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PRODUCTION OF TECHNICALLY SPECIFIED RUBBER (TSR) BY THE CENAT PROCESS

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INTRODUCTION

This paper on the installation and operation of the first Commercial TSR factory in Sri Lanka is presented in four parts.

Part 1 — Building, machinery and installation.

Part 2 — Maintenance and performance of machinery.

Part 3 — Production and palletisation.

Part 4 — Marketing and purchase of raw material.

PART 1

Building, Machinery and Installation

The building of the CENAT factory is a simple rectangular structure of 136 ft. x 50 ft. (41.45 m x 15.2 m). The maximum usable height of the building is 17 ft. (5.18 m) and is protected on all sides. The building is designed to receive additional machinery to increase the output of the factory to 300 tonnes per month, but as utilised today, has sufficient space to accommodate the machinery of a 100 tonnes plant, store a fortnight's supply of raw material, and 100 tonnes of manufactured rubber.

The machinery used in the blending, size reduction, drying and baling of new process rubber is described in great detail by Graham, (1969) and Smith, (1969).

The machinery installed at the CENAT factory was supplied by the GUTHRIE CORPORATION and is the standard machinery installed in most of their estate factories in Malaysia. A locally manufactured Mascerator has been added to the process line for the pre-treatment of low grade rubber.

A brief description of the machinery is as follows:

(*a*) *Mascerator or creper*—This machine is of the inclined type and is fitted with locally cast 26" x 14" (66 mm x 35 mm) rolls. The machine is operated at 26 r.p.m. and is driven off a 30 h.p. motor.

(*b*) *Rotary cutter of granulator*—The granulator installed at the factory is of the larger type with a plan dimension of 18" x 12" (45 mm x 30.5 mm). The fixed blades are 18" (45 mm) in length and the rotating knives sweep a diameter of approximately 10" (25.4 mm). The lower half of the granulator is fitted with a screen through which the granulated rubber is discharged. The machine is driven off a 50 h.p. motor at 1200 r.p.m., and is conveyor fed.

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(*c*) *Extruder* — This machine was originally received as an extruder pelletiser, but was modified before installation to operate only as an extruder. The extruder is driven off a 25 h.p. motor and has a scroll speed of 104 r.p.m.

(*d*) *Uni-dryer* — This is an insulated tunnel unit, containing drying boxes which move on a conveyor chain. The speed of the movement of the boxes and the operating temperature can be controlled, and once set, remain constant through out the drying operations.

(*e*) *Baling press*— This is hydraulically operated and is capable of delivering a maximum line pressure of 6000 lb per sq in. The size of the pressed bale is 15" x 22" (380 mm x 570 mm).

PART 2

Maintenance and Performance of Machinery

The mascerator installed at the CENAT factory was originally fitted with imported chilled rolls as a precaution against frictional wear but it was found to be operating very much below the required capacity owing to the poor gripping of the rubber. These rolls were later replaced with locally cast close grained soft rolls, which are horizontally grooved with 3/16 in. (4.76 mm) 'V' cuts and diagonally with 1/16 in. (1.588 mm) spiral cuts at $\frac{1}{4}$ in. (6.35 mm) intervals. The machine itself has required very little maintenance in spite of being subjected to continuous operation.

The granulator has a capacity well in excess of the requirements of the CENAT factory and is therefore operated only every 25 min in an h. The performance of the machine depends to a very large extent on the accurate sharpening of the fly knives and their clearance between the dead knives. From this point of view the granulator is sensitive, but when correctly set, is capable of giving an output over 2000 lb (907 kg) an h. The knives are hand sharpened weekly and changed after 100 tonnes of production. Local engineering firms charge anything between Rs. 45/- and Rs. 120/- for the precision grinding of a set of blades, but the cost is negligible considering the output of the granulator.

The extruder installed at the CENAT factory when first commissioned, was found to be operating below its rated capacity, and the output was measured at 220lb (100kg) per h. Having studied the types of raw material available in Sri Lanka, the manufacturers supplied larger sized die plates, which immediately increased the output of the machine to the specified 450 lb (204 kg) an h. The Scroll and Barrel of the extruder unit are subjected to high frictional wear and the first set required rebuilding after a production figure of less than 100 tonnes. Weld filling with alloy electrodes which resist frictional wear was necessary but the cost was excessive owing to the high cost of electrodes in Sri Lanka. The functional end of the extruder was recently redesigned and renewed by a local engineering firm. The measured output of the extruder in its present form is in excess of 550 lb (250 kg) per h and the initial difficulties of excessive wear have been overcome. The main function of the extruder is to convey the granules through a multi-cavity die plate in order to convert the rubber to the form of strings of a uniform cross section, which are convenient for drying. Judging by the quality of the end product, this function is performed exceptionally well; the volatile matter content of extruder manufactured CENAT 20 and 50 is consistently between 0.27% and 0.30%.

The Uni-dryer is a well tried out machine and is reliable and convenient to operate. The manufacturers of the dryer recommend that the machine should be operated on high speed diesel oil (automotive diesel) but owing to the high cost of this type of fuel in Sri Lanka experiments were carried out in order to convert the machine to operate on heavy diesoline. These trials were successful and the cost involved was negligible. The machine is today continuously operated on heavy diesoline, resulting in more than a 50% saving in fuel costs.

The hydraulic press installed at the CENAT factory needs little or no maintenance except for the occasional bleeding of fluid lines. The press operations are manually controlled which requires constant supervision as the dwell time *etc.* are in the hands of the operating labourer. A fully automatic unit would therefore have been preferable.

PART 3

Production and Palletisation

Trial production at the CENAT factory was commenced in November, 1971 and was continued till the end of that year. Several types of raw material were tried out with varied results.

(a) *Selected RSS material*—One type of raw material utilized was low grades of smoked sheet and RSS cuttings. Treatment commenced with a 24 to 48 h soak in water containing a detergent. The rubber was then mascerated 3 to 5 times and the resulting blanket was cut to 18" x 12" (45 mm x 30.5 mm) pieces before being granulated. The granules were subjected to further washing in a blending tank, and dried for 3 h at a temperature of 98 to 99 °C. The rubber was baled at a pressure of 4000 psi (27.6 MN/m).

The finished product when subjected to analysis was within the SCR 5 specification with dirt values between 0.02 and 0.035% and the PRI in the 75 to 85 unit range.

This grade of rubber utilizing selected RSS material contains to be commercially produced at the CENAT factory and has received ready acceptance in the international markets. The mean values of a years production of CENAT 5 as this rubber is known, is shown in Table 1.

(*See Table 1—page 146*)

The dirt values fluctuate between 0.01 and 0.03% which is considered acceptable, but 8% of the production exceeded the 0.03 level, and 3.2% exceeded the 0.40 level. As production continued the process of manufacture was constantly reviewed in the hope of eliminating fluctuations of dirt values, but no immediate solution was seen. It was therefore considered prudent to be more selective in the purchase of raw material and a system of screening of each receiving consignment was introduced. As production continued it was established that poor handling of material in RSS shippers' stores was the cause. RSS cuttings and more often clippings swept from floors were finding their way to the factory.

The PRI of the rubber is constantly between 70 and 90 units and the P_0 is between 40 and 50. Some consumers, it appeared, preferred a lower P_0 in "CENAT 5" but no definite information is available to us in this connection.

TABLE I

CENAT BLOCK RUBBER FROM RSS CUTTINGS MEAN VALUES

Limits of		No. of one ton pallets falling into each grade	% of pallets falling into each grade
DIRT	0.01	1	0.2
	0.01 — 0.02	166	39.9
	0.021 — 0.03	151	36.3
	0.31 — 0.04	59	14.2
	0.041 — 0.05	8	1.9
	0.05	31	7.5
PRI	100 — 91	2	0.5
	90 — 81	295	70.6
	80 — 71	107	25.6
	70 — 60	14	3.3
	60	—	—
P_o	50	5	1.2
	40 — 50	391	93.5
	30 — 39	22	5.3
	30	—	—
MOD	4.5 — 5.49	—	—
	5.5 — 6.49	180	64.3
	6.5 — 7.49	100	35.7

(Data based on the production of 600 tonnes or 1800 samples tested).

Various experiments were nevertheless carried out, to bring the P_0 down to between 35 and 40 and the results of these trials are shown in Table 2.

TABLE 2

EFFECT OF SOAKING TIME, NUMBER OF PASSES THROUGH THE MASCERATOR AND DRYING TEMPERATURE ON THE P_0 OF REPROCESSED RSS

Soaking time in days	Number of passes through mascerator	Drying temp. (°C)	P_0	PRI
1	5	97	47	81
1	10	97	38	79
2	5	97	42	78
2	10	97	40	75
1	5	100	43	78
1	10	100	40	70
2	5	100	43	74
2	10	100	39	70

Soaking period, drying temperature and the number of passes through the mascerator had varied effects on the P_0 of the rubber. Reductions up to 8 units were observed but the resultant reductions of the PRI (between 10 to 12 units) was not considered as a desirable feature.

(*b*) *Raw materials type 2 and 3. Estates and dealers scrap rubber*

The second and third types of raw material evaluated at the CENAT factory was field coagula from estates and dealers scrap grades.

Treatment for both types began with a 24—36 h soak in water. The rubber was once mascerated, granulated and subjected to washing in a tank fitted with high pressure jets of water. The granules were next extruded and dried at a temperature of 96-97 °C. During time was set at $3\frac{1}{2}$ h.

The product when subjected to analysis revealed widely fluctuating values, indicating the inconsistency of the raw material. Dirt content of field coagula from reputable estates was between 0.05 and 0.4%, with a PRI ranging from 30 to 40 units. These were both undesirable features which in theory, could be compensated for, and eliminated during the process of manufacture. Control over collection and storage would be the answer but no progress was made in this direction as none were initiated by the factory.

Dealers scrap grades were extremely dirty and the first few consignments tried out at the CENAT factory were outside specifications for this reason. PRI of this rubber was marginally better and varied between the smaller range of 40 and 50 units.

Contrary to expectations "Estate field coagula" was not up to standard from point of view of consistency. The rubber was certainly cleaner in comparison to dealers scrap, but was not consistently so. Dealers scrap though lower in allround quality was from point of view of manufacture easier to process. Once the process of manufacture was decided on, only occasional variations were necessary. Pre-treatment was obviously necessary in order to remove dirt and was duly incorporated in the process. Phosphoric acid and oxalic acid treatment for improvement of PRI was also required as shown in Table 3 and is now carried out when manufacturing CENAT 20 and 50 from dealers scrap grades.

TABLE 3

EFFECT OF PRI OF THE PRODUCT BY SOAKING LOTS OF COMMERCIAL FIELD COAGULA IN 0.5% PHOSPHORIC ACID SOLUTION FOR 2 H.

Sample No.	*PRI*	
1	36	
2	35	
3	43	
4	29	*Before*
5	35	*soaking*
6	40	
7	51	
8	39	
9	32	
10	56	
11	63	
12	64	*After*
13	63	*soaking*
14	61	
15	65	
16	63	

Palletisation

The bale size of each 73½ lb (33⅓ kg) CENAT rubber is 15" x 22½" (380 mm x 570 mm). Thirty of these are packed into a pallet measuring 40" x 48" (1000 mm x 1200 mm) in overall size. The cubic footage of each pallet is measured at 50.52 cu ft. (14.3 m3) as a 6 in. free allowance of height is allowed by the carriers.

The cost of a pallet is in the region of Rs. 90/-. A breakdown of this figure is given in Table 4.

TABLE 4

COST OF PALLET CONSTRUCTION

Wire nails			
3" nails 54 Nos. (1 lb)	Rs. 1.90		
2" ,, ,, (1 lb)	1.85		
1½" ,, ,, (2/5 lb)	.90		
1" ,, ,, (1/5 lb)	.35	Rs.	5.00
Polythene (PE) wrapping			
Bale wrapping 2½ lb @ 2/-	Rs. 5.00		
Interleaving ½ lb @ 2/-	1.00		
Black PE wrapping 2½ lb @ 2/75	7.00		
Steel strapping			
97' strapping (4 lb) @ 2/10	Rs. 8.40		
10 Nos. seals	1.00	Rs.	9.40
Wood			
Treated rubber wood 4.08 cu ft @ 13/50		Rs.	55.00
Other costs			
Labourer/transport/wastage (2/00, 2/00, 4/00)		Rs.	8.00
		Rs.	90.40

The cost of palletisation is higher in Sri Lanka than in any other country where TSR is manufactured. This is mainly owing to the high cost of timber, inspite of the fact that treated rubber wood is being utilized for the construction of pallets.

PART 4

Marketing

The first few tonnes of CENAT rubber were available for sale in December 1971 but no worth while bids were received from foreign buyers or their local counterparts. As the factory moved into full scale commercial production in 1972 the problem of marketing was indeed acute. The cost of raw material is governed by the selling prices of scrap crepe which on an average were higher than the bids received for any one of the CENAT grades. The first few months were very anxious months and the factory was compelled to carry large stocks of manufactured rubber with no likely prospects of sales at an economic price. The manufacturers of CENAT rubber were of the view, that even if it was necessary to market the rubber initially at a loss, the manufacturers themselves should do so, so that any experience gained in marketing the product will accrue directly to the manufacturer. A Director of the company therefore applied for, and

received Governmental approval to travel to Western Europe for the express purpose of marketing CENAT rubber. Once the first few 100 tonnes reached their final destinations and the product was tried out by end users marketing prospects seemed to improve. The factory in association with the Rubber Research Institute of Sri Lanka continued to maintain strict quality control and as production continued the sales figures improved considerably.

Today, as things stand, CENAT 20 and 50 are saleable at only a small discount over the quotation for the corresponding SMR grades in the Western European countries. CENAT 5 is marketed at the RSS 1 price and in recent times a substantial premium has been recorded. The manufacturers of CENAT rubber feel the present marketing levels shall be improved on, but the quantities available limit progress in this direction.

Another disadvantage in marketing CENAT rubber is the manufacturers inability to ship a replacement in case of a factory breakdown. No other TSR is available in substantial quantities, nor is it possible to replace with a corresponding RSS grade owing to the country's obligations under various bi-lateral trade agreements.

CONCLUSION

The data presented has shown that a readily marketable product can be produced from sheet cuttings, low grades of sheet and cup lump material by the CENAT process. There is a sustained demand for CENAT block Rubber from a number of countries suggesting that it is a form of natural rubber acceptable to the consumer.

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