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APPROPRIATE TECHNOLOGY FOR THE MANUFACTURE OF PULP AND PAPER PRODUCTS

APPROPRIATE INDUSTRIAL TECHNOLOGY APPLICATION IN THE PULP AND PAPER INDUSTRY IN THE PHILIPPINES

Background Paper

APPROPRIATE INDUSTRIAL TECHNOLOGY APPLICATION IN THE PULP AND PAPER INDUSTRY IN THE PHILIPPINES

by

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Table of Contents

FOREWORD

Realizing the need and importance of the application of appropriate industrial technology in developing nations, the United Nations Industrial Development Organization (UNIDO) initiated the move to sponsor the International Forum on Appropriate Industrial Technology to be held in India on 20-30 November 1978.

UNIDO has noted that there is really "an essential need for a more comprehensive developmental and industrial strategy designed to meet basic socio-economic needs and achieve adequate growth of technological capability in developing countries." This strategy should be suitable for and within the capability of the developing countries, and should not just follow strictly the pattern of highly-developed nations.

This international forum will discuss in detail 12 different industries. This paper is a modest contribution of the Philippines on its experience in the application of appropriate industrial technology in the pulp and paper industry.

ABSTRACT

Pulp and paper research and development work conducted at the Forest Products Research and Industries Development Commission (FORPRIDECOM), Philippines during the past years have shown the technical feasibility of using indigenous materials (not only from traditional but also from non-conventional sources), for the production of different types of pulp and paper products, using suitable pulping processes.

Practical experience in the Philippines has also demonstrated that appropriate technologies can be successfully applied in commercial operations both in the categories of small pulp mills and large-scale activities, depending on the raw materials used.

During the past two decades or so, a great increase in industrial activity in the production of a wide variety of products has been noted in quite a number of developing countries. However, there were some apprehensions as to whether this pattern of industrial growth is really appropriate to effectively meet the basic socio-economic and technological requirements of developing nations (1).[3/]

It is well known that the pulp and paper industry is a capital-intensive industry. In view of this, most developing countries can not afford to put up such industry. Although in few particular cases very high investment costs would not be required, almost all mills would need high capital costs especially in this highly-competitive industry where the economy of scale is of primary importance.

Furthermore, most developing countries lack the traditional pulp and paper materials, i.e., the softwood species. As such, they have to use whatever resources are available to them to meet their raw material requirements for the production of different grades of paper.

These are specific instances where appropriate industrial technology will come in.

UNIDO defines appropriate technology "as the most suitable production process and technique for particular production sectors and projects in a given set of circumstances, which should include development objectives and resource-endowments and circumstances. For the modern industrial sector in developing countries, the area of technological choice should be

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3/ Underscored numbers in parenthesis refer to literature cited.

extended to the consideration of various alternative techniques which may be more suitable to factor situations in these countries" (1).

For the purpose of this paper, the specific applications of appropriate industrial technology may be classified into two categories as follows:

a. Small pulp mills which use high-quality materials for specialty-grade paper; and

b. Large-scale integrated pulp and paper mills which use non-traditional raw materials.

These two groups fall under the UNIDO definition of appropriate technology. Although conventional pulp and paper mills require high investment costs to make the project viable, the operation of small pulp mills, which fall under the first category, would still be economically feasible if the end-product will command a high market price as in the case of abaca (Musa textilis Nee) pulp and the specialty papers made from it.

The prevailing cost of abaca pulp in the world market is about 4-5 times that of coniferous wood pulp which is the most commonly used material for papermaking. The high price of abaca pulp is attributed mainly to its exceptional high-quality and partly to its low fiber recovery and high labor cost in fiber extraction. However, even with the high cost of abaca pulp, there is an increasing demand for it in the world market.

The second case can be considered as the application of alternative technology in the utilization of the available materials in the area. It has been recognized that the utilization of mixed tropical hardwoods presents complicated problems due to the heterogeneity of species and, consequently, the wide variation in their physical, morhological, and chemical properties.

In the highly developed countries, the traditional raw materials used for pulp and paper are softwoods wherein only a limited number of well-known species with the desired characteristics are used. This is specially true in the case of newsprint since conventional newsprint is normally made from 100% softwood species (about 70-80% groundwood and 20-30% bleached chemical pulp).

As mentioned earlier, most developing nations lack softwood species as these countries are located in the tropics wherein a very high percentage of their forest stands are composed of mixed hardwoods. Hence, it is imperative that these developing countries should use indigenous materials which are abundant in their regions, and adopt and/or develop new technologies suitable for the available raw materials for the production of different grades of paper with the desired qualities.

STATUS OF THE PHILIPPINE PULP AND PAPER INDUSTRY

In 1971, Philippine pulp production was 26,566.25 MT (Metric tons) but in 1975, this figure jumped to 107,151,07 MT or an increase of 303.34% based on the 1971 figure. Likewise, paper and paperboard production increased by 57.02% from 140,674.9 MT in 1971 to 220,887.3 MT in 1975. As a consequence, importation of paper and paperboard decreased from 151,372 MT in 1971 to 41,863 MT in 1975 or a decrease of 72.35% (2). The increase in pulp and paper production and the reduction of paper importation during the period have been due to the operation of two integrated pulp and paper mills, both based on the utilization of mixed tropical hardwoods.

At present, the Philippine pulp and paper industry consists of 22 firms; 6 integrated pulp and paper mills, 3 pulp mills, and 13 paper mills. Of the 6 integrated mills, 3 utilize mixed tropical hardwoods in their operation. These 3 mills alone account for 82.9% of the total pulp capa-

cities and 15.3% for paper and paperboard (both figures include the non-integrated mills). These figures show the important role which tropical hardwoods play in the Philippine pulp industry.

In addition to the mixed hardwoods, other raw materials used by the industry include abaca and sugarcane bagasse. Additional fibrous-material requirements of the paper mills are met by imported pulp (11.12%) and secondary fibers (40.89%) (2).

PHILIPPINE EXPERIENCE

A. Research and Technology Transfer

FORPRIDECOM has been engaged in pulp and paper research for more than 20 years. Since this is the only agency in the Philippines, engaged in research and development along this field, it has undertaken studies not only on forest products but also on other materials as well. These materials include hardwoods, softwoods, bamboos, grasses, and agricultural fibrous materials such as abaca, sugarcane bagasse , kenaf, etc., and mixtures of these materials.

These investigations have shown the potentialities of indigenous materials for the production of various types of paper products, using different pulping processes. Results of these studies have been published in scientific and technical journals in the Philippines as well as in other countries. A comprehensive list of these researches (as of 1976), conducted not only on the evaluation of individual species and mixtures of tropical hardwoods but also on other materials, have been published (3). It is encouraging to note that results of such investigations have been availed of by industry.

FORPRIDECOM has also been actively engaged in the transfer of technology by working in close collaboration with the industry through cooperative and/or technical assistance projects, consultancy, and in manpower training/development for the industry.

Technologists are sent out regularly to the field to look into the problems of the pulp and paper industries to pinpoint the possible causes of these problems and to determine the relevant needs. Data gathered are compiled, analyzed, and channelled to the experts concerned for thorough study and proper action. These efforts facilitate the direct delivery of pulp and paper technology to the end-users. After this transfer of technology, a follow-up is made. The feedback, analyzed and evaluated, reflect the effectivity of the delivery to these industries in terms of better-quality products and efficient use of materials. Ultimately, this technology transfer insures the continuous growth and expansion of the industries concerned (4).

Other methods by which available technologies are delivered to end-users are through publications in technical and scientific journals, popular articles for laymen, press releases in local newspapers, radio and television, and local and international conferences.

I. Abaca

Abaca, better known as Manila hemp in the world market, is a perennial plant which belongs to the banana or Musa family. About 90% of the world's production is grown in the Philippines, hence the name Manila hemp.

Before the widespread utilization of abaca for pulp and paper, the bulk of the fiber production was utilized by the cordage industry due to its durability and resistance to salt-water decomposition. Recent trends,

however, have shown increasing usage of this material for the production of a variety of high-grade specialty papers. It was reported that about 70-75% of all abaca exports of the Philippines in 1972 were absorbed by the pulp industry (5).

The wide acceptance of abaca for specialty-grade paper manufacture, even if the cost is high, is due to its inherent characteristics not normally found in other materials. The chemical properties of this fiber, together with those of other Philippine fibrous materials, are shown in Table 1. It will be noted that all the desirable attributes of a good pulping material are exhibited by the two groups of abaca fibers namely, the 17 commercial grades of abaca fibers and the abaca fibers from 7 abaca varieties. These desirable characteristics are high in average holo-cellulose and pentosan contents, and low lignin, ash, silica, alcohol-benzene extractives, and hot-water extractives (6).

Furthermore, the extremely long fibers of abaca (over 3.5 mm) and its thin fiber cell-wall in relation to fiber diameter make this material highly desirable for the production of papers which require high strength.

Pulping experiments on abaca have proven the desirability of this fiber for pulp production. Using the alkaline sulfite, soda, and sulfate processes, high screened pulp yields of 71.9%, 66.4% and 66.7% respectively, were obtained.

As shown in Table 2, all the pulps produced gave exceptionally high strength properties (7). On the over-all, not much differences were observed in the strengths of the pulps obtained from the three processes. Therefore, on the technical point of view, any of these processes would be applicable for abaca fibers.

Other pulping and papermaking investigations on this materials, conducted at FORPRIDECOM, confirm the above favorable results (8-11).

II. Mixed Hardwoods

As early as 1962, FORPRIDECOM has conducted studies on the pulping and papermaking qualities of naturally-occurring mixtures and other mixtures of Philippine hardwoods (12-14). Extensive investigations have also been undertaken on the production of newsprint from mixed hardwoods and mixtures of other materials as well (15-16). These studies indicate the suitability of mixed hardwoods for the manufacture of newsprint and other types of paper.

B. Industrial Application of Appropriate Technology

I. Abaca Pulping

In the Philippines, there are at present four abaca pulp mills, and one integrated pulp and paper mill. The total annual production of these mills is about 18,000 metric tons. From this figure, it will be noted that all are small pulp mills with capacities of 1,000 to 6,000 metric tons per year (mtpy).

Based on literature and actual pulping studies conducted on and found suitable for abaca fiber, there are three technical options that can be used. These are the alkaline-sulfite, soda, and kraft processes. Although the over-all pulp-strength properties obtained were almost the same for the three processes, the alkaline sulfite process would be preferred due to its higher yield. This is a great economic advantage as the abaca fiber is a very costly material. In view of this, most of the production of these mills are alkaline-sulfite pulps. However, there are also certain instances wherein the end-user of the pulp specifies either the kraft or soda process to be used. Due to the size of these mills, there is greater flexibility in their operation. As such, these small mills can easily shift from one pulping operation to another, to supply

the specific pulp requirements of the end-users, without much difficulty.

The bulk of the abaca pulp produced are exported to the United Kingdom, Germany, Japan, and other countries. Users of abaca pulp in these countries are all agreed that this abaca pulp possesses exceptionally high strength properties. According to these users, the only limiting factor on the increased usage of abaca pulp is its prohibitive cost. If the price of this pulp can only be reduced, a tremedous expansion in the utilization of abaca for different grades of paper would be expected. The present price of abaca pulp varies but most are in the range of US $1,400-1,600 per metric ton.

A small percentage of this abaca pulp is used locally as part of the furnish for the manufacture of cigarette and other specialty papers.

II. Utilization of Mixed Tropical Hardwoods

As mentioned earlier, tropical hardwoods contribute significantly to the Philippine pulp and paper industries (82.9% of the total pulp capacities and 45.8% for paper and paperboard). The bulk of the species which are used belong to the Philippine mahogany group namely: almon (Shorea almon Foxw.), bagtikan (Parashorea plicata Brandis), mayapis [Shorea squamata (Turcz.) Dyer.], red lauan (Shorea negrosensis Foxw), tangile [Shorea polysperma (Blanco) Merr.], tiaong (Shorea agsaboensis Stern), and white lauan [Pentacme contorta (Vid.) Merr. & Rolfe].

Fast-growing species such as bagras [Eucalyptus deglupta Blume Myrt.], gubas (Endospermum peltatum Merr.), Kaatoan bangkal [Anthocephalus chinensis (Lamk) Rich. ex Walp], Moluccan sau [Albizia falcataria (L.) Fosberg.], and yemane (Gmelina arborea Roxb.) are also utilized. Furthermore, quite a good number of secondary and/or lesser-known species are also used by the industry.

The biggest mill in the country is actually an integrated wood-

processing complex with veneer and plywood, sawmill and lumber processing, and wood seasoning plants. This mill has a very selective pulping system wherein only logs with specific gravity of 0.55 or lower are accepted for pulping. These logs are then sorted out into light-colored and dark-colored woods. The light-colored logs are used for the production of refiner-grounded pulp whereas the dark-colored woods are sent to the kraft-pulp mill.

The main products of this integrated mill are newsprint and kraft linerboard. Other grades of paper are also manufactured, depending on the demand. The kraft line produces an easy bleach cook for the kraft linerboard. The linerboard is made from a blend of the hard cook kraft pulp and a small percentage of imported kraft pulp. The imported kraft pulp is necessary to improve the tearing resistance of the linerboard.

The newsprint mill can be considered unique in that it is the only newsprint mill in the world which uses 100% hardwoods, i.e., 30-40% bleached kraft pulp and 60-70% refiner groundwood (bleached with peroxide). Table 3 presents the properties of the newsprint samples made from this mill, together with those of imported newsprints, and the Philippines and United States standard specifications for this type of paper (17-18). The test results show that the newsprint samples met the standards for this type of paper.

It may be noted that the two other integrated mills do not have forest concessions of their own but their raw-material needs are supplied through purchased logs and wood-processing wastes (from sawmills, veneer plants, etc.).

One of the mills produces bleached hardwood-kraft pulp for conversion to writing and printing grades of paper. A small percentage (about 10-15%)

of imported bleached chemical pulp is blended with the hardwood pulp to improve the strength of the resulting paper.

The third mill also uses the kraft process for pulping mixed hardwoods. It produces corrugating medium, linerboard and heavy-duty kraft paper for shopping bags. As in the other mills, a certain percentage of imported kraft pulp is mixed with the hardwood pulp in the production of linerboard and heavy-duty kraft paper.

In spite of the heterogeneity of the species used, the Philippine pulp and paper mills have overcome the attendant difficulties and problems in the utilization of such materials and have made their operations viable. All these have been made possible through the application of appropriate technology and, of course, the availability of highly-qualified and well-trained technical personnel.

IMPACT ON AREA/REGIONAL DEVELOPMENT

All the pulp and paper mills cited in this report have contributed partly, in one way or another in varying degrees, to the attainment of the major national development goals of the country. Some of these goals are: promotion of social development, maximum economic growth feasible, maximum utilization of labor force, equitable distribution of income and wealth, regional development, industrialization, maintenance of acceptable price level, and balance of payments stability (19).

It is obvious that all these mills have provided gainful employment to a great number of people not only those directly involved in the mill's operations (such as the technical, semi-skilled and labor groups) but also those indirectly affected like the producers and/or suppliers of the raw materials, contractors, and maintainers of infra-structures, handlers and/or distributors of products, etc. With the establishment of these

mills, especially the mixed hardwood mills, new communities have grown in the areas which used to be wilderness, together with the attendant services, infra-structure, and other benefits related thereto.

In the case of the abaca industry, a new outlet has been developed (abaca pulp) in addition to the traditional fibers for the cordage industry and for the handicraft or cottage industry. The exportation of abaca pulp has earned more foreign exchange to the Philippines and also resulted in the reduction of the importation of flax pulp (part of which was replaced by abaca pulp) for cigarette-paper manufacture.

The existing production of newsprint is now sufficient to meet the local requirements. There is a plan to increase the present capacity to meet the additional projected demand for this product.

As such, the perennial importation of newsprint in the Philippines has virtually been stopped with the operation of this mill; consequently, this conserves the foreign-exchange requirement for the annual importation of this paper.

Furthermore, the operation of the mixed-hardwood mills have encouraged the plantation of fast-growing trees for pulpwood. In fact, the Philippine government has recently launched the Industrial Tree Plantation Program, with certain incentives, to supply the expected large demand of the pulp and paper industry. Several individuals and agencies are now taking advantage of and are participating in this program.

RECENT TRENDS IN RESEARCH AND DEVELOPMENT

A. Potentials of Coconut Trunk/Stem

The Philippines is scheduled to have a massive replanting program of coconut farms starting 1980 to replace the over-matured and low-

yielding coconut trees. For this program, it has been estimated that about 6 million cubic meters of coconut trunks will be cut annually for 40 years (20).

In anticipation of the forthcoming availability of a sizable volume of potential raw materials, FORPRIDECOM initiated studies on the utilization of coconut trunk to determine the possible uses of this material. These utilization researches fall under several categories namely: wood anatomy, chemical composition, physical and mechanical properties, sawing and lumber conversion, seasoning, preservation, energy possibilities, secondary manufacture, structural components, pulp and paper, particleboard, fiberboard, novelties and curios, furniture, machining, and waste and residues utilization (20).

These studies have indicated the potential of this material for pulp and paper, fiberboard, particleboard, charcoal production and briquetting, lumber, electric and telecommunication poles, novelties, and a host of other uses (21).

Table 1, shows the chemical properties of coconut trunk (22) which are comparable to the other pulping materials such as bamboos, hardwoods, and softwoods. Its fiber length of 1.94 mm and Runkel ratio of 0.51 (21) indicate its desirability as a material for pulp and paper.

Kraft-pulping studies on this material, using 15.6% active alkali and 3 hours total cooking time, gave a total yield of 44.3% (screened yield was 42.0%) (23). This yield is comparable to the average yield obtained from the 7 Philippine mahogany species and those of 21 Philippine hardwoods, using the same pulping conditions.

The unbleached pulp showed moderate strength properties. Burst, tear, and tensile strengths were found satisfactory but folding

endurance was low. These papermaking experiments have indicated that coconut trunk could be a potential source of raw material for the pulp and paper industry (23).

B. New Process and Machine For Fiber Extraction

An efficient, novel, and economical method of fiber extraction has been awarded Letters Patent No. 9200 by the Philippines Patent Office to FORPRIDECOM (24), with the authors as co-inventors. This invention, "Process and machine for extracting and processing fibers from fiber-bearing materials of agricultural and minor forest products origin" is expected to revolutionize the abaca industry. The machine and process have been proven to continuously extract abaca fibers with a fiber yield higher by 50-60% over those of the other processes.

At present, the laboratory-size fiber-extraction machine has been field tested, using abaca-stripping wastes at the abaca plantation of one of the abaca-pulp mills. Normally, these stripping wastes have practically no value and are left in the field to rot. It was found that good-quality fibers can be recovered when processed by the FORPRI-DECOM machine and process. The fabrication of a commercial-size machine of this type is now in progress.

As has been mentioned before, the high price of abaca is partly attributed to its low fiber recovery and high labor cost in fiber extraction. With this new machine, fiber recovery will be increased and labor cost decreased which will eventually lead to lower cost of fibers. The introduction of this machine and application of the process to the Philippine pulp and paper industry will, therefore, encourage the use not only of abaca but also other agricultural fibrous materials for

increased production of paper pulp.

During the recently concluded "Best Invention of the Year Contest," held in connection with the celebration of the Philippine Inventor's Week in April, 1978, this invention won the Presidential Award (First Prize) due to its novelty, importance and relevance to countryside development, one of the development goals/thrusts of the Philippine government.

C. Non-Polluting Pulping Process

Another FORPRIDECOM invention, "A new process of producing high-grade chemical pulp" was granted Letters Patent No. 9154 by the Philippines Patent Office (25). This process utilizes advantageously the properties of potash liquor to dissolve the lignin and hemicellulosic components of fibrous materials (such as abaca), at well defined conditions, while preserving the cellulose so that it could be recovered as a high-quality papermaking pulp. This spent liquor, recovered directly from the digester, has the potentials of liquid fertilizer. Used as such, it minimizes the dangers of environment pollution.

At present, there are small pulp mills in the Philippines, where chemical recovery is not economically viable. Invariably, the spent liquor, after some treatment or settling from the lagoon, is drained and eventually finds its way into the streams and rivers within the vicinity of the mill, and endangers aquatic life. In these situations the danger of environmental pollution may be a deterrent factor in pulp production.

This condition may be remedied by the FORPRIDECOM pulping process which provides a new cooking formulation that produces not only a high-quality unbleached chemical pulp for a wide range of papermaking needs but also for bleached pulps for making fine and specialty papers. The pulps produced from the process possess properties comparable to those prepared from the other well-known alkaline-pulping processes. However,

one big advantage of this new pulping process is that the potash salts in the spent liqour, combined with the extracted organic compounds of the fibrous material, are directly recovered after the cooking cycle and can be utilized and/or processed as plant fertilizer. No pulping effluent, therefore, is wasted and the dangers of environmental pollution are minimized.

D. Preparation of Standards for Paper Products

FORPRIDECOM has been deeply involved in the preparation of standards for different types of paper and paperboard in cooperation with the Philippines Bureau of Standards, Philippine Standards Association, Bureau of Supply Coordination, National Institute of Science and Technology, and other government agencies and private firms.

The preparation of standards for any type of product is of primary importance which benefits both consumers and manufacturers. Without product standards, the quality of a good product may deteriorate to the detriment of the consumers. With standard specifications, consumers would be assured of good-quality products they purchase at any time. On the other hand, manufacturers will be encouraged to improve their products and maintain their quality to insure a steady share of the market.

The role of FORPRIDECOM in the preparation of standards may be divided into two phases, as follows:

1. Testing and evaluation of the particular type of paper product obtained from different sources (both locally produced and imported, if available); and
2. Preparation of the standard for each specific product, in cooperation with the above-mentioned agencies, by providing the technical personnel with the necessary expertise. FORPRIDECOM personnel have served the appropriate technical and sectional committtees, either as Chairman, Co-chairman or

members.

As of this date, Philippine standards for the following types of paper and paperboards have been prepared: onionskin, mimeograph, bond, newsprint, toilet and facial tissues, carbon paper, heavy-duty kraft, kraft wrapping, machine-finish uncoated book, yellow ruled pad, waxed paper, stencil paper, file folders, linerboard, corrugating medium, corrugated fiberboard boxes, extensible sack-paper, textbook paper, notebooks, grade-school pads and paper table napkins. Standards for bristol board and chipboard are still under preparation.

In the preparation of these standards, references from other countries have been used as guides, although specific requirements for each paper product are considered to suit local needs and conditions. This is the main reason why samples for each type of paper (imported and locally-produced) are tested prior to setting up the standard specifications.

RECOMMENDATIONS

In view of the urgency, importance, and relevance of appropriate industrial technology to the economy of developing countries, it is recommended that more international cooperation among developing and highly-industrialized countries should be encouraged and established. FORPRIDECOM, an agency of the Philippine Government, is willing to cooperate with both national and international agencies in this regard subject to appropriate review and approval of higher authorities.

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Table 1. Average Proximate Chemical Composition of Some Philippine Fibrous Raw Materials

Raw Materials[a]	Holo-cellulose %	Pento-sans %	Lignin %	Solubilities in Alcohol-benzene %	Solubilities in Hot-water %	Solubilities in 1%NaOH %	Ash %	Silica %
1. 17 Commercial grades of abaca	85.8	16.3	10.0	1.2	1.9	19.3	1.1	0.10
2. 7 abaca varieties	86.0	16.6	10.7	0.87	1.4	20.4	1.0	0.19
3. 6 Bamboos	63.7	20.1	23.0	4.1	4.3	29.0	4.9	2.9
4. 41 Hardwoods	64.6	16.1	26.9	4.0	3.0	17.6	1.5	...[b]
5. 6 Softwoods	65.0	11.0	31.0	2.1	1.4	13.1	0.4	...
6. Coconut trunk[c]	66.7	22.9	25.1	2.6	2.8	22.9	2.8	0.18

[a] Except for No.6, all data were obtained from: E.U. Escolano, P.C. Francia and J.A. Semana. The Philippine Lumberman 22(12):20-26 (December 1976).

[b] Three dots (...) indicate values were not determined.

[c] From: P.C. Francia, E.U. Escolano and J.A. Semana. The Philippine Lumberman, 19(7):20-23(July 1973).

Table 2. Physical Properties of Abaca Pulps Produced by Different Processes[a/] and of Export-Grade Abaca Pulp[b/]

Type of Pulp	Freeness (CSF) ml	Burst Factor	Tear Factor	Folding endurance (MIT) double folds	breaking length meters	Sheet density gm/cc
Alkaline sulfite	700	43	484	1,344	7,410	0.49
	500	102	195	2,050	13,200	0.66
	300	94	155	2,750	13,700	0.73
Soda	715	60	587	1,474	6,100	0.47
	500	104	285	2,360	12,800	0.66
	300	112	238	3,740	12,900	0.72
Sulfate	685	51	307	830	5,510	0.45
	500	87	208	1,650	10,050	0.63
	300	91	166	1,980	10,350	0.69
Commercial Abaca Pulp	640	70	429	1,366	8,480	0.55
	500	87	210	1,400	10,900	0.60
	300	86	160	1,750	11,800	0.70

[a/] From: P.V. Bawagan, Pulping abaca fibers for export specialty papers, In Selected Abaca Research: Fiber Properties, International Documentation Centre for Abaca, University of the Philippines at Los Baños, Laguna, Philippines, pp. 25-29, 1978.

[b/] Obtained from commercial abaca pulp samples and tested at FORPRIDECOM.

Table 3. Properties of Philippine Commercial Newsprints Made From 100% Hardwood Pulp, Imported Newsprint, and the Philippine and United States Standard Specifications for Newsprint

Sample	Substance [a] (basis weight): g/m^2	Substance [a] (basis weight): 24x36-500, lbs.	Thickness [b]: microns	Thickness [b]: mils	Bursting strength: kg/cm^2	Bursting strength: psi	Tearing resistance, gms.: M.D.	Tearing resistance, gms.: C.D.	Tensile strength kg/15 mm.: M.D.	Tensile strength kg/15 mm.: C.D.	Opacity, %	Brightness, %
Commercial Hardwood newsprints												
Sample A	50.3	30.9	88.9	3.5	0.47	6.7	16.0	21.0	3.1	1.5	96.0	53.0
Sample B	53.2	32.7	94.0	3.7	0.62	8.8	20.0	22.0	2.9	1.5	96.5	52.7
Average of 13 imported newsprints [c]	54.0	33.2	88.9	3.5	0.46	6.6	20.8	28.2	2.9	1.3	92.0	54.5
Philippine standard specification for newsprint PNS 841-01:00, 1974	52.0	32.0	83.8	3.3	[d]	-	-	-	2.8	1.3	95.0	50.0
U.S. Government paper specification standard for newsprint JCPA10, 1960	52.0	32.0	88.9	3.5	-	-	-	-	2.5	1.2	90.0	-

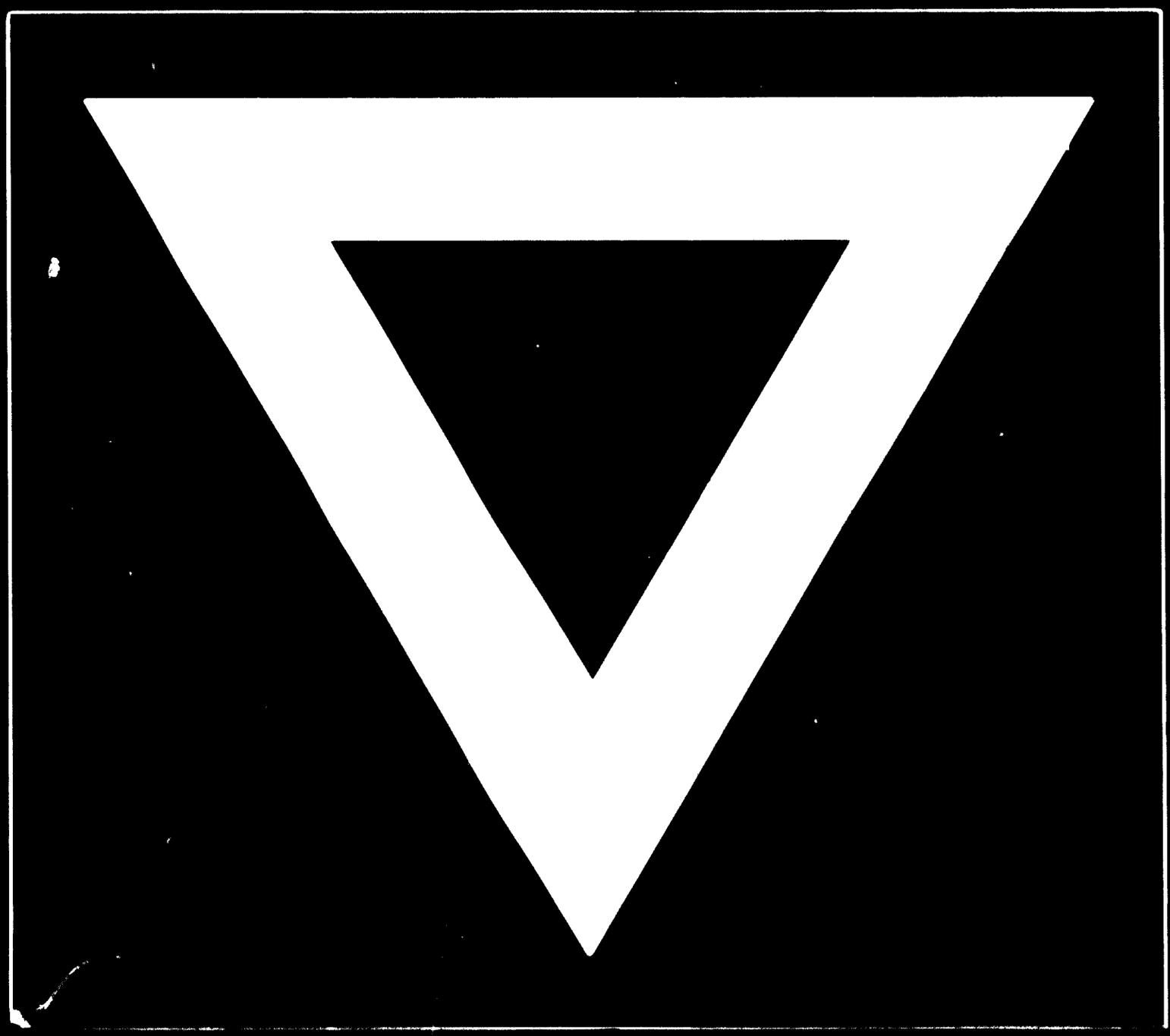
[a] Tolerance for substance is ±5%.

[b] Tolerance for thickness is ±12.7 microns (0.5 mils).

[c] These imported newsprint samples came from the U.S.A., Canada, India and Sweden, and tested at FORPRIDECOM.

[d] A dash (-) indicates the item is not applicable/required.

B-37



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