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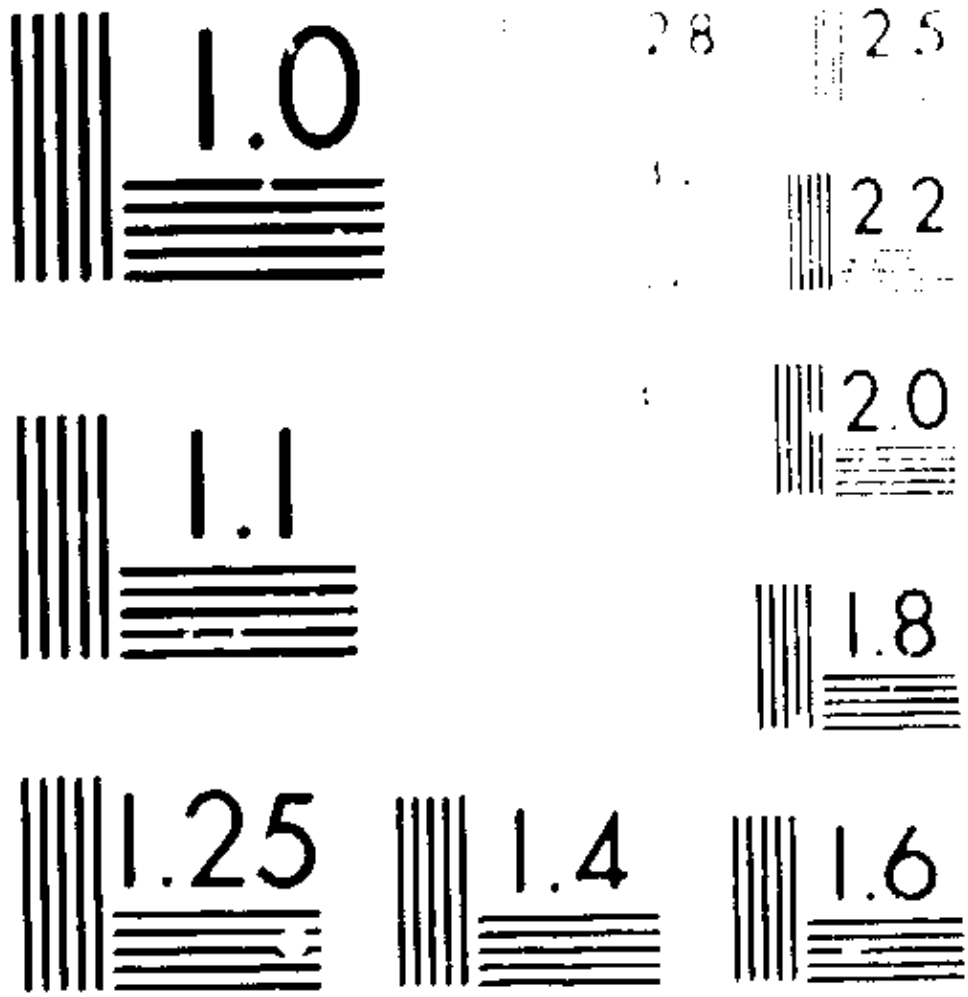
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THE PULPING OF MIXED TROPICAL HARDWOODS - THE PHILIPPINE EXPERIENCE *

by

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As is well known, PICOP has been one of the pioneers in this field, operating the first newsprint line in the world making this product out of 100% tropical hardwoods on a large commercial scale. What is so special about using tropical hardwoods in the manufacture of paper? Why has it taken so long to do so? To understand this best, we have to start with the long history of the manufacture of paper, which, together with the invention of the written word, is one of the most important accomplishments of mankind.

From the earliest times, men have felt the need to communicate by means of symbols and pictures depicting their ways of life, their thoughts, and expressing their language. Today, we can still study the life of prehistoric man through the drawings he has left us in many caves in numerous localities around the world. Later on, as we enter the historic era, stone and bronze, as well as clay, palm leaves, the bark of many trees, wood, shells and bones were used by man to inscribe his thoughts. The study of writing, one of man's most important accomplishments, is in itself a fascinating field which unfortunately is beyond the scope of the present paper, where we can only concentrate on one of the materials used for this purpose.

The need for a more practical and permanent way to record his thoughts led man to look for materials which could be more or less permanent, and at the same time more easily handled and stored. Before the fortieth or fiftieth centuries before Christ, the Mesopotamians were already using clay tablets for writing. This was in itself an improvement, but the handling of these tablets was still cumbersome. We do not know if they had also discovered the use of vegetable materials or the bark of certain trees for this purpose, but if they had, no samples have survived for us to see.

By 3,500 B. C. the Egyptians began to strip the bark of the papyrus reed which grows extensively along the banks of the river Nile, spread it out, and by joining a number of strips form a sheet to write on. Later on, they pounded this bark into a fibrous mass and formed a crude sheet for this purpose and at last, man had a light material to write on which could be easily transported and stored. Because of the peculiar characteristics of the Egyptian climate, thousands of papyrus manuscripts have survived to date and can be seen in leading museums around the world. Incidentally, it was the reed papyrus, that gave paper the name it now carries in most languages.

By the third century before Christ, another medium had been invented on which to inscribe information, namely, parchment. Parchment sheets were produced from the skins of animals such as sheep, goats, and calves, by removing the hair, and cleaning, stretching, and drying them. Parchment was more expensive than papyrus and did not compete with it seriously until the third or fourth centuries when this type of product appears to have been lost, at least to European culture, and parchment became the most popular material for writing in said continent until the 13th or 14th centuries.

It is probable that the Incas, who, in the Andes range of South America, for many centuries before Christ had a civilization as developed as any in Asia and Europe at that time, used a vegetable material taken from some kind of palm to form a sheet somewhat like papyrus. This material may have also been known to the Mayas in Mexico, but the evidence on this is quite sketchy, and no samples have survived.

It was in China, where the first sheets that may be called the forerunner of modern paper, appeared at about 200 B. C. These were made by soaking short lengths of bamboo until these were soft and then beating them into a pulp with stamps. The pulp was then placed in a vat and diluted with water, and sheets were formed by dipping a mold consisting of a shallow tray with a removable side and a bottom of woven reeds into this suspension, allowing it to drain through the mold, and the resulting sheets

were removed and dried by hanging in the sun. This is essentially the same process used today in making hand-made paper sheets.

For many centuries, the Chinese were the only manufacturers of paper, although by 610 A. D. this process had spread to Korea and Japan. The Chinese brought this process to Western Asia during the eighth century A.D., during their military expeditions where the Arabs picked up the techniques using linen rags at first, but later on going to cotton rags, flax and other available fibrous vegetable material.

The Arabs brought the paper making process to Europe when they invaded Spain and Sicily in the ninth and tenth centuries A. D. and by the twelvth century, paper making was firmly established in said continent. The earliest known paper mills in Europe were located in Jativa in Spain in an area then occupied by the Arabs. A contribution of the Arabs to our present nomenclature of paper is the word "ream" which comes from the Arab word "rizma" which is their term for five hundred.

The manufacture of paper went on in Europe in much the same way with but small improvements for the next seven centuries, and this same technique was taken to America in the seventeenth century. Cotton rags continued to be the main raw material for the manufacture of paper, but by the end of the eighteenth century, the supply of rags was no longer able to keep up with the demand for paper; this same increase in demand, and the developments of the industrial revolution during the first half of the nineteenth century paved the way for the mass production of paper in large quantities at a cheaper cost. These factors also created many new uses for paper, as it was now very much cheaper, among which we have the use of paper in packaging, resulting in the development of an extensive variety of paper containers. Thus, the use of paper expands beyond writing materials into industrial uses.

There is an old saying that necessity is the mother of invention, so that by the middle of the 19th century, processes had been worked out for the separation of cellulose fibers from wood, the most abundant source of this fiber, by both chemical and mechanical means for paper making. At the

same time the machines developed to mass-produce paper at high speeds became faster and larger and their capacity increased beyond all imagination. These developments, however, required a strong fiber which would matt well and run smoothly over high-speed machines, and this started to limit the type of wood which could be used in the production of paper.

I will not go into the detail of the characteristics of wood fibers which make these desirable for papermaking nor the need to produce the cheaper grades of paper in large volumes to keep costs down because as paper makers, you are all well aware of these. All that I will say at this time is that with the machinery and processes developed, the most suitable woods for papermaking during the first half of the twentieth century were believed to be the conifers, mostly grown in temperate climates, because of their average fiber lengths which run in the vicinity of 3.5 millimeters and in some cases go up as high as 5 millimeters.

Studies were also made on the pulping characteristic of the broadleaf (hardwood) species which grow in both temperate and tropical climates, but the fibers from these have a very much shorter length than those of the conifers, going from an average of just below one millimeter to about one and one-half millimeters. Some of these species have been pulped for many years, but these pulps were usually used as fillers in furnishes with a large preponderance of long fiber pulp.

Now we come to the case of the Philippines. We know that before the coming of the Spaniards in the 16th century, some Filipino communities had the use of an alphabet and had written communications, writing on palm leaves and bamboo strips. Unfortunately, no samples of these have survived, because the moist, hot climate and the prevalence of termites were not conducive to the preservation of these materials.

We do not know if paper in the form of hand sheets was ever produced in the Philippines during the Spanish occupation which lasted from 1565 to 1899; the records of this period do not say anything about this, but it could have been possible as the country had the materials and could have had Chinese technical know-how to do so. The facts are that right

through the first three decades of the twentieth century there was no production of paper in the Philippines on an industrial scale. During the middle of the nineteen thirties, a very detailed study was made by a group of Philippine industrialists headed by Don Andres Soriano on the possbility of producing paper from bamboo but nothing materialized from it due to the outbreak of the Second World War. In the meantime, in the late thirties the Compañia General de Tabacos de Filipinas built one of the first pulp and paper mills in the world using sugar cane bagasse as the principal raw material at Bais, on the island of Negros. It was a small mill with a capacity of some 15 tons per day of bond paper; actually, it was supposed to serve as a pilot plant for a similar but much larger mill to be built by this same company at Tarlac on the island of Luzon. Because of the beginning of World War II, this mill did not start up until 1947, and the second mill was never built for a number of reasons.

The end of World War II brought in a sharp increase in demand for paper products in the Philippines and it soon became evident that there was a need to establish a domestic pulp and paper industry. In 1949, Don Andres Soriano, one of the leading industrialists in the country and President of San Miguel Brewery, Inc. (now San Miguel Corporation) established the first corrugator in the country to complement a modern glass container plant that had been established the year before, and started a search for the raw materials necessary to establish the complementing pulp and paper industry. Market studies were conducted which indicated that writing papers, newsprint and containerboard were the types of paper with the fastest growing market.

It soon became evident that the raw materials that had been considered before the war, bamboo and bagasse as well as abaca (Manila Hemp) were not available in sufficient quantities that could be economically gathered at any one place to feed the minimum size mill that could be considered for the manufacture of mass-produced paper such as newsprint and containerboard. Consequently, the only other alternative was wood, of which the Philippines had extensive resources. However, it turned out that most of the wood resources in the Philippines consisted of hardwoods in tropical rain forests

with a very limited amount of softwood conifers concentrated in the highlands of Northern Luzon and Zambales. Thus, the wood believed to be good for pulp and paper was very limited in supply, and that which was readily available, was not believed to be suitable for pulp and paper making.

The tropical rain forests in the Philippines are heterogenous in nature with a multiplicity of species, most of them broadleaf hardwoods which make excellent raw materials for the timber industry. Fortunately, the predominant trees in these forests belong to the dipterocarp family which for many years has given us the Philippine hardwoods so well known around the world. This family is in itself also heterogenous consisting of 7 genera and 52 species whose main differences as far as the timber trade is concerned are weight, hardness and color which varies from pale yellow to red-brown. Of these, the group with the best pulping characteristics is that commonly known as Philippine Mahogany consisting of 7 species. Besides these, there are a variety of less important, softer, mostly second growth species, palms, ferns and vines found in very much smaller proportions. The Agathis tree, which is one of the very few conifer type trees found in a tropical rain forest in the Philippines, is very rare, and is only found in very few areas.

As mentioned earlier, Don Andres Soriano believed that a pulp and paper industry was needed in the Philippines, and that containerboard was one of the papers that would grow most in demand. As the tropical rain forest was essentially what was available, he decided to work on the products from this forest as a source of raw materials for his project: as he was confident that man would find a way to use less desirable raw materials if these were available cheaply and in quantity.

In 1950 Don Andres Soriano obtained a timber concession in the Bislig Bay area on the eastern coast of the island of Mindanao and organized Bislig Bay Lumber Company, Inc. to operate it. Samples of the most important woods in this concessions were carefully collected and sent to the U. S. Forest Products Laboratory at Madison, Wisconsin, U. S. A. with samples of other potential raw materials such as kenaf, ramie and hemp. The testing of these materials ran through 1951 and further tests were made at the

Institute of Paper Chemistry in Appleton, Wisconsin, at Herty Laboratories in Savanah, Georgia and at Bauer Brothers in Springfield, Ohio. These tests indicated that most of these woods were pulpable and that some kinds of paper could possibly be made from these. Some samples of both newsprint and containerboard were actually made on a pilot plant scale and tested with encouraging results.

Because of these encouraging results, a pulp and paper laboratory was established by San Miguel Brewery in 1952 and a research program was initiated to continue the work done at these institutions and systematically catalogue the pulping characteristics of all of these potential raw materials. At the same time, the first of a number of studies to look into the economic feasibility of establishing a pulp and paper industry in the Bislig Bay area was made by Mr. W. D. Hisey of Sandy Hill Iron and Brass Works, Ohio, U.S.A.

In accordance with the policy of Don Andres Soriano to get good technological know-how to support his projects, he got International Paper Company to join San Miguel in this project, and in 1952 he organized Paper Industries Corporation of the Philippines (then called Bislig Industries, Inc.) as the vehicle to carry it out. This company also obtained a pulpwood and timber concession just north of that of Bislig Bay Lumber Company, Inc. It is interesting to note that both concessions were obtained from the Government by public bidding, and that these companies were the only bidders, as there was little interest in the timber industry in those early days.

After carefully going over the results of all the research work done to date, in 1954 International Paper decided to send a team of experts to the Bislig area to examine its suitability as a site for a pulp and paper industry. This team consisted of five men, each one of them a specialist in his own field, covering those of pulp and paper making, energy generation, water supply, marketing and forestry.

In the meantime, the pulp and paper industry had been learning how to use a growing proportion of short fiber pulp in its furnishes, principally because a growing demand for paper was beginning to outpace the

supply of conifers. This, of course, gave the possibility of eventually using tropical hardwoods a very big boost.

The laboratory and pilot plant studies had identified the different species in the Bislig timber stands that could be pulped, but the problem that came up was that none of the individual species could be said to represent a predominant one within these, and it would be impractical to go into an extensive segregation of species. Consequently, to get any volume at all, we would have to pulp mixtures of species and this became the next problem to tackle. Furthermore, while data on the pulpability of mixtures of such species had been obtained in a laboratory, and to some extent in a pilot plant scale, nobody ever had really used such mixtures for the full-scale manufacture of paper, and one of the things that was recommended by the International Paper team was that a sample of these woods, large enough to run tests under actual mill conditions, be sent to the United States to be converted into paper which in turn would be tested where ultimate tests are made - in the marketplace.

Two shipments totalling 1,000 cords of wood were prepared and shipped to the United States in 1957 and manufactured into both containerboard and newsprint in two of International Paper's pulp and paper mills, and part of the paper made was brought back to the Philippines where it was actually used on a commercial basis, the rest of it being similarly tested in the United States. The preparation of this shipment was very carefully controlled, as it had to represent, as closely as possible, the pulpable species in the timber stands of the Bislig area in the proportions these exist in the forest. At about the same time, the forestry consulting firm of Mason, Bruce and Girard was commissioned to make a detailed evaluation of both timber concessions, to establish the present volume and distribution of species within these as well as their future potential.

These studies, and the actual mill tests established that certain grades of paper could be made by using predetermined mixtures of tropical hardwoods from the Bislig area under certain conditions, and that there was enough timber in the area to sustain a commercial pulp and paper operation. The field

now appeared clear to start on this project but another thirteen years were to go by until this mill actually started up. At this point, it will be proper to remember the people who did the initial work to enable Don Andres Soriano to establish this industry, the first of its kind in the tropics. We had Messrs. Raoul E. Kahn and Luis H. Lim of San Miguel Brewery who supervised the original laboratory studies and preliminary technical and economic work. Messrs. Simeon de Jesus and Narciso Pamatmat who did most of the actual testing at the San Miguel Pulp and Paper Laboratory and Messrs. Ramon Olbes and Felix Chinte who were most active on the forestry side of the project. I consider myself fortunate to have been able to work with them from the very early stages of this project.

As this paper only deals with PICOP's experience in using mixed tropical hardwoods, I'll not go into the political, economic, transportation, and engineering problems which were met and had to be solved, nor the number of confirmatory laboratory and pilot plant tests and forest timber cruises that had to be made to satisfy all the parties that participated in this project, after it was established that mixed tropical hardwoods could be used as a raw material for the pulp and paper industry. These are more appropriately the subject of a study on the problems to be considered in establishing basic industry in a developing country. It is enough to say that these were solved one by one, and the PICOP mill finally started up during the second half of 1971. Don Andres Soriano did not live to see this event as he died on the 30th of December, 1964, and his sons, Jose M. Soriano and Andres Soriano, Jr., took over the overall direction of the project. Mention must also be made of Messrs. Alfredo Villa Abrille and Gabriel Formoso and their staff who very efficiently supervised the design and construction of the mill, and Messrs. Latimore Foster, Patrick Scheu and George Low of International Paper Company who actively participated in the design, construction and start-up of the mill.

The PICOP mill was originally designed to produce 200 metric tons of newsprint and 180 metric tons of containerboard a day on two paper machines. To do this, both mechanical and kraft pulping facilities were included as

well as a three-stage kraft bleach plant. Because of its remote location, it had to be completely self-sufficient to generate its own steam and electrical energy and its own caustic soda and chlorine requirements, and it had to have such other facilities as extensive repair and machine shops, housing, a hospital, schools, ship loading installations, and many others, most of which do not have to be provided by similar mills in the more developed countries.

As mentioned earlier, the species commonly known as Philippine Mahogany are of great value for the production of sawn lumber and plywood, and their value as such is considerably higher than their value as pulpwood. Only those parts of the trees which could not go into the manufacture of these products could be economically used for the manufacture of pulp and paper, these consisting of the waste generated in the manufacture of the above mentioned products, and much of the logging waste that used to be left in the forests as unsuited for the above. On the one hand, this increased the utilization of the timber in the forests substantially and also gave value to manufacturing wastes which previously had no value at all, but it also created new problems in the harvesting and handling of much larger volumes of wood of sizes which had not been handled in the past. It required the felling, handling, and debarking of logs ranging in diameter from some 10 inches (25 cm.) to some 6 feet (198 cm.) and in length from 39 inches (1 meter) to 40 feet (12 meters). We also had to provide the facilities to classify the wood to be pulped, and the wood to be used for other timber products had to be further classified into logs to be exported as such, those to be made into veneers and plywood, and those to be sawn into lumber. Thus, we had to build elaborate wood handling and classifying facilities of original design which has been modified and expanded a number of times on the basis of experience.

The decision to make both newsprint and kraft containerboard were based on market considerations, but this resulted in that we had to make three different kinds of pulp, a bleached groundwood pulp and a bleached kraft pulp for newsprint, and an unbleached kraft pulp for linerboard and corrugating medium. Laboratory and pilot plant tests had indicated that an

expected, in the case of groundwood pulp, the lighter color wood bleached easier than the darker colored wood, and consequently, from the very beginning, we decided to segregate the lighter color wood which was used for groundwood pulp, from the darker color wood, which was used for kraft pulp. The dividing line, completely arbitrary at first, has been shifted a number of times as we gained the necessary experience.

The mill's start-up was not easy. The translation of laboratory and pilot plant results to full-scale operations, particularly with inexperienced personnel brought many unexpected problems. We were trying to do two things which had never been done before - make a satisfactory newsprint sheet out of 100% unknown short fiber, and make a satisfactory linerboard sheet also out of unknown short fibers with a minimum of purchased expensive long fiber. In the case of corrugating medium, which already had been made with a 100% short fiber furnish, other problems came up where least expected. Some of these problems were solved using techniques from developed countries, but as they too had no experience with these particular fibers, we had to solve most of our problems ourselves, working out our own techniques, which was time-consuming and expensive. As some problems were solved, others came up, but little by little, these were also solved, and today PICOP has the distinction of being the first pulp and paper mill in the world to produce newsprint out of 100% short fibered mixed tropical woods. Typical specifications of the papers produced today at PICOP are attached to this study.

Today, nine years after the PICOP mill was started up, PICOP is producing newsprint, linerboard and corrugating medium meeting accepted international standard specifications out of tropical hardwoods at machine speeds approaching those used in developed countries using softwoods for these types of papers. The use of mixed tropical hardwoods for the manufacture of pulp and paper has been established. New techniques continue to be developed and applied. Chip groundwood has given way to thermomechanical groundwood and is giving way to chemi-mechanical groundwood in producing mechanical pulp, and new kraft pulping and bleaching techniques using mixed hardwoods

have been worked out to give an improved product, and more remains to be done. A whole new field, that of fast-growing plantation trees in the tropics tailored to produce the types of pulp required by the market, is being eyed with great interest. The use of tropical hardwoods in the mass production of pulp and paper has become a reality.

PAPER INDUSTRIES CORPORATION OF THE PHILIPPINES

NEWSPRINT
METRIC SPECIFICATIONS

PROPERTIES

1.	Basis Weight, GSM		
	Maximum		54.0
	Aim		52.0
	Minimum		50.0
2.	Caliper, microns (or mm x 100)		
	Maximum		94
	Aim		91
	Minimum		89
3.	Mullen, Kgs/cm^2		
	Minimum		0.42
4.	Densometer, Sacs/100 cc air		
	Aim		12.0
5.	Moisture, %		
	Maximum		8.0
	Aim		7.0
	Minimum		6.0
6.	Tear, Gms		
	Minimum	CD	30
7.	Smoothness, Secs.		
	Minimum	Top	25
8.	Brightness, % G. E.		
	Maximum	Top	50.0
	Minimum		47.0
9.	Water Drop, Secs.		
	Aim	Top	25
10.	Tensile, Kgs/15 mm		
	Aim	MD	1.96
		CD	0.89
	Minimum	MD	1.52
		CD	0.71

PAPER INDUSTRIES CORPORATION OF THE PHILIPPINES

KRAFT LINERBOAPD SPECIFICATIONS-STANDARD GRADES

GRADE (G./Sq.M.)	26# (127)	33# (161)	38# (185)	42# (205)	47# (229)	64# (312)	69# (331)
1. Basis Weight, lbs./MSF							
Maximum	27.3	34.6	39.9	44.1	49.4	67.2	72.5
Target	26.0	33.0	38.0	42.0	47.0	64.0	68.0
Minimum	24.7	31.3	36.1	39.9	44.6	60.8	65.5
2. Mullen, psi							
Target	-	85	90	105	115	135	145
Minimum	60	75	85	100	105	125	135
3. Moisture, %							
Maximum	7.0	7.0	7.0	7.0	7.0	-same-	7.0
Minimum	5.0						5.0
4. Cobb Size g./sq.m. (2-min.)							
FS Maximum	40	40	40	40	40	40	40
WS Maximum	60						60
5. Smoothness, sec. FS							
Maximum	12	12	12	12	12	12	12
Target	9	9	9	9	9	7	7
6. Luminous Reflectance, %							
Maximum	31	31	31	31	31	31	31
Target	29	29	29	29	29	29	29
Minimum	27	27	27	27	27	27	27

PAPER INDUSTRIES CORPORATION OF THE PHILIPPINES

CORRUGATING MEDIUM SPECIFICATIONS-STANDARD GRADES

GRADE (G./Sq.M.)	23# (112)	24# (117)	26# (127)	30# (147)
1. Basis Weight, lbs./MSF				
Maximum	24.2	25.2	27.3	31.5
Target	23.0	24.0	26.0	30.0
Minimum	21.8	22.8	24.7	28.5
2. Concors, lbs. (1lot)				
Target			56	64
Minimum	38	38	52	60
3. Ring Crush, lbs.				
Target CD				
4. Water Drop, sec.				
Maximum	300	300	300	500
Minimum	100	100	100	100
5. Moisture, %				
Maximum	7.0	7.0	7.0	7.0
Minimum	5.0			5.0