend is for tropical wood to be sawed domestically, which is leading to a drastic reduction in the import of logs and replacement of these logs with Soviet log and American log. Regarding import from U.S.A., American lumber, instead of log, is being imported into Japan in ever larger volumes. By the end of this century, however trees forested in Japan in the postwar years will become ready for felling.

However, the overall lumber sawing is expected to remain on the same level, and in view of the existing trend of wooden dwelling being replaced increasingly with relatively low-priced fireproof dwellings, the demand for lumber is observed to tread a path of steady diminution. As a natural consequence, it will be difficult to secure the current volume of output of sawdust.

The principal uses of sawdust are fuel (including Ogalite), littering material, mushroom cultivation and compost making, which altogether account for 87% of total sawdust consumption. Among fuels, Ogalite production is observed to decrease henceforth due to the high cost of sawdust, in favor of the manufacture of pellet-form molded fuel that lends itself conveniently to automatic feeding, ease of extinction and use in place of oil.

The use of sawdust as fuel will decrease henceforth, or at best will remain on the same level. Sawdust being ideal for use as littering material for livestock, consumption in this sector is certain to increase in the years ahead. Mushroom cultivation is likely to progress further henceforth and to especially lead to greater consumption of sawdust deriving from hard wood. As for sawdust for compost making, the demand of sawdust for compost proper will decrease in the years ahead since waste littering material for livestock is used for this purpose.

Sawdust is insufficient today, especially sawdust of good quality. Therefore, sawdust making machines have been developed particularly for producing sawdust from slabs and low-quality materials, but the sawdust produced is costly since much electric power is required.

6. Conclusion

As described above, virtually the entire volume of available sawdust is being consumed in the form of fuel, littering material, for mushroom cultivation and for compost making, and is quantitatively insufficient. Also, since increased production cannot be anticipated, this situation of insufficiency is certain to continue into the future.

Sawdust has become very expensive in recent years, not only because of its quantitative insufficiency but also since it has come to be utilized by industries producing products of high added values, as for the manufacture of fuel for use in place of oil, for use by the livestock industry, and for use in mushroom cultivation. This situation is making the procurement of inexpensive sawdust difficult, and this tendency is likely to continue even henceforth.

Owing to the reasons outlined above, the procurement of inexpensive raw material sawdust necessary for the manufacture of powdered activated carbon has become difficult even today, and greater difficulty is anticipated in the years ahead.

EXISTING SAWMILLS IN THE PHILIPPINES
As of 31 December 1982

Company	Sawmill Site	Daily Rated Capacity (BD.FT.)	Annual Log Requirement (CU.M.)	Timber* License
	REGION 2			
	ISABELA			
1. Acme Plywood & Veneer Co., Inc.	Ilagan	18,000	12,225	TLA 75
2. Bagac Sawmill	San Mariano	18,000	12,225	
3. Citizen's Sawmill	Jones	10,000	6,800	
4. Consolidated Logging & Lumber Mills, Inc.	Angadanan	18,000	12,225	TLA 105
5. Ever Sawmill	San Mariano	18,000	12,225	
6. First Isabela Wood Ind's.	Reina Mercedes	10,000	6,800	
7. Golden Flame Sawmill	San Mariano	12,000	8,150	
8. Green Valley Timber Corp.	Alicia	18,000	12,225	
9. Highland Sawmill	San Mariano	18,000	12,225	
10. Isabela Lumber Ind's.	Alicia	18,000	12,225	
11. Isabela Sierra Lumber	Cauayan	18,000	12,225	TLA 312
12. J. F. Siquian Lumber Corp. I	San Mariano	18,000	12,225	TLA 280
13. J. F. Siquian Lumber Corp. II	Angadanan	20,000	16,116	TLA 280
14. Jones Logging Corp.	Libertad	12,000	8,150	TLA 38-1
15. JTC Lumber & Ind'l. Co.	Naguilian	18,000	12,225	
16. La Pena Sawmill	San Mariano	15,000	10,200	
17. Liberty Logging Corp.	Jones	18,000	12,225	TLA 250-1
18. Luzon Mahogany Timber Ind's. Inc.	Benito Soliven	15,000	10,200	TLA 243-1

Company	Sawmill Site	Daily Rated Capacity (BD.FT.)	Annual Log Requirement (CU.M.)	Timber* License)
19. Mayantoc Sawmill	San Mariano	18,000	12,225	
20. Mercedes Lumber Producers Co.	Reina Mercedes	18,000	12,225	
21. Mini-Expo Ind's.	Ilagan	10,000	6,800	
22. Northern Isabela Lumber Producers	Ilagan	18,000	12,225	
23. Republic Sawmill	Echague	18,000	12,225	
24. Rotary Sawmill	Ilagan	18,000	12,225	
25. Sampaguita Sawmill	Cauayan	18,000	12,225	
26. Sanafe Timber Corp.	San Mariano	15,000	10,200	TLA 283
27. San Mariano Sawmill	San Mariano	10,000	6,800	
28. Security Sawmill	Jones	18,000	12,225	
29. Sierra Madre Projects	Palanan	18,000	12,225	
30. Timber Exports, Inc.	Echague	18,000	12,225	
31. Timberking Sawmill	Echague	18,000	12,225	
32. Western Cagayan Lumber Inc. I	Cabagan	10,000	6,800	TLA 173
33. Western Cagayan Lumber Inc. II	Cabagan	30,000	27,169	TLA 173
		547,000	380,910	

REGION 4

MANILA

1. Alaska Lumber Co.	Manila	15,000	14,151	
2. Atlas Wood Industries Inc.	Valenzuela	30,000	28,302	
3. Canada Sawmill	Valenzuela	20,000	18,868	
4. Canumay Wood Corp.	Valenzuela	30,000	28,302	
5. Capitol Sawmill	Valenzuela	30,000	28,302	

Company	Sawmill Site	Daily Rated Capacity (BD.FT.)	Annual Log Requirement (CU.M.)	Timber* License
6. Century Hardwood Lumber	Manila	15,000	14,151	
7. Consolidated Wood Products	Parañaque	15,000	14,151	
8. Dy Pac & Co., Inc.	Manila	20,000	18,868	
9. Extensive Wood Processing Corp.	Valenzuela	30,000	34,000	
10. Goodyear Ind'l Corp.	Valenzuela	30,000	28,302	
11. Hylec Development, Inc.	Quezon City	30,000	28,302	
*12. Industries Development Corp.	Quezon City	30,000	28,302	TLA 2
13. Industrial Timber Corp. I	Valenzuela	30,000	28,302	
14. Industrial Timber Corp. II	Valenzuela	30,000	28,302	
15. John Gotamco & Sons	Quezon City	30,000	28,302	
16. Makiling Sawmill Co.	Caloocan City	15,000	14,151	
17. Manila Mill & Timber Co., Inc.	Manila	30,000	28,302	
18. Manila Wood Industries	Manila	30,000	28,302	
19. New St. Joseph Lumber	Quezon City	30,000	28,302	
20. Oceanic Sawmill Co.	Valenzuela	20,000	18,868	
21. Ong Yong & Sons, Inc.	Quezon City	30,000	28,302	
22. Oversea Sawmill, Inc.	Valenzuela	15,000	14,151	
23. Panama Sawmill Co.	Valenzuela	20,000	18,868	
24. Philwood Sawmill Co.	Manila	30,000	28,302	
25. Premium Wood Ind's., Inc.	Valenzuela	30,000	28,302	
26. Rizal Super Sawmill	Pasig	30,000	28,302	
27. Sahara Wood Corp.	Valenzuela	20,000	18,868	
28. Seventh Ave. Sawmill I	Caloocan City	20,000	18,868	

Company	Sawmill Site	Daily Rated Capacity (BD.FT.)	Annual Log Requirement (CU.M.)	Timber* License
29. Seventh Ave. Sawmill II	Caloocan City	30,000	28,302	
30. Southern Sawmill I	Manila	30,000	28,302	
31. Southern Sawmill II	Manila	30,000	28,302	
32. Tanduay Lumber Co.	Manila	10,000	9,434	
33. Unique Builders	Quezon City	15,000	14,151	
34. Valenzuela Hardwood & Ind'l Supply, Inc.	Valenzuela	30,000	28,302	
		850,000	807,588	
	REGION 5			
	CAMARINES NORTE			
1. Basud Trading	Daet	15,000	14,151	
2. Camarines Norte Lumber Development Co., Inc.	Capalonga	10,000	9,434	
3. Camarines Std. Sawmill	Labo	30,000	28,302	
4. Heirs of Leonardo Mendoza	Capalonga	30,000	28,302	
5. Lerum Sawmill	Labo	15,000	14,151	
6. Marosy Timber	Labo	30,000	28,302	
7. Mt. Makisig Wood Products	Basud	10,000	9,434	
8. Republic Hardwood, Inc.	Labo	35,000	50,376	
9. Royal Woods, Inc.	Capalonga	20,000	18,868	
		195,000	201,320	
	CAMARINES SUR			
1. Country Lumber Co.	Goa	15,000	14,151	

Company	Sawmill Site	Daily Rated Capacity (BD.FT.)	Annual Log Requirement (CU.M.)	Timber* License
2. Danas Sawmill	Lagonoy	15,000	14,151	
3. Nelson Sawmill	Goa	15,000	14,151	
4. St. Anthony Sawmill	Camaligan	15,000	14,151	
5. Sipocot Mahogany	Sipocot	18,000	16,981	
6. Tible & Tible Co. I	Lupi	15,000	14,151	
7. Tible & Tible Co. II	Lupi	10,000	9,434	
8. Villasol Sawmill (M. Villafuerte Jr.)	Sipocot	10,000	9,434	
		113,000	106,604	
	REGION 6			
	NEGROS OCCIDENTAL			
1. Amity Timber Co.	Candoni	25,000	23,584	
2. Basay Lumber Corp.	Ilog	30,000	28,302	
*3. Insular Lumber Co. I	Fabrica, Hinobaan	100,000	94,339	TLA 60
*4. Insular Lumber Co. II	Fabrica, Hinobaan	30,000	28,302	TLA 60
*5. Negros Investment & Development Co. I	Himamaylan	15,000	14,151	TLA 57
*6. Negros Investment & Development Co. II	Himamaylan	20,000	18,868	TLA 57
*7. Negros Trinity Lumber	Moises Padilla	15,000	14,151	TLA 286
*8. North Negros Loggers	Talisay	25,000	23,584	TLA 40
9. Supersonic Lumber	Victorias	15,000	14,151	
10. V. U. Lumber Co.	Silay City	15,000	14,151	
		290,000	273,583	

Company	Sawmill Site	Daily Rated Capacity (BD.FT.)	Annual Log Requirement (CU.M.)	Timber*
	REGION 7			
	NEGROS ORIENTAL			
1. Negros Occidental Timber Corp.	Sibulan	20,000	18,868	
2. Negros Timber Co., Inc.	Sta. Catalina	25,000	23,584	
3. Occidental Lumber Mill	La Libertad	6,000	5,660	
4. Oriental Lumber Co.	Sibulan	20,000	18,868	
5. Phil. American Timber Company	Ayongon	20,000	18,868	
6. Phil. Hardwood Lumber Mill	Bais	30,000	28,302	
		121,000	114,150	
	REGION10			
	AGUSAN DEL NORTE			
*1. Bueno Industrial & Dev't Corp.	Butuan City	25,000	28,302	TLA 61
*2. Builders Wood Prods., Inc.	Butuan City	30,000	33,962	TLA 318
3. Bunawan Sawmill Co.	San Vicente	20,000	16,981	
4. Butuan Bay Wood Export Co., Inc.	Magallanes	40,000	45,284	
*5. Butuan Logs, Inc.	Butuan City	25,000	28,302	TLA 82
6. Davao Mahogany Prods., Inc.	Butuan City	30,000	33,962	
*7. Del Rosario & Sons Logging I	Butuan City	25,000	28,302	TLA 177
*8. Del Rosario & Sons Logging II	Butuan City	15,000	16,981	TLA 177
*9. Eureka Enterprises Corp.	Butuan City	30,000	33,962	TLA 170
10. Grace Park Industries	Butuan City	2,000	2,264	
11. Grand Timber Corp.	Butuan City	20,000	22,642	

Company	Sawmill Site	Daily Rated Capacity (BD.FT.)	Annual Log Requirement (CU.M.)	Timber*
*12. Kalilid Wood Ind's Corp. (P.B. de Jesus & Co., Inc.)	Butuan City	30,000	33,962	TLA 232-1
13. Lake Mainit Timber Corp.	Butuan City	10,000	11,321	
*14. Liberty Forest, Inc.	Butuan City	30,000	33,962	TLA 34
15. Mainit Lumber Co., Inc.	Butuan City	30,000	33,962	
16. Mainit Lumber Co., Inc. II	Butuan City	30,000	33,962	
17. Nasipit Lumber Co., Inc. I	Nasipit	50,000	70,775	
18. Nasipit Lumber Co., Inc. II	Nasipit	50,000	70,775	
19. Ong Yiu & Sons	Butuan City	30,000	33,962	
*20. Republic Timber Corp.	Butuan City	15,000	16,981	TLA 42
*21. Sta. Ines Melale Forest Products Corp.	Magallanes	60,000	67,924	TLA 51
22. Timbertown Sawmill	San Vicente	15,000	16,981	
*23. SPV Timber & Const., Inc.	Butuan City	10,000	11,321	TLA 260
*24. RC Aquino Timber & Plywood	Butuan City	30,000	33,962	TLA 68
		652,000	766,455	
	MISAMIS ORIENTAL			
1. Cagayan de Oro Timber Co.	Cagayan de Oro	25,000	28,302	
2. Kauswagan Sawmill	Cagayan de Oro	20,000	22,642	
3. North Mindanao Bay Timber	Cagayan de Oro	20,000	22,642	
*4. P & B Enterprises Co., Inc.	Tagoloan	30,000	33,962	TLA 41
*5. Pedro N. Roa Ent., Inc.	Cagayan de Oro	30,000	33,962	TLA 26
*6. Southeast Aquatic Corp.	Cagayan de Oro	15,000	16,981	TLA 263
*7. Sun Valley Lumber Co.	Cagayan de Oro	15,000	16,981	

Company	Sawmill Site	Daily Rated Capacity (BD.FT.)	Annual Log Requirement (CU.M.)	Timber* License
*8. T. H. Valderrama & Sons, Inc.	Tagoloan	30,000	33,962	TLA 63
*9. Timber Industries of the Philippines, Inc.	El Salvador	45,000	50,343	TLA 110
10. Visayan Box Factory, Inc.	Cagayan de Oro	20,000	22,642	
*11. Remedios O. Fortich Timberland Co., Inc.	Tagoloan	12,000	13,585	
		262,000	296,004	
	REGION 11			
	DAVAO DEL NORTE			
*1. Aguinaldo Dev't. Corp.	Maco	20,000	22,642	TLA 52
*2. Aguinaldo Dev't. Corp. (portable)	Maco	2,000	Logging Wastes	TLA 52
3. Apex Exploration	Maco	4,000	4,528	
*4. Consolidated Plywood Ind's. Inc.	Panabo	35,000	39,623	TLA 213
*5. Davao Stevedore Terminal Co., Inc.	Panabo	30,000	33,962	TLA 98
*6. Desiderio Dalisay Investments, Inc.	La Paz, Carmen	30,000	33,962	TLA 5
7. Industrial Lumber Co.	Tagum	20,000	22,642	
*8. Manuel Nieto Corp.	Mabini	18,000	20,377	TLA 4
9. Standard Hardwood Co., Inc.	Nabuntaran	15,000	16,981	
*10. Valderrama Lumber Mfrs. Co., Inc.	Compostela	55,000	62,262	TLA 96
*11. Valderrama Lumber Mfrs. Co., Inc. (Portable)	Compostela	2,000	Logging Wastes	TLA 96
*12. Valderrama Lumber Mfrs. Co., Inc.	Compostela	20,000	22,642	TLA 96
		251,000	279,621	

Company	Sawmill Site	Daily Rated Capacity (BD.FT.)	Annual Log Requirement (CU.M.)	Timber* License
	DAVAO DEL SUR			
1. Agri-For Everglade	Davao City	2,000	2,264	
2. Brickwood Interior, Inc.	Davao City	30,000	33,962	
*3. C. Alcantara & Sons, Inc.	Davao City	30,000	33,962	TLA 91
4. Columbia Sawmill	Davao City	15,000	16,981	
*5. Davao Enterprises Corp.	Davao City	30,000	33,962	TLA 160-1
*6. Davao Gulf Lumber Corp.	Davao City	25,000	28,302	TLA 199
7. Davao United Lumber	Davao City	20,000	22,642	
8. Fact Development Corp.	Davao City	15,000	16,981	
9. Felbet's Timber	Davao City	20,000	22,642	
10. G.T. Processing	Davao City	4,000	4,528	
11. Hilton Sawmill	Davao City	30,000	33,962	
12. Hudson Sawmill	Davao City	30,000	33,962	
13. Instant Wood Processing	Davao City	10,000	11,321	
14. Jomon (Phil.) Industries Corp.	Davao City	10,000	11,321	
*15. L. S. Sarmiento & Co., Inc.	Davao City	30,000	33,962	TLA 79
16. MCP-Agro Ind'l. Ent. Inc.	Davao City	4,000	4,528	
*17. Mindanao State Mahogany Corp. (SUDECOR)	Davao City	30,000	33,962	TLA 56
18. Mintrade (Davao)	Davao City	30,000	33,962	
19. Northern Hill Development	Davao City	8,000	9,056	
20. Panakan Lumber Co.	Davao City	15,000	16,981	
*21. Phil. Lauan Industries Corp.	Davao City	15,000	16,981	TLA 153
22. R. C. Otero Enterprises	Davao City	15,000	16,981	

Company	Sawmill Site	Daily Rated Capacity (BD.FT.)	Annual Log Requirement (CU.M.)	Timber* License
*23. Sta. Clara Housing Industries Inc.	Davao City	20,000	22,642	TLA 69/70
24. South Bay Lumber Co.	Davao City	30,000	33,962	
25. Talomo Sawmill	Davao City	20,000	22,642	
26. Wood Industrial Traders	Davao City	25,000	28,302	
27. Yujuico Logging & Trading Corp.	Davao City	20,000	22,642	
28. Elias P. Dacudao Ent.	Davao City	25,000	28,302	TLA 198
		558,000	631,697	
	DAVAO ORIENTAL			
*1. Angala Enterprises Inc.	Banay-Banay	15,000	16,981	TLA 3
*2. Buenavista Timber Corp.	Manay	25,000	28,302	TLA 108
*3. Consolidated Plywood Ind's. Inc. (Portable)	Baganga	4,000	Wastes	TLA 213
*4. Consolidated Plywood Ind's. Inc.	Baganga	40,000	45,282	TLA 213
*5. Cuison Lumber Co., Inc.	Puntalinao Banay-Banay	25,000	28,302	TLA 33-1
*6. Davao Timber Corp. I	Mati	30,000	33,962	TLA 16
*7. Davao Timber Corp. II	Mati	30,000	33,962	TLA 16
*8 Eastcoast Development Ent. Inc.	Baganga	30,000	33,962	TLA 201
*9. North Camarines Lumber Co., Inc.	Baganga	25,000	28,302	TLA 76
*10. Pahamotang Logging Ent., Inc.	Manay	20,000	22,642	TLA 9
		244,000	271,697	
	SOUTH COTABATO			
*1. B & B Forest Dev't. Corp.	Kiamba	25,000	28,302	TLA 23

Company	Sawmill Site	Daily Rated Capacity (BD.FT.)	Annual Log Requirement (CU.M.)	Timber* License
2. Lomuyon Timber Industries Inc.	Gen. Santos City	30,000	33,962	
3. M. F. Timber Ind's, Corp.	Gen. Santos City	30,000	33,962	
*4. Mindanao Lumber Dev't. Co., Inc.	Kiamba	30,000	33,962	TLA 36
*5. Habaluyas Ent., Inc.	Gen. Santos City	30,000	37,736	TLA 299
		145,000	167,924	

Note: * Timber License as of December 31, 1982

Source: Presidential Committee on Wood Industries Development

Appendix 10A-1. COST OF RAW MATERIALS, SUPPLIES AND UTILITIES

The respective costs of raw material sawdust, supplies and utilities are as follows:

1) Raw Material Sawdust

Raw material sawdust will be available from sawmills free of charge, but expenses will be incurred for transporting the sawdust from sawmills to plant by truck. These expenses essentially consist of truck depreciation expenses, maintenance expenses, truck driver remuneration expenses and gasoline expenses.

However, in the financial analysis, the expenses for gasoline were included in sawdust cost, while other expenses were respectively included in the depreciation expenses, maintenance expenses and plant personnel labor expenses.

Therefore, the cost of sawdust per ton of product will consist of only the gasoline cost incurred for transporting 70 m^3 of sawdust (equivalent to 1 ton of product) to the plant. Consumption of gasoline per ton of product will be estimated at 35 ℓ.

2) Electricity Charge

As pointed out in Chapter 9, the plant's power receiving capacity is 275 kW. The power consumption per ton of product being 500 kWh, the power consumption per month will run up to 20,000 kWh (500 kWh/t x 40 tons).

The electricity charge per kWh is calculated as follows:

(a) Demand charge 9 ₱/kW x 150 kW = ₱1,350

(b) Service charge 0–15,000 kWh
0.62420 ₱/kWh x 15,000 kWh = ₱9,363

15,000–20,000 kWh
0.59420 ₱/kWh x 5,000 kWh = ₱2,971

Therefore, the mean electricity charge per kWh will be as follows:

₱(1,350 + 9,363 + 2,971) / 20,000 kWh = 0.6842 ₱/kWh

3) **Packing Bags**

Bags for Sawdust Char Transportation

By the time the plant starts operation, 5,000 plastic bags of 15-kg capacity (₱8/bag) are to be procured for use in the transfer of sawdust char from carbonization plant to activation plant. Assuming that a bag is usable for 30 times of char transfer, the cost of these bags per ton of product will run up to about U.S.$4.00.

Bags for Product

The bag for powdered activated carbon product has a capacity of 20 kg and consists of the inner and outer bags. The inner bag is made of 2-ply kraft paper while the outter bag is made of 3-ply kraft paper, among which one of these layers is made of polyethylene laminated sheet. A domestically produced two-colored bag is available in Davao at an estimated price of about ₱30.

4) **Kerosene (for afterburners)**

The quantity of kerosene consumed by afterburners is 150 liters/ton-product.

Based on the conditions described above, the cost of materials, supplies and utilities per ton of product, as of prices in September 1984, will be as shown in Table 10A-1-1.

Table 10A-1-1 COST OF MATERIALS, SUPPLIES AND UTILITIES PER TON OF PRODUCT (Sept., 1984)

	Consumption per ton Product	Unit Price (₱)
Sawdust (Gasoline)	35 ℓ	8.37
Electricity	500 kWh	0.69
Bag (for Sawdust Char)	9 bags	8
Bag (for Product)	50 bags	30
Kerosene (for Afterburner)	150 ℓ	8.37

Appendix 11A-1

degree centigrade or celsius (O°C) and at an absolute pressure equivalent to one atmosphere.

(bb) "Tonne" means 1000 kilograms.

(cc) 'Visible Emission" means an emission greater than five percent opacity.

(dd) "Volatile Organic Compound" or "Organic" means any compound containing carbon and hydrogen, or carbon and hydrogen in combination with any other element which has an absolute vapor pressure of 0.10 kg/cm², equivalent to 77.6 mm Hg or greater under actual storage conditions.

SEC. 58. *Maximum Permissible Emission Standards for Visible Emissions and Particulate Matter.*—

(a) For fuel-burning equipment and industrial plant:—

(1) The concentration of air impurities emitted from *existing sources* at the point of emission determined in accordance with the provision of these Rules and Regulations shall be such that, when compared in the appropriate manner with the Ringelmann Chart or an equivalent method approved by the Commission, impurities shall not appear to be darker than Shade 2 on the Chart.

(2) The concentration of air impurities emitted from *new* sources under the above Regulation shall be such that impurities shall not appeal to be darker than Shade 1 on that Chart.

Exceptions to Regulations 58 (a) (1) and (2) shall apply to the following circumstances:—

(i) When in the opinion of the Commission, it is not reasonably practicable to achieve these standards and a permission has been granted in writing for a conditional variation of these Rules and Regulations.

(ii) The concentration of air impurities hereinbefore precribed may be exceeded for a total period not in excess of 20 minutes in any period of 24 hours if the emission of air impurities in excess of such standard of concentration is solely due to the lighting up of any boiler or incinerator from cold, provided that at no time should the concentration of air impurities be such that when compared in the appropriate manner with the Ringelmann Chart, such air impurities would appear to be darker than Shade 3 on that Chart and that all practicable means are employed to prevent or minimize the emission of air impurities.

(iii) The standard of concentration of air impurities hereinbefore prescribed may be exceeded for a period not in excess of 10 minutes in any period of eight hours in the case of boilers burning up to one tonne of fuel per hour of 20 minutes in any period of eight hours in the case of boilers burning more than one tonne but less than five tonnes of fuel per hour or 30 minutes in any period of eight hours in the case of boilers burning more than five tonnes of fuel per hour if the emission of air impurities in excess of, such standard of concentration is solely due to the soot blowing of a boiler, provided that at no time should the concentration of air impurities be such that when compared in the appropriate manner with the Ringelmann Chart such air impurities would appear to be darker than Shade 3 on said Chart and all practicable means are employed to prevent or minimize the emission of air impurities.

(iv) For kilns used for firing bricks, tiles, pipes, pottery or refractories, Regulation 58(b) shall apply.

(b) Boilers or incinerators emitting solid particles;

For existing boilers and incinerators, concentration of solid particles at the point of emission adjusted to a basis of 12% carbon dioxides, shall be such that the total mass of such solid particles does not exceed 500 mg/scm.

For new boilers or incinerators (new sources) the maximum permissible emission limit under the above Regulation shall be 300 mg/scm.

(c) Any trade, industry, process, industrial plant or fuel-burning equipment emitting solid particles, except those referred to in paragraph (b) of these Regulations.

The concentration of solid particles at the point of emission of existing sources shall not exceed 500 mg/scm.

For new sources the maximum permissible emission limit for particulate matter shall be 300 mg/scm.

SEC. 59. *Maximum Permissible Emission Standards for Specific Air Pollutants from Stationary Sources.*—

For any trade, industry, process, fuel-burning equipment or industrial plant emitting air pollutants, the concentration at the point of emission shall not exceed the limits set in Table 1.

TABLE 1.—*Maximum Permissible Emission Standards for Specific Air Pollutants from Stationary Sources*

Pollutant	Standard Applicable to Source	Maximum Permissible Emission Standard
Antimony and its compounds	any source	10 milligrams/scm as antimony
Ammonia	any source	400 milligrams/scm
Arsenic and its compounds	any source	10 milligrams/scm as arsenic
Cadmium and its compounds	any source	10 milligrams/scm as cadmium
Total of antimony, arsenic, cadium, lead, mercury and their compounds	any industrial source	10 milligrams/scm (Addition of each metal or compound expressed as the metal in each case)
Carbon Disulfide	any source	100 milligrams/scm
Carbon Monoxide	any industrial source	500 milligrams/scm
Copper and its compounds	any source	100 milligrams/scm
Chlorine (and chlorine Gas)	any source	60 milligrams/scm
Formaldehyde	any source	600 milligrams/scm
Hydrofluoric Acid & Fluorine compounds	aluminum reduction any other industrial source	20 milligrams/scm as hydrofluoric acid 50 milligrams/scm as hydrofluoric acid
Hydrogen Chloride & Chlorine compound	any source	200 milligrams/scm as Chlorine
Hydrogen Sulfide Gas	any source	15 milligrams/scm
Lead and its compounds	any source	10 milligrams/scm
Mercury & its compounds	any source	5 milligrams/scm as mercury
Nickel and its compounds	any source, except nickel carbonyl for which it should be	20 milligrams/ scm as nickel 0.5 milligrams/scm as nickel
Nitric acid or Oxides of Nitrogen	any source	2 grams/scm as No.
Phenol	any source	400 milligrams/scm
Phosphorus Pentoxide	any source	200 milligrams/scm
Sulfuric Acid, Sulfur Dioxide & Sulfur Trioxide	any trade, industry or process excluding sulfuric acid manufacture	1500 milligrams/scm as sulfur dioxide
Sulfuric Acid, Sulfur Dioxide and Sulfur Trioxide	any trade, industry or process manufacturing sulfuric acid	2 grams/scm as sulfur dioxide
Total Oxides	any fuel-burning plant	250 milligrams/scm as Sulfur Dioxide, or where limit cannot be met, control to be by stack height
Zinc and its compounds	any source	100 milligrams/scm

* NOTE: If the emission standard cannot be met due to economic and technical limitations, then the ambient air quality standard should prevail.

MGA KAUTUSANG PAMPANGASIWAAN AT ALITUNTUNIN NG MGA MINISTRI, KAWANIHAN AT TANGGAPAN

(MINISTRY, BUREAU AND OFFICE ADMINISTRATIVE ORDERS AND REGULATIONS)

Ministri Ng Panahanang Tao

MINISTRY OF HUMAN SETTLEMENTS

REPUBLIC OF THE PHILIPPINES
MINISTRY OF HUMAN SETTLEMENTS
PAMBANSANG KOMISYON SA PAGSUGPO SA POLUSYON
(NATIONAL POLLUTION CONTROL COMMISSION)
772 PEDRO GIL ST., COR. TAFT AVENUE
ERMITA, MANILA

EFFLUENT REGULATIONS OF 1982

Pursuant to the provisions of Section 6 (1) of Presidential Decree No. 984, otherwise known as the "Pollution Control Decree of 1976" the National Pollution Control Commission hereby adopts and promulgates the following rules and regulations:

SECTION 1. *Title.*—These rules and regulations shall be cited as the "Effluent Regulation of 1982".

SEC. 2. *Scope.*—These rules and regulations shall apply to all industrial and municipal wastewater effluents:

SEC. 3. *Definitions.*—The following words and phrases, as used in these rules and regulations, shall have the following meanings unless the context clearly indicates otherwise:

a) "BOD" means a measure of the approximate quantity of dissolved oxygen that will be required by bacteria to stabilize organic matter in wastewater or surface water. It is a semi-quantitative measure of the wastewater organics that are oxidizable by bacteria. It is also a standard test in assessing wastewater strength.

b) "Coastal Water" means an open body of water along the country's coastline starting from the shoreline (MLLW) and extending outward up to the 200-meter isobath or three-kilometer distance, whichever is farther.

c) "Commission" refers to the National Pollution Control Commission.

d) "Effluent" is a general term denoting any wastewater, partially or completely treated, or in its natural state, flowing out of a manufacturing plant, industrial plant or treatment plant.

e) "Inland Water" means as interior body of water or watercourse such as lake, reservoir, river, stream, creek, etc., that has beneficial usages other than public water supply or primary contact recreation. Tidal affected rivers or streams are considered inland waters.

f) "Primary Contact Recreation" means any form of recreation where there is intimate contact of the human body with the water, such as swimming, water skiing, or skin diving.

g) "Protected Water" means a watercourse or a body of water, or any segment thereof, that is classified as a source of public water supply or primary contact recreation, or that is designated by competent government authority as a national park or reserve.

SEC. 4. *Metals and Toxic Substances.*—Industrial and other effluents when discharged into bodies of water classified as Class A, B, C, D, and SB, SC and SD in accordance with the 1978 NPCC Rules and Regulations shall not contain the following substances in levels greater than those indicated:**

		Protected Inland Waters (Class A & B)	Protected Coastal Waters (Class SB & NP*)	Other Inland Waters (Class C & D)	Other Coastal Waters (Class SC & SD)
Barium	(Ba)	2	2	2	5
Cadmium	(Cd)	0.01	0.02	0.05	0.1
Copper	(Cu)	1	1	1	1
Chromium (Hexavalent)	(Cr +6)	0.05	0.05	0.1	0.1
Dissolved Iron	(Fe)	1	5	10	20
Lead	(Pb)	0.1	0.1	0.5	0.5
Lithium	(Li)	0.5	0.5	1	1
Dissolved Manganese	(Mn)	1	1	1	5
Mercury Total	(Hg)	0.002	0.002	0.002	0.002
Molybdenum	(Mo)	0.1	0.1	0.1	0.5

*NP–National Park or Reserve.
** Maximum allowable Levels in mg./1.

Nickel	(Ni)	0.5	[illegible]	0.5	1
Selenium	(Se)	0.05	0.1	0.2	1
Silver	(Ag	0.1	0.1	0.5	1
Zink	(Zn)	5	5	5	10
A enic	(As)	0.1	0.1	0.1	0.5
Boron	(B)	—	—	2	—
Beryllium	(Be)	0.5	0.5	0.5	1
Free Chlorine	(Cl)	1	1	1	1
Cyanide	(CN)	0.1	0.1	0.1	0.5
Fluoride	(F)	3.	3	6	10
Polychlorinated Byphenyl	(PCB)	0.003	[illegible]	[illegible]	.003

SEC. 5. *Physical and Chemical Substances.*— Effluents from domestic wastewater treatment plants and industrial plants not covered under Section 6 of these Regulations, when discharged into bodies of water classified as Class A, B, C, D, SB and SC in accordance with the 1978 NPCC Rules and Regulations, shall not contain the following physical and chemical characteristics in levels greater than those indicated:

	Protected Inland Waters (Class A & B)	Protected Coastal Waters (Class SB & NP)	Inland Waters (Class C & D)	Coastal Waters (Class SC)
a) Color in platinum cobalt units	100	100	100	200
b) pH	6-8.5	6-8.5	6-8.5	5.5-9
c) Temperature in °C	40	40	40	40
d) Phenols in mg./1.	0.05	0.05	0.1	1
e) Suspended solids in mg./1.	30	50	75	200
f) BOD in mg./1.	30	50	80	250
g) oil/Grease in mg./1.	5	5	10	15
h) Detergehts in mg./1.	1	1	5	10

SEC. 6. *Effluent Standards for Strong Industrial Wastes.*—a) Effluents from manufacturing plants with BOD valued greater than 300 mg/1 and effluents from dessicated coconut factories, tanneries, cassava and starch manufacturing plants, slaughterhouses, meat processing plants and petroleum refineries shall not exceed the following maximum permissible limits when discharged into inland or coastal waters:

	Inland Waters (Class C & D)	Coastal Waters (Class SC)
a) Color in platinum cobalt units	150	300
b) pH	6-9	5-9
c) Temperature in °C	40	40
d) Phenols in mg./1	1	10
e) Suspended solids in mg/1	100	400
[illegible] BOD in mg/1	150	500
[illegible] and Grease in mg/1	10	15

[illegible] or wastewaters produced in sugar cane or molasses-based distilleries and palm oil and rubber processing plants, the BOD of the effluent shall not exceed 250 mg/1 when discharged into inland waters and 1000 mg/1 when discharged into coastal waters.

c) Effluents discharged into protected inland and coastal waters shall meet the requirements of Section 5 above.

SEC. 7. *Bacteriological Characteristics.*—The bacteriological quality of effluents from industrial wastewater and municipal or domestic sewage treatment plants shall be such that coliform organisms in 80 percent of the 10-ml. portions of any five consecutive samples taken during a period of one month shall not exceed an MPN of 5,000 per 100 ml. for discharges in class A, B and SB waters and an MPN of 20,000 per 100 ml. for discharges in other inland waters.

SEC. 8. *Additional Requirements.*—

a) In addition to fulfilling the above-stated requirements in Sections 4 to 7, no effluent shall cause the quality of the receiving body of water to fall below its prescribed quality in accordance with its classification or best usage.

b) Where the combined effect of a number of individual effluent discharges causes one or more quality parameters to exceed the said limits, the maximum permissible concentrations of such parameters shall be reduced proportionately so as to maintain the desired quality.

c) When discharging effluents into coastal waters, the location and design of the discharge outfall shall be based on prevailing oceanographic and wind conditions so that discharged materials shall not find their way back to the shore and that there shall be minimum deposition of sediments near and around the outfall.

SEC. 9. *Prohibiting.* No industrial or domestic sewage effluent shall be discharged into Class AA waters.

SEC. 10. *Method of Analysis for Effluents.*—For purposes of these Regulations, any domestic or industrial effluent discharged into any water body or watercourse shall be analyzed in accordance with the latest editions of the "Philippine Standard Methods for Air and Water Analyses", the "Standard Method for the Examination of Water and Wastewater" published jointly by the American Public Health Association, the American Waterworks Association and the Water Pollution Control Federation of the United States, or in accordance with such other methods of analysis as the Commission may prescribe.

SEC. 11. *Maximum Quantity to be Discharged.*—For the protection of public health and the aquatic resources of the country and for substances or pollutants not otherwise covered in the preceding section, the Commission may prescribe the maximum quantity of such substance or pollutant that may be discharged into any body of water or watercourse, including the maximum rate at which the substance may be so discharged.

SEC. 12. *Penalties.* Any person or group of persons found violating or failing to comply with any Order or Decision of the Commission, or any provision of these Regulations, shall be liable under Section 9 of the Pollution Control Law (PD No. 984) and/or Section 106 of the 1978 NPCC Revised Rules and Regulations.

SEC. 13. *Separability Clause.*—If any section or provision of these Regulations is held or declared unconstitutional or invalid by a competent court, the other sections or provisions hereof shall continue to be in force as if the sections or provisions so annuled or voided had never been incorporated herein.

SEC. 14. *Repealing Clause.*—Any provision of the 1978 Rules and Regulations and the other rules and regulations of the Commission which is inconsistent with any section of these Regulations is hereby repealed.

SEC. 15. *Amendments.*—These Regulations may be amended and/or modified from time to time by the Commission.

SEC. 16. *Effectivity.*—These Regulations shall take effect thirty days after publication in the *Official Gazette.*

APPROVED:

(Sgd.) GUILLERMO A. PECACHE
Brig. General, AFP (Ret.)
Commissioner

Appendix 14A-1 INFLATION RATE IN INDUSTRIALLY ADVANCED COUNTRIES

The inflation rates of industrially advanced countries in recent years are as shown in the following table.

CHANGE IN PRICES (%) 1)

Year	Consumer Price			Average Export Prices3)
	U.S.A.	Japan	7 Countries2)	
1978	7.7	3.8	6.9	5.7
1979	11.3	3.6	9.2	11.9
1980	13.5	8.0	12.1	11.9
1981	10.4	4.9	9.8	6.3
1982	6.2	2.6	6.9	3.3
1982	3.0	2.0	5.0	3.0

(Note) 1) In US$ terms
2) U.S.A., Japan, West Germany, U.K., France, Italy and Canada
3) Export price of industrially advanced countries

(Source) IMF

According to this table, Japan's inflation rate is proceeding at an average annual growth rate of slightly over 4%, while that of other countries is proceeding at faster rates.

The following table shows the projected annual inflation rates of principal industrialized countries.

PROJECTED ANNUAL INFLATION RATE (%)

	1984	1985
U.S.A.	4.0	5.25
Japan	2.25	3.0
W. Germany	3.0	3.25
U.K.	5.0	5.25
France	7.5	5.75
OECD Total (24 Countries)	5.25	5.25

(Source) OECD

According to these tables, the inflation rates of industrially advanced countries appear to be subsiding in recent years. However, the mean annual inflation rates of OECD countries are expected to exceed a growth rate of 5%.

In view of the situation described above, the foreign currency inflation rate of 5% is adopted in this study.

Appendix 14A-2 RISE OF COMMODITY PRICES IN THE PHILIPPINES

Table 14A-2-1 shows the situation of rises in wholesale prices in the Philippines.

In this table, the wholesale price indices in Metro Manila for Portland cement and structural steel, which are raw materials having a deep relationship with this project, are as follows:

Year	Portland cement	Structural steel
1976	95.0	78.6
1977	98.1	83.8
1978	100.0	100.0
1979	132.2	119.6
1980	186.9	129.8
1981	207.6	137.9
1982	223.9	129.8
1983	226.9	137.3

Also, the consumer price indices (CPI) for all items are as follows:

1978 (Average)	100.0
1979 (Average)	117.5
1980 (Average)	138.9
1981 (Average)	157.1
1982 (Average)	173.2
1983 (Average)	190.5
1984 (Jan.)	238.2
(Feb.)	245.4
(Mar.)	250.8
(Apr.)	254.6
(May)	258.9
(Jun.)	275.2
(Jul.)	299.8

Source: Copy obtained at NEDA

Meanwhile, the inflation rates are as follows:

		(%)
1983	Jan.	6.9
	Feb.	6.6
	Mar.	6.4
	Apr.	6.2
	May	6.7
	Jun.	7.3
	Jul.	7.9
	Aug.	9.1
	Sept.	9.1
	Oct.	10.3
	Nov.	16.7
	Dec.	26.1
1984	Jan.	33.3
	Feb.	36.6
	Mar.	39.3
	Apr.	40.7
	May	42.1
	Jun.	49.2
	Jul.	58.8

Table 14A-2-2 shows the wages of laborers in the Philippines.

Incidentally, the trends up till 1982 in the exchange rate of the peso to U.S. dollar are as shown in the following table:

	₱/US$
1978 (Year end average)	7.3712
1979 (Year end average)	7.4110
1980 (Year end average)	7.5114
1981 (Year end average)	7.8996
1982 (Year end average)	8.54

Source: Based on Central Bank

Subsequent exchange rates are as follows:

	₱/US$
1983 June	11.0
1983 October	14.0
1984 June	18.0

These exchange rates can be rewritten as follows when compared with the exchange rate of 1978 set as the base figure of 100:

	INDEX
1978 (Year end average)	100.0
1979 (Year end average)	100.54
1980 (Year end average)	101.90
1981 (Year end average)	107.17
1982 (Year end average)	115.86
1983 (Jun.)	149.23
(Oct.)	189.93
1984 (Jun.)	244.19

Represented in graphical form, these indices will be as shown in Fig. 14A-2-1. This graph shows that, in terms of the peso, commodity prices in the Philippines are rising at a very fast pace. On the other hand, when taking into consideration the decrease of the value of the peso with respect to the U.S. dollar, the rise in commodity prices in terms of the U.S. dollar will not be so high.

The rise in CPI (all items) and the rise in the peso's foreign exchange rate both assume almost the same pattern, but the rise in CPI is slightly higher. That is, in terms of 1978 standards (index = 100), the CPI in July 1984 runs up to 299.8, and the foreign exchange index in June 1984 to 244.19, indicating that the CPI is higher by about 20%. Accordingly, the rise in commodity prices in the Philippines in terms of the U.S. dollar may be regarded as being about 3% on the yearly average.

It will be difficult to estimate in what manner the commodity prices in those Philippines will rise in the future, but in terms of the U.S. dollar the commodity price index in the Philippines is expected to be almost the same as the mean CPI of industrially advanced countries.

Based on the reasons described above, the CPI in the Philippines in terms of the U.S. dollar up till the end of March 1987, when this project is expected to be completed, shall be assumed to rise at an annual rate of 5%.

Table 14A-2-1 WHOLESALE PRICE INDEX OF SELECTED MATERIALS USED IN CONSTRUCTION ACTIVITIES IN METRO MANILA (1978 = 100)

Period	Automotive diesel fuel[1)]	Portland cement[2)]	Reinforcing steel	Asphaltic material	Metal products	Lumber products	Electrical machineries and fixtures	Structural steel
1976	91.6	95.0	100.2	95.4	88.6	77.6	82.0	78.6
January	85.7	88.9	101.0	95.4	84.5	59.6	78.4	77.9
February	92.1	91.1	101.0	95.4	88.0	62.5	78.4	78.7
March	92.1	92.3	102.6	95.4	88.6	69.1	79.8	78.7
April	92.1	92.3	102.6	95.4	88.6	73.5	79.8	78.7
May	92.1	92.3	102.6	95.4	88.6	74.9	80.7	78.7
June	92.1	94.1	102.6	95.4	88.6	74.9	81.0	78.7
July	92.1	96.5	100.7	95.4	88.7	81.9	81.0	78.7
August	92.1	98.5	97.8	95.4	88.8	81.9	82.8	78.7
September	92.1	98.5	97.8	95.4	89.2	81.9	85.6	78.7
October	92.1	98.5	97.8	95.4	89.8	81.9	85.6	78.7
November	92.1	98.5	97.8	95.4	89.9	94.3	85.6	78.7
December	92.1	98.5	97.8	95.4	89.9	94.3	85.6	78.7
1977	97.6	98.1	90.8	100.0	91.6	94.9	92.3	83.8
January	92.1	98.5	97.8	100.0	91.1	94.3	87.8	78.7
February	92.1	98.1	97.8	100.0	91.1	94.3	87.8	78.7
March	92.1	98.1	97.8	100.0	93.7	94.3	89.8	78.7
April	94.1	98.1	97.8	100.0	93.7	94.3	89.8	78.7
May	100.0	98.1	97.8	100.0	92.8	94.3	89.8	78.7
June	100.0	98.1	91.1	100.0	91.6	94.3	92.3	78.7
July	100.0	98.1	84.9	100.0	90.8	94.3	92.3	88.8
August	100.0	98.1	84.9	100.0	90.8	94.3	92.3	88.8
September	100.0	98.1	84.9	100.0	90.8	96.2	96.1	88.8
October	100.0	98.1	84.9	100.0	90.8	96.2	96.1	88.8
November	100.0	98.1	84.9	100.0	90.8	96.2	96.6	88.8
December	100.0	98.1	84.9	100.0	90.8	96.2	96.6	88.8
1978	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
January	100.0	98.1	80.6	100.0	90.2	100.0	98.0	88.8
February	100.0	98.1	80.6	100.0	91.6	100.0	98.0	92.0
March	100.0	98.1	93.5	100.0	94.9	100.0	98.0	92.0
April	100.0	98.1	106.5	100.0	98.3	100.0	98.3	93.2
May	100.0	98.1	106.5	100.0	99.8	100.0	98.3	96.4
June	100.0	98.1	106.5	100.0	100.5	100.0	98.3	96.4
July	100.0	100.6	106.5	100.0	101.7	100.0	101.3	96.4
August	100.0	100.6	106.5	100.0	102.8	100.0	101.3	96.4
September	100.0	100.6	106.5	100.0	104.3	100.0	101.3	96.4
October	100.0	100.6	102.2	100.0	104.1	100.0	102.4	117.3
November	100.0	100.6	102.2	100.0	105.8	100.0	102.4	117.3
December	100.0	108.5	103.8	100.0	106.0	100.0	102.4	117.3

Period	Automotive diesel fuel[1)]	Portland cement[2)]	Reinforcing steel	Asphaltic material	Metal products	Lumber products	Electrical machineries and fixtures	Structural steel
1979	131.9	132.2	122.0	125.1	120.5	140.3	108.5	119.6
January	100.0	108.5	103.8	100.0	109.2	109.1	102.4	117.3
February	110.2	108.5	103.8	100.0	109.8	109.1	102.4	117.3
March	121.5	134.4	119.4	117.9	115.1	126.0	103.5	117.3
April	121.5	134.4	121.5	117.9	118.3	126.0	105.3	120.4
May	121.5	134.4	121.5	117.9	121.9	130.6	105.3	120.4
June	121.5	134.4	121.5	117.9	122.5	130.6	107.7	120.4
July	121.5	134.4	123.9	117.9	123.1	143.9	108.1	120.4
August	153.1	134.4	129.8	142.3	124.6	175.9	111.8	120.4
September	153.1	134.4	129.8	142.3	125.0	175.9	111.8	120.4
October	153.1	134.4	129.8	142.3	125.0	152.1	114.7	120.4
November	153.1	147.1	129.8	142.3	125.2	152.1	114.7	120.4
December	153.1	147.1	129.8	142.3	126.4	152.1	114.7	120.4
1980	228.1	186.9	133.3	213.6	135.9	191.0	129.0	129.8
January	153.1	147.1	129.8	142.3	131.6	152.1	117.2	120.4
February	221.7	183.8	129.8	205.9	132.6	152.1	120.6	120.4
March	221.7	191.2	129.8	205.9	134.4	198.8	120.6	120.4
April	221.7	191.2	129.8	205.9	135.1	198.8	128.2	120.4
May	221.7	191.2	129.8	205.9	135.1	198.8	128.2	120.4
June	221.7	191.2	129.8	205.9	135.6	198.8	132.1	120.4
July	221.7	191.2	129.8	205.9	135.6	198.8	132.1	120.4
August	250.9	191.2	129.8	237.2	135.8	198.8	132.1	123.1
September	250.9	191.2	135.8	237.2	136.7	198.8	132.1	145.3
October	250.9	191.2	141.7	237.2	139.0	198.8	136.5	145.3
November	250.9	191.2	141.7	237.2	139.1	198.8	136.5	150.4
December	250.9	191.2	141.7	237.2	139.9	198.8	136.5	150.4
1981	261.1	207.6	141.1	256.1	151.3	204.8	129.6	137.9
January	250.9	191.2	141.3	237.2	145.3	204.8	125.0	136.7
February	250.9	191.2	141.3	237.2	145.1	204.8	125.0	136.7
March	250.9	191.2	141.1	237.2	145.1	204.8	125.0	136.7
April	264.2	191.2	141.1	262.4	145.4 r)	204.8	126.9	136.7
May	264.5	191.2	141.1	262.4	157.8	204.8	131.0	151.5
June	264.5	191.2	141.1	262.4	156.0	204.8	131.0	151.5
July	264.5	223.9	141.1	262.4	153.0	204.8	131.0	135.0
August	264.5	223.9	141.1	262.4	153.4	204.8	131.0	135.0
September	264.5	223.9	141.1	262.4	153.4	204.8	131.0	133.3
October	264.5	223.9	141.1	262.4	153.6	204.8	131.0	133.3
November	264.5	223.9	141.1	262.4	153.6	204.8	133.5	133.3
December	264.5	223.9	141.1	262.4	154.0	204.8	133.5	135.0

Period	Automotive diesel fuel[1]	Portland cement[2]	Reinforcing steel	Asphaltic material	Metal products	Lumber products	Electrical machineries and fixtures	Structural steel
1982	264.2	219.8	141.1	262.4	151.3	203.6	139.8	129.8
January	264.5	223.9	141.1	262.4	157.7	204.8	133.5	138.4
February	264.5	223.9	141.1	252.4	157.7	221.4	133.5	135.0
March	264.5	223.9	141.1	262.4	157.9	221.4	133.5	128.2
April	264.5	223.9	141.1	262.4	154.0	216.8	133.5	128.2
May	264.5	223.9	141.1	262.4	154.0	216.8	133.5	128.2
June	264.5	223.9 r)	141.1	262.4	151.8	216.8	133.5	128.2
July	263.4	223.9 r)	141.1	262.4	152.4	194.6	145.0	129.9
August	263.4	223.9 r)	141.1	262.4	153.1	195.0	145.0	128.2
September	263.4	223.9 r)	141.1	262.4	144.7	188.8	145.0	128.2
October	264.4	223.9 r)	141.1	262.4	144.7	188.8	145.0	128.2
November	264.4	223.9 r)	141.1	262.4	144.2	188.8	145.0	128.2
December	264.4	223.9 r)	141.1	262.4	143.8	188.8	145.0	128.2
1983	302.7	229.8	170.7	295.8	167.9	203.4	149.7	137.3
January	264.4	223.9 r)	141.1	262.4	143.7	187.2	145.0	128.2
February	264.4	223.9 r)	141.4	262.4	144.0	187.2	145.0	123.0
March	264.4	223.9 r)	141.1	262.4	144.0	187.2	145.0	123.0
April	264.4	223.9 r)	141.1	262.4	145.3	187.2	145.0	123.0
May	264.4	223.9 r)	141.1	262.4	149.4	187.2	145.2	133.3
June	264.4	223.9 r)	141.1	262.4	154.4	187.2	145.2	133.3
July	306.0	223.9 r)	163.3	295.1	163.6	203.7	145.2	143.6
August	306.0	223.9 r)	163.3	295.1	165.2	203.7	145.7	141.8
September	310.9	224.3 r)	168.5	295.1	176.3	203.7	145.7	141.8
October	313.9	224.3 r)	175.4	295.1	183.6	220.6	151.6	141.8
November	404.7	259.2	248.0	397.6	211.8	240.2	164.6	152.1
December	404.7	259.2	283.1	397.6	232.8	246.1	173.6	162.4

1) Incl. other petroleum products, refined.
r) Revised.

Sources of basic data: National Census and Statistics Office (NCSO) and other reporting establishments

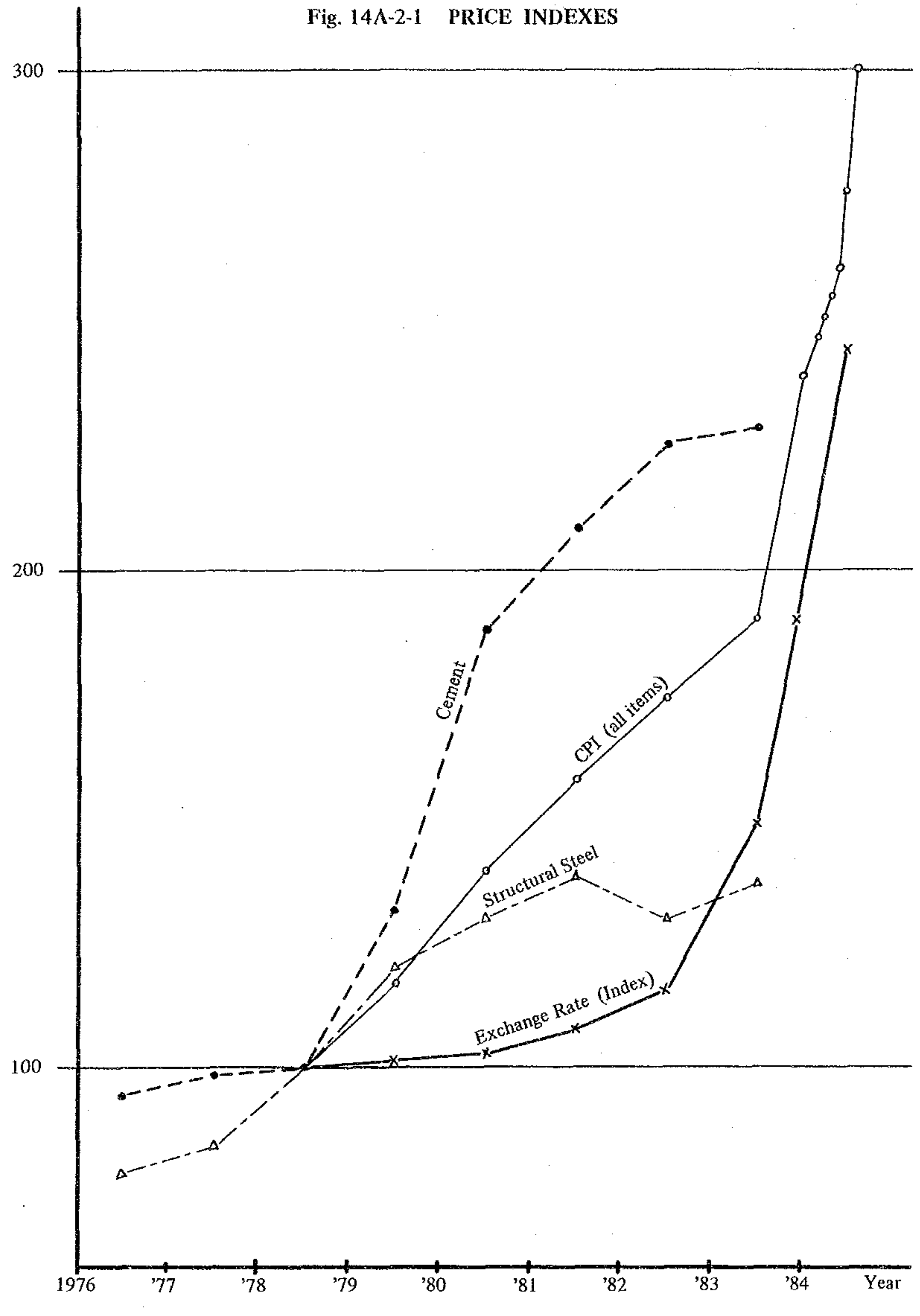
Processed by: NCSO

Table 14A-2-2 INDEX OF AVERAGE DAILY BASIC WAGE RATES OF LABORERS IN INDUSTRIAL ESTABLISHMENTS IN METRO MANILA, 1970–1980 (1972 = 100)

Period	Nominal		Real	
	Skilled (1)	Unskilled (2)	Skilled (3)	Unskilled (4)
1970	90.6	88.4	114.4	111.6
1971	95.3	94.4	105.1	104.1
1972	100.0	100.0	100.0	100.0
1973	105.3	102.6	92.4	90.0
1974	115.1	110.8	75.6	72.8
1975	119.7	120.1	72.7	72.9
1976	124.4	126.2	71.2	72.3
1977	137.5	132.9	72.9	70.4
1978	154.4	138.4	76.1	68.3
1979	170.1	145.8	70.8	60.7
January	164.8	140.9	76.5	65.4
February	165.8	141.1	77.3	65.8
March	165.5	1432.3	75.4	64.9
April	167.7	144.3	72.8	62.7
May	168.3	145.7	70.9	61.4
June	170.3	146.2	70.9	60.9
July	171.6	147.1	70.0	60.0
August	171.8	147.4	67.8	58.2
September	172.3	147.1	67.2	57.4
October	173.7	148.3	67.1	57.3
November	174.5	149.2	67.2	57.5
December	175.0	149.5	66.7	57.0
1980	180.9	151.5	63.7	53.4
January	177.1	149.5	66.4	56.1
February	177.7	149.9	65.8	55.5
March	177.9	148.9	65.8	54.3
April	180.2	150.9	65.0	54.4
May	179.8	150.9	64.5	54.1
June	180.4	150.9	64.2	53.7
July	181.8	151.8	63.4	52.9
August	182.0	152.1	63.0	52.6
September	182.6	152.8	62.6	52.4
October	183.3	153.0	62.2	51.9
November	183.7	153.3	61.4	51.2
December	183.9	153.5	61.3	51.1

Source of basic data: Cooperating establishments

Fig. 14A-2-1   PRICE INDEXES



Appendix 15A-1. RAW MATERIALS AND LABOR COST (AS OF APRIL, 1987)

1) Cost of Materials, Supplies and Utilities

Table 10A-1-1 shows the cost of materials, supplies and utilities per ton of product as of April 1987.

Since the time of commencement of plant operation is scheduled for April 1987, the cost per ton of product at that time is compiled in Table 15A-1-1 by using "factor 1.1297" described in Chapter 14, Paragraph 14.5.6.

Table 15A-1-1 COST OF MATERIALS, UTILITIES AND SUPPLIES PER TON OF PRODUCT (As of Apr., 1987)

(US$)

	Cost per Ton Product (Sept., 1984)	Factor	Cost per Ton Product (Apr., 1987)
Sawdust (Gasoline)	16.3	1.1297	18.4
Electricity	19.0	- ditto -	21.5
Bag (for Sawdust Char)	4.0	- ditto -	4.5
Bag (for Product)	83.3	- ditto -	94.1
Kerosene (for After-burner)	69.8	- ditto -	78.9

2) **Labor Cost**

Table 13-2 shows the annual labor cost as of September 1984.

The annual labor cost as of April 1987, or at time of commencement of plant operation, is calculated as shown in Table 15A-1-2, by using "factor 1.1297" described in Chapter 14, Paragraph 14.5.6.

Table 15A-1-2 ANNUAL LABOR COST (Apr., 1987)

(US$)

	Sept., 1984	Factor	Apr., 1987
Annual Labor Cost	72,800	1.1297	82,242

Appendix 15A-2 TAX CREDIT ON NET VALUE EARNED

In the Philippines, private corporations are offered governmental aid in the form of "Tax Credit on Net Value Earned" as a means of promoting domestic industrial development. Special tax credit consideration is offered to pioneer domestic producers.

That is, the Rules and Regulations to Implement, BATAS PAMBANSA BILAND 391, stipulate the following in connection with the above-mentioned tax credit:

1) Net Value Earned

"Net value earned" shall mean sales less cost of raw materials and components, factory supplies and factory utilities (gas, fuels, electricity and water) and depreciation of capital equipment.

2) Tax Credit on Net Value Earned

For the first five (5) years of commercial operation, registered non-pioneer domestic producers shall be entitled to a tax credit equivalent to five per cent (5%) of net value earned as defined in Rule I, Section 1. Registered pioneer domestic producers, on the other hand, are entitled to a tax credit equivalent to ten per cent (10%) of net value earned.

The annual tax credits accruing to this project on the basis of the Rules and Regulations to Implement are calculated as follows:

(US$)

Net Value Earned

= Total Revenue – [Raw Material + Supplies + Depreciation (of Machinery) + Utilities]

	1st Year	2nd Year	3rd Year onward
Total Revenue	411,600	670,320	705,600
Raw Mat. Supplies & Electricity	73,046	104,352	104,352
Depr. of Machinery	62,969	62,969	62,969
Depr. of Vehicle	15,107	15,107	15,107
	151,122	182,428	182,428
Net Value Earned	260,478	487,892	523,172
Tax Credit on Net Value Earned	26,048	48,789	52,317

Appendix 15A-3 TAX CREDIT ON NET LOCAL CONTENT OF EXPORT

In the Philippines, private corporations are offered governmental aid in the form of "Tax Credit on Net Local Content of Export" as a means of promoting domestic industrial development.

That is, the Rules and Regulations to Implement, BATAS PAMBANSA BILAND 391, stipualte the following in connection with the above-mentioned tax credit:

1) Net Local Content

"Net local content" shall mean value of export sales less depreciation of capital equipment and the value of imported raw materials, components, supplies associated with export sales/registered operations whichever is appropriate.

2) Tax Credit on Net Local Content of Exports

For the first five (5) years of commercial operation, registered new or expanding export producers shall be entitled to a tax credit equivalent to ten per cent (10%) of net local content as defined in Rule I, Section I.

The annual tax credits accruing to this project on the basis of the Rules and Regulations to Implement are calculated as follows (75% of net local content of exports consists of export sales):

(US$)

Net Local Content of Exports

= Export Sales − [Imported Raw Materials + Imported Supplies

+ Depreciation of Machinery (Export Portion only)]

	1st Year	2nd Year	3rd Year onward
Export Sales	308,700	502,740	529,200
Imported Raw Materials	—	—	—
Imported Supplies	—	—	—
Depreciation (Machinery & Vehicle)*	58,557	58,557	58,557
Net Local Content of Exports	250,143	444,183	470,643
Tax Credit on Net Local Content of Exports	25,014	44,418	47,064

* 75% of depreciation of machinery.

Appendix 15A-4

Table 15A-4-1 AVERAGE RETURN ON PAID-UP CAPITAL (Case A)

(US$)

Year	Net Profit Before Tax	Income Tax	Net Profit After Tax
1988	-66,517	0	-66,517
1989	146,113	0	146,113
1990	187,702	0	187,702
1991	190,062	0	190,062
1992	192,442	0	192,422
1993	202,953	70,478	132,475
1994	213,485	74,164	139,321
1995	239,124	83,138	155,986
1996	249,656	86,824	162,832
1997	260,188	90,510	169,678
Total	1,815,188	405,114	1,410,074
Average (10 Years)	181,519		141,007
Paid-up Capital	507,067		507,067
Average Return on Paid-up Capital	35.8%		27.8%

Table 15A-4-2 AVERAGE RETURN ON PAID-UP CAPITAL (Case B)

(US$)

Year	Net Profit Before Tax	Income Tax	Net Profit After Tax
1988	-119,176	0	-119,176
1989	82,921	0	82,921
1990	118,025	0	118,025
1991	153,200	0	153,200
1992	160,826	0	160,826
1993	176,624	61,263	115,361
1994	192,422	66,792	125,630
1995	223,326	77,609	145,718
1996	239,124	83,138	155,986
1997	254,922	88,667	166,255
Total	1,482,214	377,469	1,104,746
Average (10 Years)	148,221		110,474
Paid-up Capital	507,067		507,067
Average Return on Paid-up Capital	29.2%		21.8%

Table 15A-4-3 DEBT SERVICE COVERAGE RATIO

	Case A	Case B
1988	0.67	0.55
1989	1.13	0.79
1990	1.82	0.97
1991	1.87	1.59
1992	1.93	1.66
1993	1.66	1.45
1994	1.74	1.59
1995	1.80	1.67
1996	1.90	1.80
1997	2.01	1.95

Table 15A-4-4 SENSITIVITY ANALYSIS (Case A)

(Internal Rate of Return)

	+10%	Base Case	-10%
On Sales Price			
IRROI before Tax	19.24	15.27	10.85
IRROI after Tax	17.33	13.58	9.47
IRROE after Tax	30.83	21.26	11.34
On Variable Cost			
IRROI before Tax	14.66	15.27	15.88
IRROI after Tax	13.01	13.58	14.14
IRROE after Tax	19.85	21.26	22.67
On Investment Cost			
IRROI before Tax	13.31	15.27	17.55
IRROI after Tax	11.75	13.58	15.72
IRROE after Tax	16.80	21.26	26.58

Table 15A-4-5 SENSITIVITY ANALYSIS (Case B)

(Internal Rate of Return)

	+10%	Base Case	-10%
On Sales Price			
IRROI before Tax	19.09	14.91	9.03
IRROI after Tax	17.30	13.33	8.12
IRROE after Tax	24.50	15.03	3.95
On Variable Cost			
IRROI before Tax	14.20	14.91	15.56
IRROI after Tax	12.67	13.33	13.94
IRROE after Tax	13.50	15.03	16.45
On Investment Cost			
IRROI before Tax	12.73	14.91	17.30
IRROI after Tax	11.29	13.33	15.58
IRROE after Tax	10.42	15.03	20.29

Table 15A-4-6 SENSITIVITY ANALYSIS

(Payout Period)

(Year)

	Case A			Case B		
	+10%	Base Case	-10%	+10%	Base Case	-10%
Sales Price	4.59	5.49	6.98	4.63	5.61	7.72
Variable Cost	5.66	5.49	5.32	5.82	5.61	5.42
Investment	6.08	5.49	4.91	6.30	5.61	4.97

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