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Five Years of Nat-Rubbers

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Improvements regarding processing and product quality achieved over five years of large-scale operation of the Decan processes for rubber preparation are described.

Latex processing based on the use, in Decan plants, of the 'ABC' method of coagulation, of more compact and reliable granulators and faster drying cycles is reviewed, as well as the preparation of CV rubbers and of OENR, and the adjustment of rate of vulcanisation by controlled washing of comminuted rubber. Pre-cleaning of lower grades and smallholders' lumps and slabs by means of hammermills and hydrocyclones is also reviewed. Also, various possibilities of improving the output of existing drier installations are examined.

Present trends in packing are surveyed, and a plea is made for the rapid adoption of an international classification method providing at least the same indications of interchangeability between different products as the RMA classification now does for rubber in sheet form.

This group of companies faced in 1959 the problem of modernising manufacturing processes of natural rubber, in connection with the equipment needs of plantations, totalling 18 000 acres, of the Société Africaine de Plantations d'Hévéas in Ivory Coast. The first stage of development concerned a reliable and economical process for production of specification rubbers from field latex. This resulted in the Decan WL process, by now well-proven, and whose basic pattern has been described by FLEUROT (1965).

Subsequently, attention was focussed on the processing of estate lower grades by methods more economical than the traditional ones, and on 'integration' of equipment with other processes including Heveacrumb. As a result, a continuous process for 'remilling' was designed and put into application in Africa, opening a new field of application and immense possibilities of upgrading economically a very large portion of the present-day rubber production. This process, described here, has been patented and is currently known as the Decan Remill Process (PROMOCI, 1967).

DECAN GRANA PROCESS

Development of an industrial process for rubber manufactured from fresh latex started in 1959 on An Loc Estate in Viet-Nam. Basically, the Michelin technique of coagulating undiluted field latex in cylindrical drums was used, the coagulum then being veneered off on a band-saw.

In view of the physical form of the coagulum obtained by sawing, it appeared logical to seek a method whereby manufacture could be carried out in a continuous and automatic manner from this stage onwards, by reducing the coagulum to a size which would allow mechanical handling. The first granulation tests were carried out in 1961 with Burtonwood Company (now U.S.I. Cumberland) in Manchester, and in 1962, the first industrial line for the treatment of natural rubber by granulation was started on Toupah Estate in Ivory Coast. Results were conclusive and further plants were installed as the crop increased. The operation is briefly as follows:

Fresh latex is coagulated in cylindrical tubs, veneered, calendered and granulated. The granules so obtained are conveyed pneumatically into an automatic apron drier. The dry rubber is compacted by means of powerful presses into bales of 34 kg each.

Two distinct types of rubber are obtained according to the degree of calendering of the coagulum: either a fast-curing, high-modulus

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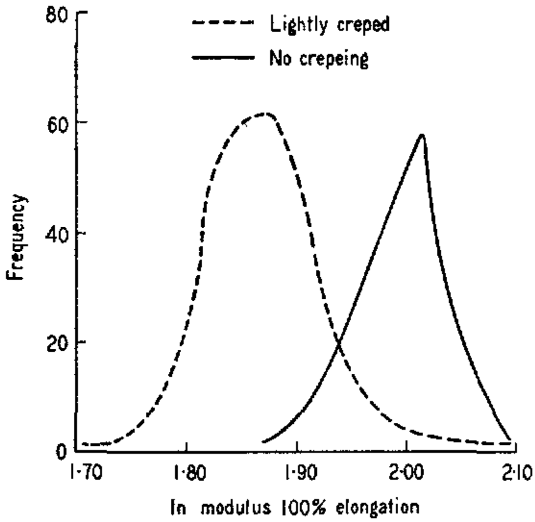

Figure 1. Frequency distribution of 100% modulus of ACS 1 mixes.

rubber, or a medium-curing rubber similar in properties to air dried sheet (ADS). Logarithmic distribution of the moduli of the two types is given in *Figure 1* over one year's production, their variability being remarkably small.

Because of their industrial and relatively mechanised nature, Decan Grana factories possess an appearance with which all planters are not quite familiar yet; but, they offer the following advantages:

(i) reduced manufacturing cost, owing to a considerable reduction of labour requirements (1.5 days per ton instead of 14 in the case of RSS);

(ii) very short factory dwell time—latex and coagula can be treated and put on the market within 24 hours; and

(iii) compact nature of the installations, with all operations well integrated to take place on a small floor area (compared to a traditional installation, and for an equal capacity, a complete Decan Grana line needs no more space than is normally required for the coagulation tanks of the former).

Adaptability of Decan Grana Process

From a technical point of view, the Decan Grana process is also characterised by a remarkable degree of flexibility. The use of mechanical stirrers (enabling an excellent blending to be obtained) and simple automatic acidification systems, the ease of handling of coagulation drums, the possibility of varying the degree of calendering and the accurate control of drying conditions enable the process to be used for the production of all rubbers known today, either new or standard, and particularly Heveacrumb, CV and LV rubbers and OENR.

The adaptability of Decan Grana process is described below:

Heveacrumb: Experience has shown that coagulum in the form of long strips is particularly well adapted to crumbling. Their consistency, width and thickness being constant, an excellent crumbling is obtained in Decan Grana lines, with better machine output than when treating coagulum of arbitrary shapes. The Decan Grana line can be adapted to the manufacture of Heveacrumb by replacing the granulators with a crumbler.

CV Rubbers: Preparation of CV rubber is easy to control with Decan Grana equipment, since mechanical agitation in large bulking tanks facilitates dispersion of the required solutions. *Table 1* shows the amounts of stabilising agent required, which are similar to those published elsewhere (SEKHAR, 1964).

Extreme values of Mooney over six days of large-scale preparation spread over six months ranged from 62.5 to 71.

TABLE 1. USE OF HYDROXYLAMINE SALTS

Hydroxylamine sulphate, percentage on dry rubber	Mooney value	
	Fresh	Aged 48 h over $CaCl_2$
0.0 (control)	84	93
0.5	68	71
1.0	63	65
1.5	62.5	64
4.5	61	63

Drying on apron driers was in no way affected by the presence of hydroxylamine salts, and normal operating conditions were maintained.

OENR: Difficulties may be expected in two aspects, with large-scale production of OENR—'stringiness' of the coagulum and collapse of the bed of granules on drying. The first difficulty was overcome by careful adjustment of the composition of the emulsion used.

Rather surprisingly, the rate of drying and the general drying behaviour were much less different from the ordinary coagulum than anticipated.

Control of Rate of Vulcanisation

Experience has shown that, as far as the rate of vulcanisation of natural rubber is concerned, consumer requirements fall broadly into two categories: some insist on the fastest possible cure, even when allied to relatively short scorch times of the compound, while technology does not permit others to use fast-curing or scorchy compounds. For example, some continental tyre manufacturers want short-curing cycles to improve the rate of amortisation of their moulds and presses, while on the other hand, manufacturers of agglomerated cork gaskets rework a large fraction of the compound several times on open rolls.

In early stages, differentiation in the rate of vulcanisation of NAT rubbers was obtained by subjecting the coagulum to a small number of crepeing passes prior to granulation in order to obtain the slower-curing variety.

This procedure had, however, the undesirable effect of rendering the process discontinuous.

Experiments have shown the possibility of lowering the rate of cure of compounds by controlled washing of the granules, obtained on the equipment shown in *Figure 2*. Typical data, obtained from three replications on the same input, are given in *Table 2*.

Application of this method has in fact demonstrated that variability of the rate of cure is no greater than that of lightly creped rubber. This is shown by the frequency distribution curves *(Figure 3)* based on the modulus at 100% extension of ACS1 compounds, which also indicate that the moduli obtained by washing are similar to those obtained by light crepeing.

Assisted Biological Coagulation

This method of coagulation developed at the Rubber Research Institute of Malaya has very decided attractions. Owing to the prolonged coagulation time, however, it requires a large floor-space if conventional coagulating tanks are used. The possibility of stacking drums is of

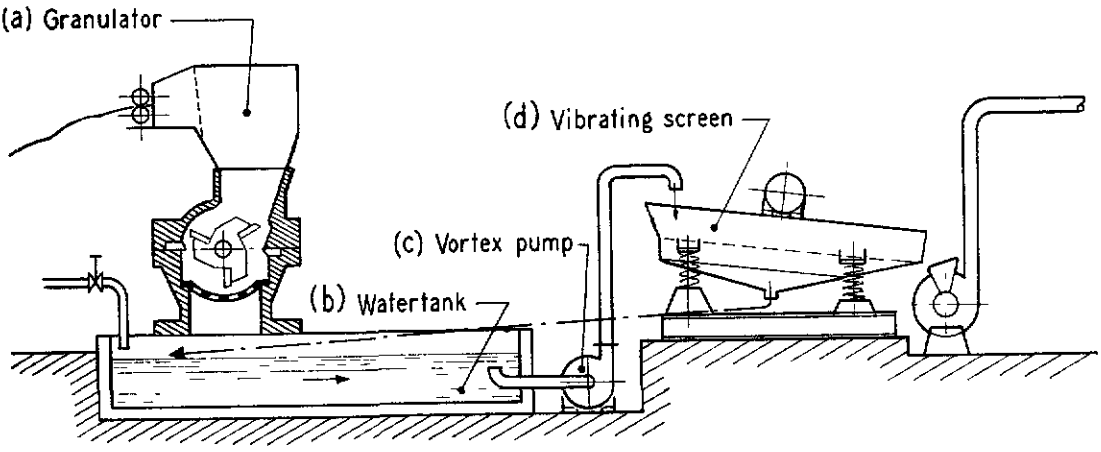

Figure 2. Equipment for washing granulated rubber prior to drying: (a) granulator; (b) water tank; (c) vortex pump; and (d) vibrating screen.

TABLE 2. LOWERING CURE RATE OF ACS 1 COMPOUND BY WASHING (M 100–KG/CM²)

Washed	6.53	6.63	7.00	6.78	6.58	6.95	6.30	6.55	6.96	6.86	6.71	6.99
Control	7.22	7.14	7.38	7.37	6.91	7.40	7.48	6.86	7.35	7.40	7.24	7.59
Difference	0.69	0.51	0.38	0.59	0.33	0.45	1.18	0.31	0.39	0.54	0.53	0.60

particular advantage in this respect. Tests carried out in the Toupah Factory have shown that the consistency of the coagulum obtained by 'ABC' method is such that no difficulties arise on veneering. Rate of drying is satisfactory. Results of typical operations are shown in *Table 3.*

Choice of Granulators

Much experience had been gained on the Girovinyle-type of granulator previously described (FLEUROT, 1966). This type of machinery has the attraction of simplicity, ruggedness and a very low power consumption per pound of rubber granulated. However, its main defect is that there is no control of particle size of the emerging material, which fact requires the inclusion of a safety margin in drying times, to ensure thorough drying of the larger particles. Preference was therefore given earlier to rotary knife granulators fitted with a screen, for granulation of fresh coagulum. In order to retain a reasonably low power consumption, and a narrow range of particle sizes, it was found necessary to equip these granulators with a pre-cutting device which provided even and reproducible rates of feed *(Figure 4)*, in the form of strips, approximately ½″ × 20″.

Specific power consumptions, as recorded in the Toupah Factory are:

Girovinyle-type granulator	15 kWh/ton
Standard USI-type granulator	40 kWh/ton
USI-type granulator with pre-cutting device	30 kWh/ton

Pre-cleaning of Lower Grades

The traditional way of pre-cleaning estate scrap material and the lower grades from smallholders' production involved scrap-washers and crepeing rolls. This rather labour-intensive process had also a tendency to degrade rubber because of the high shear

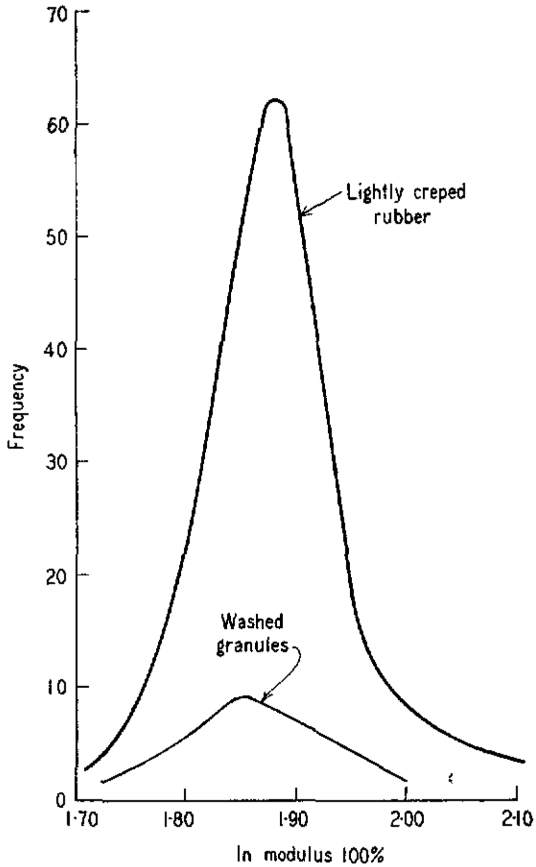

Figure 3. Compared frequency distribution of modulus of rubber lightly creped before or washed after granulation.

TABLE 3. ASSISTED BIOLOGICAL COAGULATION IN DECAN GRANA EQUIPMENT

(a) Unpreserved latex

Initial pH	Serum pH after coagulation	Sugar g/kg D.R.	% Nitrogen content	ML 1+4′ 100°C	PRI	ACS 1 mix	
						M 100 kg/cm²	Scorch time t+5, ML, 121°C
6.4	5.5	3	0.42	90	79	6.76	12 min
6.4	5.5	6	0.44	90	82	6.69	11 ,,
6.4	5.2	9	0.44	87	80	6.38	11 ,,
6.4	5.1	12	0.46	87	80	6.44	10½ ,,
6.4	5.0	15	0.42	86	87	6.41	14½ ,,
Control*	5.2	0	0.44	85	84	6.46	13¼ ,,

*Coagulated with acetic acid

(b) Ammoniated latex (pH 8.3) plus variable amounts of acetic acid prior to sugar addition

Initial pH	pH after coagulation	Acetic acid g/kg D.R.	Sugar g/kg D.R.	% Nitrogen content	ML 1+4′ 100°C	PRI	ACS 1 mix	
							M 100 kg/cm²	Scorch time t+5, ML, 121°C
7.5	5.7	0.0	4.5	0.44	88	76	6.15	10½ min
7.3	5.7	0.9	4.5	0.44	86	84	6.53	12 ,,
7.0	5.6	2.1	4.5	0.44	88	80	6.78	13 ,,
6.6	5.5	3.9	4.5	0.42	88	81	6.74	11½ ,,
6.1	5.4	6.3	4.5	0.42	92	86	6.74	12¾ ,,
5.6	5.2	9.0	4.5	0.42	85	90	6.44	13 ,,
Control	5.5	10.5	0.0	0.43	87	91	6.60	13¼ ,,

applied over a relatively long period. It was found that a better degree of cleaning could be obtained by using a succession of comminution-and-washing steps. The latter were obtained by the use of specially designed vortex pumps and vibrating screens. Dirt contents obtained after three passes through a hammermill associated with a vortex pump and vibrating screen are summarised in *Table 4*.

The prospects for using such equipment, either alone or in association with other processes such as crumbling or pelletising, appear to be considerable.

Improving Drier Outputs

Experiments published elsewhere (GYSS, 1967) have shown that the rate of drying of granulated rubber could be considerably increased during the constant-rate evaporation stage, by holding the granules in a vibrating fluid bed *(Figure 5)* and thus avoiding the formation of a temperature gradient within

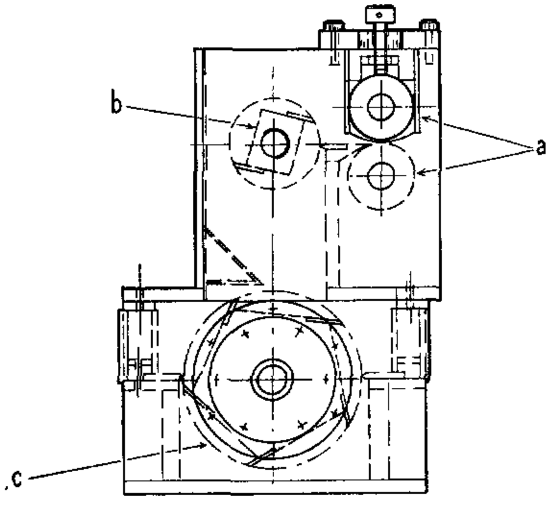

Figure 4. Granulator with pre-cutting device.

the rubber layer. Pilot plant trials indicate that the moisture content of granulated rubber can be brought to below 5% in less than 15 minutes on a vibrating drier *(Figure 6)*. Because of the continuous nature of this process and its high efficiency, it appears very tempting to combine this form of drying with an apron drier in the second stage. Tests on a 1 ton/hour unit are now in hand.

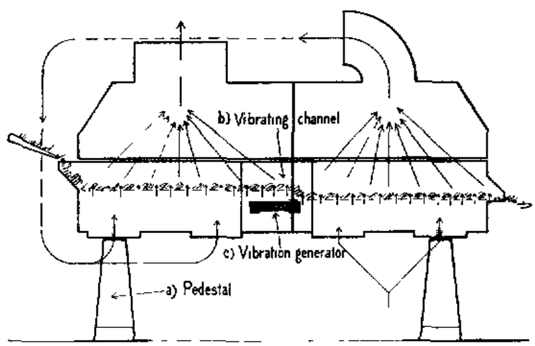

Figure 5. Vibrating fluid bed drier.

MARKETING OF NAT-RUBBERS

Since 1960, this group has produced more than 36 000 tons of rubber sold on specifications outside RMA standards. In 1962, this group took, alone at that time, a decisive step in a new direction, by equipping new factories for the treatment of the total crop of large estates into granulated rubber.

In 1965, this choice was vindicated by the efforts made by the Rubber Research Institute of Malaya to induce Malaysian rubber producers to take a similar step. Today, those who have responsibilities regarding the future of natural rubber are unanimous in acknowledging the need to progress firmly in this direction. But many producers are still doubting the advisability of such conversion, because of what they regard to be technical and commercial risks in the change-over.

Commercial risks, if any, will disappear with the adoption on an international scale of a new set of technical specifications for natural rubber, permitting the creation of a new international classification. In effect, the first difficulty for a commercial producer of granulated rubber appears at the very moment he is looking for a name for his product. One could think of the adoption of a house or brand name for natural rubber so produced, following the lead given by synthetic elastomers. But this would be misleading because the position of natural rubber producers differs fundamentally

TABLE 4. LOWERING DIRT CONTENT (P.P.M.) BY HAMMERMILLING

Pass No.	Screen size, mm	Input material			
		Coagu-lum	Slab with cut-scrap	Cup-lump	Cut-scrap with bark
1	50×50	290	3 850	430	40 000
2	30×12	250	520	150	5 300
3	10×10	40	180	100	1 000

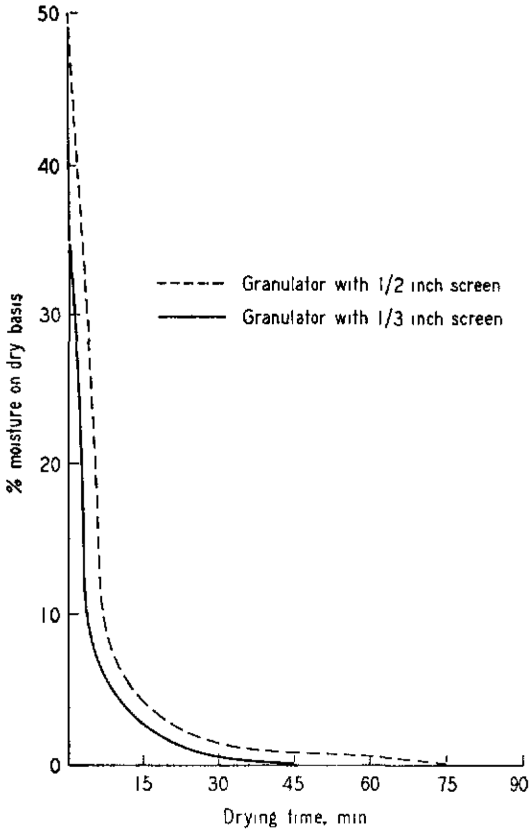

Figure 6. Drying of granulated rubber in vibrating fluid bed driers.

from that of the synthetic rubber producers, for the following reasons:

(a) All natural rubber producers treat basically the same raw material and their manufacturing processes differ only within the measure in which they preserve the intrinsic properties of the natural product; synthetic rubber manufacturers, on the other hand, are wholly responsible for the quality of their product.

(b) The size of producing units is not at all comparable; outputs and commercial circuits have no common measure. Some ten groups are responsible for the manufacture of about 3 200 000 tons of synthetic rubber, whereas the production of 2 500 000 tons of natural rubber is distributed between thousands of producers, who are also located far from the main consuming areas.

It is feared therefore that the present confusion in the field of new natural rubbers is likely to increase even more, and that proliferation of new brand names for natural rubbers which are practically similar and available in small amounts only is likely to present grave dangers and hamper considerably the development of the new forms of rubber. It is obvious that rubbers offered in an expensive form of packing, and sold today with a premium, will soon saturate a relatively narrow market, and that further outlets will have to be found by arousing the interest of the large manufacturers who are looking essentially for economy and reliability of supplies. Economy implies simple modes of packing, strictly adapted to their needs. Safety of supplies can only be guaranteed on a large scale by the interchangeability of the sources of supplies.

If one thinks that it has taken nearly fifty years of effort to have the RMA standards internationally recognised, the present situation of new forms of rubber appears to be somewhat retrograde.

This is why work on standardisation carried out today by international organisations is regarded as being extremely significant and vital for the future of natural rubber and for the development of new and more competitive forms. But it is essential that the definition of the technical specifications should take into account practical problems on the producing as well as the trading and the consuming sectors.

The authors therefore feel that an essential requisite of the specifications scheme to be eventually adopted should be that it is sufficiently complete to enable a new international classification to be established to ensure interchangeability of supplies irrespective of the producing country or even the estate—at least to the same, if not greater, extent of what is achieved today by the RMA classification.

CONCLUSIONS

A review of the improvements made over five years' operation of the Decan processes shows that relatively little change in the original pattern was needed to adapt them to the later trends in natural rubber manufacture.

The adaptation to manufacture of Hevea-crumb, OENR and CV rubbers is described.

The use of granulators and hammermills in the cleaning of estate scrap and smallholders' coagulum is described, and it is shown that such equipment can advantageously replace scrap-washers and macerators.

The combined use of vibrating driers and apron driers is suggested as the means of improving output of the latter.

The dangers inherent in present diversification of brand names of specification rubbers are pointed out, and a plea is made for rapid adoption of an international classification of new forms of natural rubber indicating the degree of interchangeability between them.

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DISCUSSION

Chairman: Mr. B. C. Sekhar

Mr. G.W. Drake asked which packing methods the authors preferred for new rubbers. Mr. Gyss replied that unit packing on pallets with external protection was desirable, although at present some ports and ships could not handle and did not allow pallets. A few consumers operating exclusively with oil firing had difficulties in disposal of old pallets. The majority of consumers found polythene wrapping of bales to prevent tack was acceptable, but a minority did not because of poor dispersion in mixing on open rolls or the small extra cost due to polythene. Producers should make a concession to cater for this minority among consumers.

Mr. C.W. Thompson asked which bale sizes were preferred. Mr. Gyss said that like all companies manufacturing baling-presses or which had a large number already in use, their choice was for the size which they made or used most extensively at present.

Mr. P.S. Chin asked for fuller details of drying behaviour in OENR production by the Decan Grana process, which the authors reported as differing less from that with ordinary coagulum than anticipated. Mr. Gyss said that comminuted rubber of both normal initial concentration and OENR containing 20 parts of Dutrex R to 80 parts of rubber took the same time to dry without either collapsing in the bed of 15 cm thickness; collapse might have occurred with a deeper bed.

The Chairman enquired what cure specifications might be appropriate for SMR. Mr. Gyss said specifications were most important to the small consumer, who lacked test facilities and for whom a single unsatisfactory batch might be a large proportion of the throughput. Scorch was important in ACS type mixes and should be indicated.