Klabin Bacell

MILL BOOKLET

2000

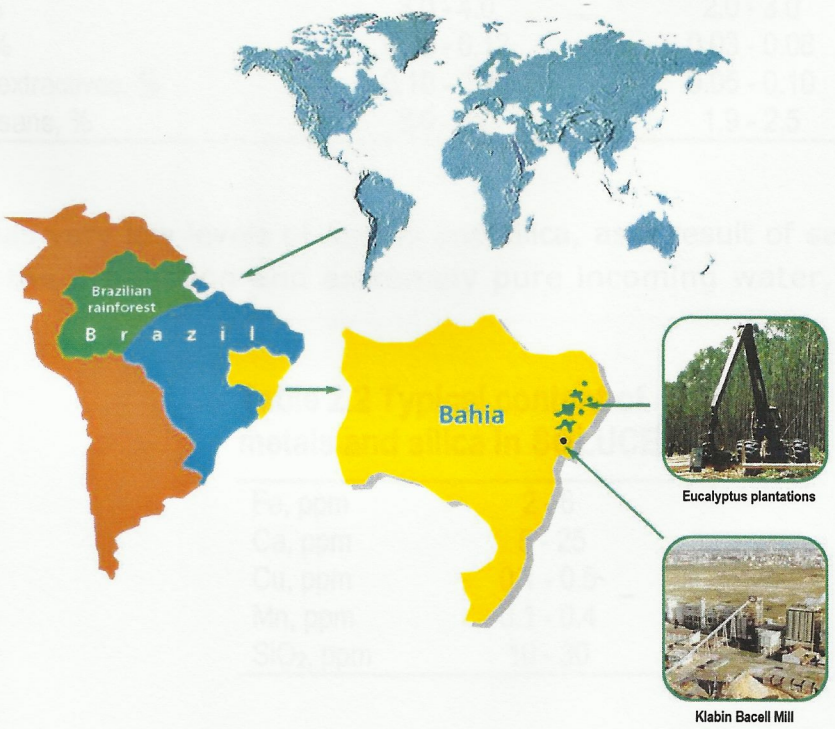
1 INTRODUCTION

The mill started as a joint venture between Klabin, the biggest pulp and paper producer in Latin America, Lenzing-Austria, the world's largest rayon fiber producer, and the World Bank's subsidiary IFC (International Finance Corporation).

While supported by the knowledge of these two industrial groups, nowadays **Klabin Bacell**'s shareholders count also with BNDES (Brazilian Development Bank) and DEG (German Development Bank).

The operations in January 1996. Formerly a paper grade pulp mill, the facility was completely modernized and converted to a dissolving pulp mill. Best available technologies as well as state-of-the-art environment protection were applied to the production of hardwood kraft dissolving pulp from eucalyptus, with 115 000 metric tons per year of nominal capacity.

The mill is located in an industrial area, 55 km distant from the port of Salvador, capital of Bahia State. Part of the Northeast region of Brazil, Klabin Bacell is 3 500 km far from the Rainforest and 2 500 km north of the city of São Paulo.



2 TAILOR-MADE PRODUCTS

Dissolving pulp has many different industrial applications, from textile fibers to drugs formulations. As a highly customer-oriented company, Klabin Bacell is engaged in attending the particular quality requirements of each application.

SOLUCELL is the brand name of Klabin Bacell's dissolving pulp.

SOLUCELL is classified according to its viscosity class, which is defined within a 50-cm^3/g window between the limits of 250 and 600 cm^3/g (intrinsic viscosity).

By means of up-to-date technology and production strategies, Klabin Bacell has flexibility enough to offer tailor-made products. Specifications are defined on a client basis, but some general characteristics of the products may be drawn, as depicted in Table 2.1.

Table 2.1 Typical working ranges for SOLUCELL

	STANDARD PULP	SPECIAL GRADES
Viscosity, cm^3/g	250 - 600	250 - 600
Brightness, % ISO	88 - 90	88 - 92
α-cellulose, %	94.5 - 96.0	95.0 - 96.5
R_{18}, %	96.5 - 97.0	97.0 - 98.0
S_{18}, %	3.0 - 4.0	2.0 - 3.0
Ash, %	0.03 - 0.12	0.03 - 0.08
DCM extractives, %	0.10 - 0.20	0.05 - 0.10
Pentosans, %	3.0 - 4.0	1.9 - 2.5

SOLUCELL has very low levels of metals and silica, as a result of severe washing throughout the production and extremely pure incoming water, as shown in table 2.2.

Table 2.2 Typical content of metals and silica in SOLUCELL

Fe, ppm	2 - 6
Ca, ppm	5 - 25
Cu, ppm	0.1 - 0.5
Mn, ppm	0.1 - 0.4
SiO_2, ppm	10 - 30

The quality of products and data provided by Klabin Bacell is assured by its **Quality System**. Klabin Bacell received independent confirmation of the quality of its manufacturing and sales processes when it earned ISO 9002 certification in December 98, after less than 3 years of operations.

Certificate of Approval

Awarded to

BACELL S.A.

RUA ALFA, 1033 - ÁREA INDUSTRIAL NORTE, 42810-000 - **CAMAÇARI/BA**
BRAZIL

Bureau Veritas Quality International certify that the Quality Management System of the above supplier has been assessed and found to be in accordance with the requirements of the quality standards detailed below

QUALITY STANDARDS

EN ISO 9002:1994

SCOPE OF SUPPLY

PRODUCTION AND COMMERCIALIZATION OF BLEACHED PULP

Original approval date: DECEMBER 04th, 1998

Subject to the continued satisfactory operation of the supplier's Quality Management System, this Certificate is valid for a period of three years from:

DECEMBER 04th, 1998

Date DECEMBER 21st, 1998

For Bureau Veritas Quality International

Raad voor Accreditatie

Certificate No: 52658

SF06/C

Accredited by the Dutch Council for Accreditation

3 RAW MATERIAL

The wood used by Klabin Bacell is 100% planted eucalyptus from the forestry company *Copener Florestal Ltda*. All plantations are located in the state of Bahia, at an average distance of 100 km from the mill.

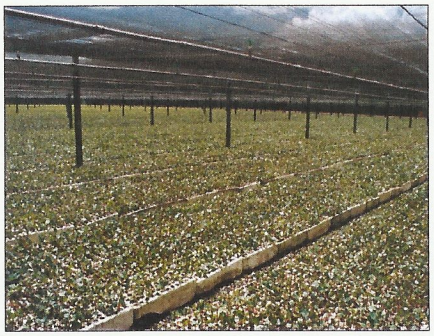
The continuous supply of high quality hardwood is guaranteed by more than 60 000 hectares of planted area, mainly composed by *Eucalyptus grandis*, *E. urophylla* and their hybrids urograndis.

The maintenance of the environmental balance and biodiversity is made through intensive research and preserving actions for the fauna and flora in more than 58 000 hectares of native areas preserved by Copener within its planted forests.

Plantation and preserved area

Forestry operations comprehend large-scale nursery seedling and advanced management techniques, which, combined with the favorable climate and continued improvement of the species, allow a forest maturation period of 5 to 7 years, with trees with an average height of 22 m and growth rate 35 to 50 m^3/ha.y. It is important to highlight that no gene manipulation is applied.

Advanced forest management techniques are applied, and debarking of the logs takes place in the forest so the nutrients return to the soil.



Nursery

4 DISSOLVING PULP PRODUCTION TECHNOLOGY

Klabin Bacell's concept was based on state-of-the-art technology throughout the production process:

Cooking line - the VISBATCH process, which combines a vapor phase prehydrolysis with kraft batch cooking by liquor displacement, specially designed for the production of different grades of dissolving pulp.

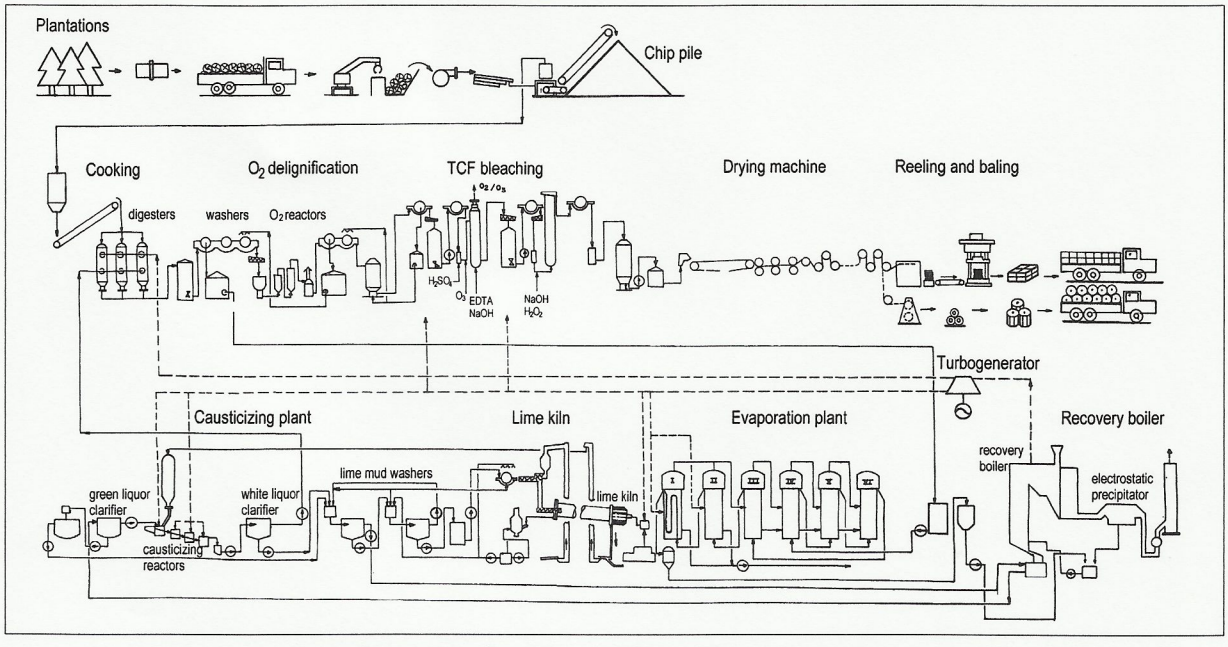
Bleaching line - the first TCF (Totally Chlorine Free) bleach plant for prehydrolysis kraft pulp.

Sheet formation - the TETRAFORMER, a new development for a low energy water removal, through a double-wire system.

Process automation – the whole operation is controlled from a central control room by means of a DCS (Digital Control System) supplied by Yokogawa.

All the industrial area is highly automated. That makes the operation of the plant very sound, and allows the technicians to concentrate on quality optimization. Major features of the pulp, namely kappa number, viscosity, brightness and S_{18} (solubility in NaOH 18%), are monitored along the process, either online or by laboratory analysis. Hence the control of process variables is virtually in real time.

Further details of Klabin Bacell's production process can be obtained on next pages.



Schematic flowchart of Klabin Bacell process.

4.1 Woodyard

At the wood receiving deck, the debarked eucalyptus logs are received and cut to a suitable length. They are intensively washed to remove sand, so very low silica levels are achieved in final product.

After washing, logs are chipped to well defined dimensions in order to improve impregnation of vapor and liquor. Chips are then screened to further improve uniformity, allowing homogeneous operation in the digesters.

Chip piles and conveyors

Chips are reclaimed from the top to the bottom by means of a remotely operated system, allowing a controlled storage time. The design of the chips reclaiming system, along with the modern chipping and screening section provides very low generation of fines or dust.

4.2 Cooking and Delignification

The VISBATCH process comprises a vapor phase prehydrolysis, which controls the hemicellulose content in brown stock. The organic acids generated during this step are neutralized by hot black and white liquors, which are then displaced by additional liquor.

After hot displacement, a conventional kraft cooking takes place, until desired delignification is reached. The hot cooking liquor is then displaced with washing filtrate from the subsequent washing stages, cooling the pulp before its discharge. Cooking yield may range from 35 to 40% over wood, depending on the final pulp grade.

Tank farm

All this process, from prehydrolysis to cold displacement, takes place in 3 parallel batch digesters, 300 m^3 each, supported by a tank farm composed by 4 pressurized vessels containing cooking and displacement liquors. The nominal capacity of the cooking plant is 350 admt/d as brown stock.

The modern design of the plant provides high heat efficiency, and allows the production of different dissolving pulp grades such as standard viscose, nitrocellulose, high tenacity filament, textile filament, lyocell, esters, ethers and acetate pulps.

The washing and screening plant provides reserve capacity as it is designed to process 360 admt/d. Screening comprises a 4-stage system, while the washing plant adds 3 more washing stages to the displacement washing that occurs already in the digesters. Good recovery of chemicals as well as high cleanliness of the pulp are achieved due to high efficiency of this plant.

After washing, brown stock may have a kappa number ranging from 7 to 11, depending on the pulp end use. Before bleaching, the brown stock is further delignified by oxygen in a very selective manner, which means lignin is removed with minimum impact on cellulose integrity.

Regularly operating with 70% efficiency on lignin removal, the 2-stage oxygen delignification is followed by 3-stage washing to yield pulp with kappa number below 3. This means that most organic carryover is removed and converted to energy in the recovery boiler. Besides keeping bleaching costs low, it is a very environmentally friendly operation, as it keeps COD (chemical oxygen demand) levels in the effluent very low.

4.3 Bleaching

After oxygen delignification, pulp is bleached by a Totally Chlorine Free (**TCF**) process.

The bleaching plant, with nominal capacity 350 admt/d, was designed to run A-ZQ-P sequence, with intermediate washing steps:

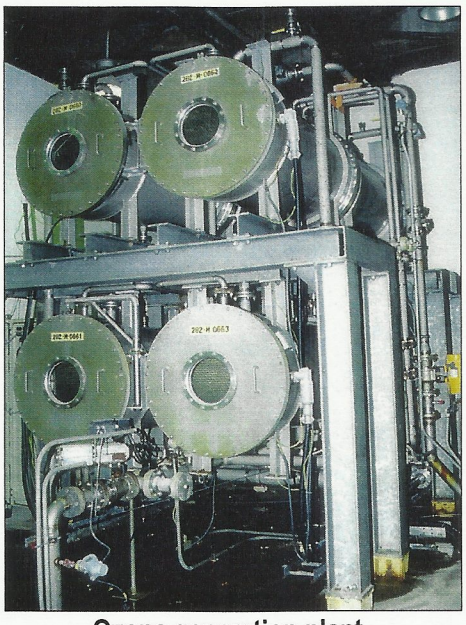
A - acid washing with sulfuric acid for metals removal

(ZQ) - Ozone reactor followed by treatment with EDTA (chelating agent)

P - Peroxide Stage

Acid washing proved to be very efficient in decreasing the metals content of the pulp to negligible levels. Furthermore, there is flexibility to have an additional metals control through a chelation step, if necessary.

Operational conditions of both ozone and peroxide stages are adjusted to control viscosity and brightness rather independently. In the ozone stage the viscosity is adjusted to the desired level, while brightness is increased.



Ozone generation plant

Once the right viscosity is achieved, the alkaline peroxide stage provides the final adjustment to the brightness target, with virtually no viscosity impairment. Afterwards SO_2 is used to stop peroxide reaction and prevent pulp degradation in the storage towers. It's also an additional guarantee of very low metals and ash content in the final product.

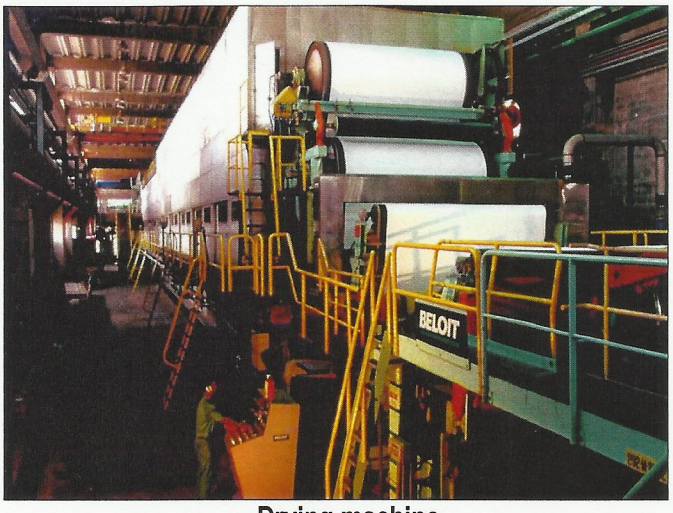
The bleached pulp is stored in two high consistency towers, which allows the delivery of homogeneous pulp to the drying machine. The management of this mix prevents transition losses between campaigns of different pulp grades.

The high controllability of the bleaching plant provides the flexibility to meet different customers' specifications regarding viscosity, brightness and metals content, and enables tailor-made production of dissolving pulp.

4.4 Pulp Drying

From the storage towers, bleached pulp passes through a 5-stage pressurized centricleaning system, which ensures its high cleanliness. After that, pulp is dried in a fourdrinier-type drying machine, with capacity for 450 admt/d.

The wet part of the machine is designed with a new concept: the TETRAFORMER. It consists of 4 double presses for water removal, either from the top and the bottom of the sheet, followed by 2 presses. It combines the formation properties of a fourdrinier machine with the low energy consumption of a double-wire press.



Drying machine

Also three *Küster* (swimming) rolls have been installed to enable uniform caliper and moisture profile. After drying in a battery of 83 steam-heated cylinders, basis weight and moisture are controlled online by a Valmet system. The usual work range for these features is presented in table 4.4.

Table 4.4 Physical properties of SOLUCELL

	usual range
Dryness, %	90 - 95
Basis weight (dry), g/m^2	700 - 800
Density (dry), g/cm^3	0.50 - 0.80

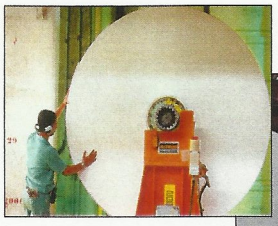
Different additives may be added to the pulp, e.g. xanthation and acetylation aids are currently applied on-demand, according to customers' needs. They are either mixed with the pulp before drying or uniformly sprayed onto the sheet surface. The second alternative is particularly interesting for the application of water-soluble additives.

4.5 Reeling and Baling

There are 2 different wrapping lines, one for bales and one for reels.

The sheet leaves the drying section of the pulp dryer and can be directed to either a winder, to produce a jumbo roll, or to the cutter and lay boy, to produce bales. The sheet cutter and the layboy are online, thus no blending of different jumbo rolls for quality equalization takes place.

Usually one bale weighs 200 kg with dimensions 80 x 64 x 50 cm, but it may also be adjusted to best fit customers' needs. Each bale is wrapped with kraft paper, held by wire strips and then 8 bales are put together and unitized with extra wire strips.



Jumbo rolls are directed to the reel line, where it is rewound into small reels, which are then wrapped with kraft paper. The dimensions of the reels are usually 80 x 150 cm (height x diameter), but may also be adjusted to meet customers' needs.

Optionally, bales and reels may be delivered unwrapped.

5 RECOVERY SYSTEM AND UTILITIES

As a characteristic of the kraft process, the integration of pulp production with chemicals recovery and power generation allows both cost and environmental benefits. By means of the process detailed below, alkali and steam are regenerated from liquors spent during cooking, while organic matter removed from wood is burned to generate power. This minimizes inorganic and organic losses to the effluent. Also air emissions are minimized, as gases are collected and incinerated in the boiler.

The **Evaporation Plant** is a 6-effect system that comprises 5 forced circulation effects and a 6th effect falling film. The plant evaporates 120 t of water per hour and concentrates black liquor to a final solids content 70 – 72%. The contaminated condensate is treated in a steam-stripping tower and the non-condensable gases are burned in the recovery boiler.

The **Recovery Boiler** has capacity to process 750 t/d of dry solids in black liquor, with a steam production of 130 t/h at 450°C and 63 bar. The water used in steam production is previously treated in a reverse osmosis plant. The boiler burns exclusively black liquor, enabling its operation as a finely controlled chemical reactor, reducing sulfate to sulfide. The smelt obtained afterwards is dissolved to form green liquor.

Recovery boiler with electrostatic precipitator

At the **Causticizing Plant** the impurities are removed from the green liquor, which is then used to slake lime. In staged causticizing reactors, the lime forms sodium hydroxide out of sodium carbonate, resulting in white liquor (sodium hydroxide and sodium sulfide) and lime mud. The causticizing plant produces 173 t/d of effective alkali.

The **Lime Kiln** burns lime mud (calcium carbonate) to form lime. It comprises a state-of-art lime mud flash dryer and has a nominal capacity of 110 t/day of burnt lime.

A **Power Boiler** provides 15-20% of the steam consumption. It burns natural gas to attend any peak demand of steam for prehydrolysis and cooking up to 30 t/h.

The **Turbogenerator** allows a power output of 12.5 MW. It means 80 to 85% from the total power supply to the mill, which is generated by means of a turbine with inlet capacity of 115 t/h of high-pressure steam, up to 42 t/h extraction and 85 t/h back pressure steam. A privately owned energy company supplies the remaining 15-20% of the power demand, which can be extended up to 90% of total consumption if necessary.

Recovery area

6 ENVIRONMENT

6.1 Water Supply

Klabin Bacell's vicinity comprises a huge underground water reservoir, which ensures a constant quality water supply. Water is pumped from 8 artesian wells within an 8-km radius from the mill, with capacity to move 1250 m^3/h of extremely pure water, as shown in table 6.1. Due to its high purity, the incoming water needs no further treatment other than pH adjustment.

Table 6.1 Fresh water quality after pH adjustment

	average	minimum	maximum
pH	7,2	6,0	8,0
Conductivity, µS/cm	106	45	161
Hardness, ppm ($CaCO_3$)	6,59	1,64	11,91
Alcalinity, ppm ($CaCO_3$)	41	15	58
Iron content, ppm	0,13	0,02	1,24
Silica content, ppm	8,3	5,0	14,5

6.2 Air Emissions

Both the recovery boiler and the lime kiln are equipped with electrostatic precipitators that remove the particulate in the flue gas streams, with an efficiency of 99.5%.

The emissions cope with strict limits regulated by the State Environmental Agency, which are based on standards of the US Environmental Agency Protection Agency (EPA).

Table 6.2 Air emissions quality

Emission source	TRS, ppmv	TPS, mg/Nm^3
Recovery boiler	3.4	76
Lime kiln	2.5	40
Dissolution tank	0.01[a]	0.16[a]

[a] Emission in grams per kg of dry solids in black liquor

Attending the kraft pulping standards declared by EPA (1998), all emission streams are burned in the recovery boiler. The non-condensable gases are collected from possible emission points: the high-concentration stream from the stripping tower and evaporation plant are fed into the flame zone, while the low-concentration stream from the liquor storage tanks and cooking area are introduced with the secondary air.

Also the kraft condensate standards recommended by EPA are met, as the condensate streams are mostly recycled to the process and the remaining is discharged to the biological treatment system.

6.3 Effluent Treatment

All effluent from Klabin Bacell is collected into two streams: organic and inorganic. Both are then adjusted to pH 6-9. Characteristics of the effluent streams before treatment are shown in table 6.3.a.

Table 6.3.a Effluent before treatment

	Flow		COD		BOD		Suspended solids	
	m^3/h	$m^3/admt$	mg/l	kg/admt	mg/l	kg/admt	mg/l	kg/admt
Organic	450	38	960	37	300	11	80	3
Inorganic	28	2	40	0.1	-	-	20	0.1

After pH adjustment, the effluent is delivered to ***Cetrel S.A. - Empresa de Proteção Ambiental***, which is the company responsible for treatment and final disposal of industry-generated effluents from the Petrochemical Complex of Camaçari, the industrial area where Klabin Bacell is located.

In the effluent and industrial waste treatment business, Cetrel was the first company in the world to be certified for ISO14001, back in 1996. Due to its performance in environmental education, environment quality, industrial safety and institutional communication, this privately-owned company has received public recognition through many national and international awards, among them the "ECO Award", granted by the American Chamber of Commerce and the "PNQ 1999" - National Quality Award, granted by the Brazilian Government.

At Cetrel, the effluent from all the industries located at the Petrochemical Complex is combined before it undergoes biological treatment.

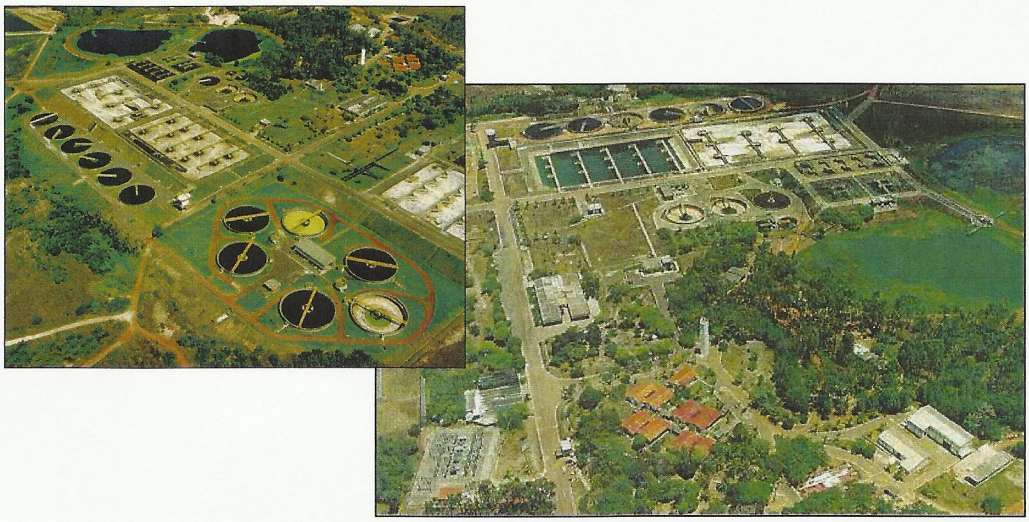
The wastewater treatment starts at a volatile removal unit, followed by an equalization basin, from where the effluent is carried to an aeration tank with

activated sludge. After organic matter degradation – with efficiency higher than 97% on BOD reduction – the liquid mass is taken to a secondary clarifier, where liquid (treated effluent) and solids (activated sludge) are separated. Part of the sludge is returned to the aeration tank, and the other part is released from the process by means of thickening, microorganism reduction, aeration and incorporation to the soil as fertilizer in reforestation areas. The treated effluent is transported to the sea through a marine disposal system consisting of an 11-km long land section and an underwater section 4.8-km long. The outfall is 25 m beneath the water, to guarantee a minimum dilution rate of 1:400, thus preventing damages to the marine ecosystem.

Table 6.3.b Total effluent from the Petrochemical Complex after treatment

Treatment efficiency, %		Effluent quality, mg/l	
BOD	COD	BOD	COD
97	85	19	240

In addition to a highly responsible treatment and disposal operation managed by Cetrel, it is worth mentioning that Klabin Bacell's effluent generation is about 40 m3 per ton of pulp, including sealing and cooling water, which is very low



Cetrel wastewater treatment plant

compared to other pulp mills. Furthermore, all the effluent generated is AOX-free, since no chlorine containing compounds are used in the process. In fact, during a technical visit to the mill, representatives from EPA manifested their appreciation for Klabin Bacell's use of "BAT" (Best Available Technology) in the production of dissolving pulp.