The Naco Process - A Selective Pulping Process For Annual Fiber Raw Material

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ABSTRACT

This paper is an intermediate report on our project in Foggia, Italy, where the first Naco process plant is installed The new cooking plant has been in operation for about 18 months, and is designed for a production capacity of 100 ADMT/24 h, and is limited by the paper machine capacity The pulp properties from wheat straw are comparable with the corresponding properties from Kraft birch or eucalyptus, confirming there are new possibilities to produce excellent pulp from annunal fiber raw material.

The new recovery system has recently been started up and the total Naco process will be evaluated in the coming months. The recovery system was delivered by Lurgi West Germany, and consists of an evaporation plant and a recovery boiler. where the liquor from the Naco pulp washing plant is first evaporated and then burnt. The Na_2CO_3 is recirculated to the cooking plant.

Later on a new bleach plant will be built based on the Ozone bleaching technique, which has been tested in a pilot plant. The Naco pulping process is almost completely free from pollution problems. as required by the strict environmental regulations in Italy.

GOAL FOR THE DEVELOPMENT OF A NEW DIGESTING PROCESS

For many years Sunds Defibrator had been looking for a new process for chemical pulping of annual fiber raw material. In the beginning of the 1980's a co-operation agreement was signed to try to develop a new idea originating from Mr. Franco Nardi and his technical group in Italy.

The following requirements were listed as being the goals for the new chemical pulping process.

- Produce a good chemical pulp from different annual raw materials.
- Best chemical pulp and paper properties.
- Small pollution load (no sulphur and chlorine involved)
- Simple process technology
- Usable for different types of raw material.
- Low investment costs.
- Low operational costs.

The new pulping technique was to be based on using the turbo-pulper as designed by Mr. Franco Nardi.

Only a small amount of NaOH should be added to the turbo-pulper together with the straw, while Na_2CO_3 should be recovered and reused. The need of NaOH should only replace the actual loss of cooking chemicals (from digesting, washing, evaporation and recovery boiler), while Na_2CO_3 should be recycled from the recovery system after separating the silicates.

TESTS AND TRIALS

The pulping system and turbo-pulper were tested in two different steps, where the first step was carried out in a laboratory batch turbo-system with a volume of 65 litres. The second step was a continuous pulping line with a turbo-pulper for a production of 5 ADMT/24 h. The results from this test were described in a report titled "The Sunds Defibrator Naco Process", which was presented at the PIRA Straw Pulping Conference in London, in October 1984.

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These tests showed that the results from continuous operation were better than the corresponding results from batch digesting. It was obvious that something very special was developed giving a 10% higher total yield at the same K. No., better pulp properties, lower reject rate etc. The explanation was found later to be in the operation of the selective, digester.

This selectivity means that all particles independent of size, will be mixed with the cooking chemicals and oxygen at a certain pressure and temperature, for the required time in order to be almost fully digested. As the time in the turbo-pulper will not be completely correct for every single fibre bundle, the total fibre flow is pumped to the static O_2—reactor, where the delignification is completed, in order to obtain an almost constant K. No. in the final pulp. This selectivity can be compared with conventional digesters, where all material must have a uniform size to obtain good pulp properties after a certain time in the digester. This uniform particle size can never be reached with straw, which explains why the digester has to be selective. Straw pulped in a conventional digester gives overcooking of the fines while larger particles are not cooked adequately, and finally leave the system as rejects.

Other types of annual raw material such as bagasse, rice straw, saw dust and waste from Kraft and corrugating medium have been tested in the turbo-pulper.

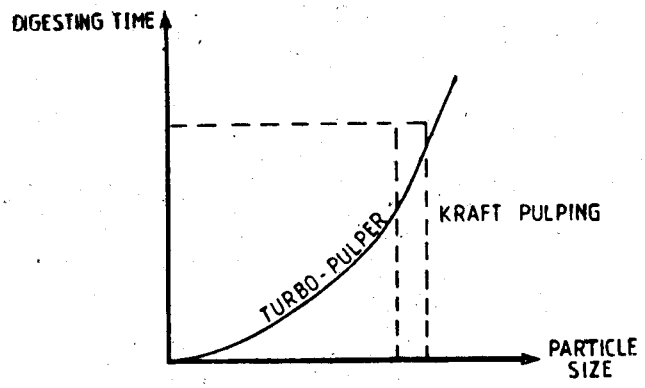

FIG. 1

SELECTIVE GRADIENT OF TIME IN THE TURBO PULPER DEPENDING OF PARTICLE SICE OF THE FEEDED STRAW COMPARED WITH A NORMAL CONTINUOS DIGESTER

Fig. 2 shows the results from a test with undepl-thed bagasse. You will note from the high freeness (°SR 22) that the pulp was unbeaten.

RESULTS FROM OPERATION OF THE NEW PRODUCTION LINE IN FOGGIA

Since early 1985, the new Naco pulping line has been in operation on wheat straw in Foggia, Italy. At

FIG. 2

Batch bagasse pulping in the NACO pilot plant

Reaction temperature	°C	:	130
Oxygen pressure	bar	:	7
NaOH (on b. d. bagasse)	%	:	15
$MgCO_3$ (on b. d. bagasse)	%	:	1
Kappa number		:	16
Brightness (unbleached), ISO	%	:	49
Drainage resistance	°SR	:	22
Tensile index	Mm/g	:	47
Tear index	mM m^2/g	:	4.2
Burst index	kPa m^2/g	:	2.0

the beginning the production capacity was 40—50 ADMT/24 h. and it has now been increased to over 75 ADMT/24 h Initially the only digesting chemicals used were NaOH and O_2, but since the recovery system has been put into operation, Na_2CO_3 is now being used. The pulp is presently bleached in a 2 stage NaOCl bleach plant, before use on the paper machine.

Fig. 3 shows the flow sheet of the new Naco digesting system. The pretreatment is done in a wet system, where the straw is mixed with water and some soda in an ordinary open pulper in order to remove wax, silica and other impurities. The straw is then separated from stones and sand in a cyclone separator, and fed to a washing and dewatering screw with fresh water showers. Finally, the straw is dewatered in a DKP-press. The washing efficiency is calculated to be around 45%, measured on the silica content.

Before entering the Naco pulping system the straw is passed through a Sunds Defibrator refiner, where the knodes are partially broken down. (Disc clearance approximate 2 mm). The straw is then pumped into the pressurized turbo-pulper and reactor system as described earlier. The pressure in the system is 6 bars, and the temperature 135°C.

Fig. 4 shows the actual conditions for the Naco digesting plant in Foggia on September 30, 1985, and these figures correspond well with the first tests made in the pilot plant.

Fig. 5 shows the pulp properties of unbleached Naco digested pulp, which also correspond very well to those obtained from the test runs in the pilot plant.

The production system is equipped with a heat recovery system for the blow steam, where all required fresh water is heated to around 90°C. The pulp is then finally washed with hot water in a twin roll press, with a washing efficiency above 90%.

Initially, there were some problems with scaling in the wash press, and it had to be stopped and cleaned with acid and high pressure water, but small amounts of caustic soda are now added, and this has solved the problem.

Since the start-up of the pulping plant at the beginning of 1985, the production has been kept within the guaranteed limits. Some small problems have stopped the production on a few occasions, but we must say that the start-up of the new system has been very successful.

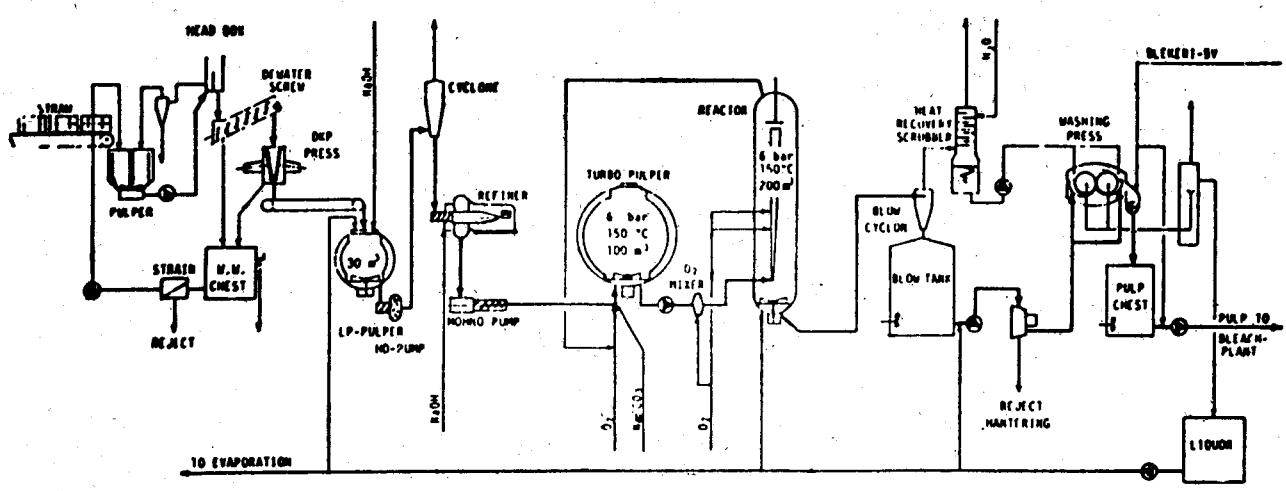

Fig. 3.
FLOW SHEET THE NACO PULPING SYSTEM AT JPZS IN FOGGIA ITALY

FIG 4

RESULTS FROM PRACTICAL OPERATIONS OF THE NACO STRAW DIGESTING PLANT AT POLIGRAFICO, FOGGIA, PER SEPTEMBER 30, 1985.

	RANGE	AVERAGE	
PULP PRODUCTION	50–85	75	TON BDP/D
STRAW CONSUMPTION		145	TON BDP/D
PRETREATED STRAW CONSUMPTION		125	TON BDP/D
YIELD TOT STRAW/PRETREATED STRAW		51/61	%
KAPPA NO.	15–24	18±2	
BRIGHTNESS	38–54	40–47	%ISO
NAOH–CHARGE	220–290	250	KG(100% NAOH TON BDP
NA_2CO_3–CHARGE	NOT YET STARTED		
O_2–CHARGE	130–160	140	KG/TON BDP
STEAM CONSUMPTION	1.7–3.3	1.8	TON/TON BDP
WATER CONSUMPTION	15–20	16	M^3/TON BDP
ELECTRICAL POWER CONSUMPTION		240	KWH/TON BDP

*DUBBLE STEAM CONSUMPTION WHEN THE PULP WASHING PRESS IS NOT IN OPERATION.

FIG. 5

PULPING WHEAT STRAW
NACO PROCESS
POLIGRAFICO FOGGIA ITALY

OPERATION CONDITIONS :	NaOH CHARGE KG/BD TON PULP	250
	O_2 – "	140
	TEMPERATURE °C	135
	PRESSURE BAR	6
PULP PROPERTIES :	°SR UNSCREENED	38
	°SR SCREENED	30
	KAPPA No.	18
	INTRINSIC VISCOSITY CC/G	760
	BRIGHTNESS % ISO	43
	DENSITY G/CC	0.6
	BREAKING LENGTH KM	6 5
	DOUBLE FOLDING No	100

OZONE-BLEACHING

During the last three years, tests have been made with different conditions of ozone-bleaching. From the literature it was suggested that ozone-bleaching should take place at low pH and high pulp consistency. However, these conditions are not suitable for the Naco system, and annual fiber material, so other conditions had to be found. In the new ozone-bleaching turbopulper tests were carried out with high pH and low pulp consistency and at a pulp temperature of 20–45°C. The bleaching conditions and pulp properties obtained are shown in Fig. 6. The final brightness after the O_3 bleaching will not be higher than 75% ISO, and if higher brightness are required the pulp has to be bleached further with H_2O_2 or NaOCl.

RECOVERY SYSTEM

The total Naco system includes a chemical recovery plant where spent liquor from the pulp washing plant is first separated from the silicates and other crystalline chemicals. The liquor is then evaporated to around 48% solids and burnt in a new type of recovery boiler without a reaction bed. From the recovery boiler green liquor is recovered as Na_2CO_3, which is reused in the digesting plant. The remaining silicates are separated as sludge from the green liquor, by adding KOH to the black liquor.

The complete system is shown in the block diagram in Fig. 7. In addition to the flows shown there is some sludge from the recovery boiler, some effluent from the evaporation plant, and some wash water from the pretreatment and bleach plant.

However the pollution load is very limited compared to other straw pulping processess.

FIG 6

OZONE—BLEACHING TESTS
HIGH PH—LOW PULP CONSISTENCY

OPERATION COND :	O_3 CHARGE ON BD pulp	%	2	2
	TEMPERATURE	°C	40	40
	PH		7	7
	PULP CONSISTENCY	%	6	2
PULP PROPERTIES :	°SR UNSCREENED		64	60
	*SR SCREENED		50	45
	KAPPA NO		6.1	4
	INTRINSIC VISCOSITY	CC/G	700	650
	BRIGHNESS	%	74	75
	YELLOWNESS	%	10	9
	DENSITY	G/CC	0.57	0.62
	BREAKING LENGTH	KM	6.2	6.2
	DOUBLE FOLDING	NO	150	200

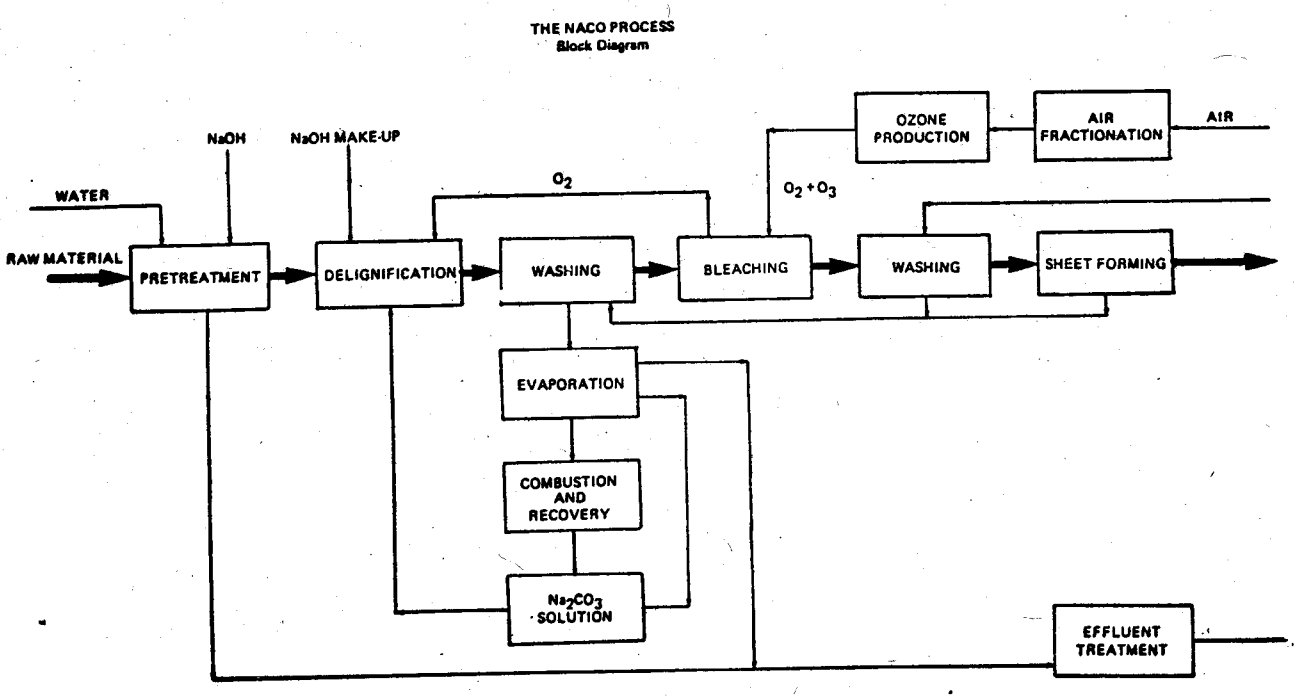

Fig. 7.

CONCLUSIONS

The results obtained to date confirm that the Naco process meets the requirements for pulping annual fibres. Plants based on this process can be built :

— with relatively small capacity which do not create logistic problems for supply of raw material.

— with an acceptable capital investment cost, including a full chemical recovery system.

— with a minimum of impact on the environment

The Naco process can be used for treating a wide range of raw materials, and will contribute substantially to the economic production of pulp and paper.