

# NEED FOR STANDARDISATION OF RUBBER MACHINERY

By

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The annual rubber production in Sri Lanka varied from 146,000 t in 1968 to 137,000 t in 1986. Sri Lanka is the fourth highest natural rubber exporter in the world and it is likely that we will remain as a raw natural rubber exporter for sometime to come. Dry natural rubber in the raw form could be presented in three main types; namely sheet rubber, crepe rubber and block rubber. The annual production of these different types of rubbers in 1986 in the major natural rubber producing countries are given in the table I. It is clear from the table that while Sri Lanka still concentrates on crepe rubber, which is a high quality rubber, all the other major natural rubber producers manufacture TSR or sheet rubber. There is competition to our crepe rubber from natural rubbers such as TSR — SL, air dried sheets and synthetic polyisoprenes. Therefore it is important to take all the precautionary measures so that crepe rubber could remain competitive in the market. Both crepe rubber and sheet rubber, our major products are visually graded and the grading system has no relationship to its properties. Other manufacturing steps like, dilution, fractionation, addition of chemicals etc., contribute to the property of the final product. Provided that all these are kept uniform, the milling process also can contribute to the variations in properties.

For the primary processing of the natural rubber in Sri Lanka, there are 150 rubber factories in the public sector and about 60 factories in the private sector. Out of the 150 public sector factories, 130 are crepe producing factories, 2 are TSR factories and the remainder being sheet factories. The sixty factories in the private sector include, 23 latex crepe factories and 6 TSR factories. The balance consist of scrap crepe factories. Apart from this large scale processing units, there are about 70,000 rolling units in the private sector for the processing of smallholder latex.

In sheet rubber manufacture, hand rollers and Guthrie rollers are used to mill the rubber. Hand rollers are fabricated in Sri Lanka for this purpose. In crepe rubber factories two-roll mills with different roller surfaces are used and all these types are locally fabricated for this purpose. In the manufacture of TSR, various types of mills including, pre-breakers, hammer mills, granulators and crepers are used but only crepers could be fabricated in Sri Lanka. New machinery are not used in scrap crepe factories, therefore, this paper is concerned only with the two roll mills used in latex crepe production in the 150 crepe rubber factories, the crepers used in the 8 TSR factories and the hand rollers used in 70,000 rolling units. There is an estimated requirement of about 700 two roll mills in the 150 crepe rubber factories and about 60 crepers in the TSR factories.

Inconsistency is a complaint made against natural rubber, very often. Even the introduction of a technical specification system has not helped to overcome these complaints completely. The larger producers however overcome such situations by constructing large factories of capacity of about 100 t/day where as most of our crepe rubber factories are only of 1 — 2 t/day. This is a clear indication that factory conditions including the machinery are contributing to the properties of the material. Due to various steps involved in the crepe rubber industry, our main

raw rubber product, contain more batch to batch variation than any other form which has only inherent property variations. However, the rubber product industry in the developed countries are now automated and rubbers with such batch variations are not acceptable to them. With such variations the final consumers have to undergo the difficult process of making adjustments with each batch. Therefore, to maintain markets it is important to minimise this and standardisation of the machinery is a necessity to achieve this uniformity.

One of the earliest observations made on commercial natural rubber was that the material become hard, inelastic and much paler in colour on exposure to temperatures below 15°C. More importantly it becomes impossible to process the rubber efficiently on a two roll mill or on an internal mixer. At the same time it was observed that this phenomenon could be reversed by the application of heat to rubber. Hence 'hot rooms' for the treatment of raw natural rubber became a feature of rubber processing factories situated in colder climates. The possibility of crystallisation in rubber was confirmed by x-ray analysis which showed that the long molecular chains get arranged in a closely packed structure. The presence of lock in stresses, arising in the creping process will increase the crystallisation rate. It is shown that the various gear ratios used in the creepers cause variations in the amount of lock in stress and thereby variation in the crystallisation rate. This means that rubber batches prepared using different gear ratios may have different crystallisation rates thus at one particular time the hardness of the two rubbers could be different causing inconsistency in processing. However, block rubber escape such effects due to the high temperatures used in drying, which reduce the lock in stresses. Crystallisation to a certain degree is important in sole crepe to facilitate the cutting process. There again the same level of crystallisation in all the samples is important. This therefore indicate the importance of standardisation of gear ratios in the crepe manufacture. During operation, the creepers shear the feed rubber and spread them throughout the width of the roll. This will condition the rubber for easy drying. Even though fairly high gear ratios should be used to ensure sufficient shearing of the rubber to remove the water, it has been found that the roll friction ratios above 1 : 1.5 does not improve the crepe performance. Therefore, we may use this gear ratio in the final smooth mill in pale crepe manufacture. However, higher gear ratios may be used in sole crepe manufacture due to importance in crystallisation.

Due to the natural stickiness, the feed rubbers, which leaves the rolls form into a continuous or semi continuous ribbon with evenly reduced thickness. When smooth mills are worked at excessive speeds the lace will rapidly lose its width and the finished lace will be of an uneven texture. However, we must also be concerned about the output per hour since otherwise the production will be uneconomical. Therefore, a speed of 20 rpm has been worked out after balancing both these points.

An adequate supply of clean water to the mills throughout the milling operation is very essential to wash out the serum substances, dirt and excessive chemicals. If this washing is not done properly it leads to discolouration as we experienced in early 1987 resulting in down-grading of the rubber. In the rubber product manufacture, cure time is the time taken for the chemical crosslinking process in vulcanisation. This is the time period in which the rubber should be kept inside the hot mould in the production of rubber products. Similarly, scorch time is the maximum time duration which a rubber compound could be kept before moulding. If it is not put to the mould before this time, the compound cannot be moulded to the proper shape. Both scorch time and cure time is affected by the serum substances, therefore, if the rubber is not properly washed the scorch time and cure time of this rubber

will be different from a rubber which is washed properly. As a result of the mistakes done in the raw rubber factories, the consumer may end up with problems such as colour matching, scorchy compounds and over or under cured products, all this leaves more reject to him. To ensure proper washing the water consumption of a 65 X 35 cm macerator or intermediate mill should be about 500 litres/hour while in the smooth mill it should be about 750 litres/hour. It is therefore important to design the spray pipes accordingly.

The efficiency of the crepe rollers vary according to the tendency of the wet rubber to slip and closed grained cast iron is found to be more suitable for crepe-rollers than chilled iron which tends to polish even though the latter when used in smooth rollers reduce rust formation due to the touching of the rollers. The character of the metal used for the manufacture of the rolls is of some importance. Hard rolls do not work well as unless the surface is deeply cut, they do not grip the rubber well, and may even heat it. It is also possible that it could over work on rubber and damage it. The material may be cut into many pieces, in a way that it is quite difficult to get a smooth crepe. On the other hand, rollers with too soft metal may soil the rubber owing to the presence of free graphite. Quite often the rubber gets contaminated with small black particles from the rollers. These particles are manually removed from latex before packing, but it is always possible that such particles could go undetected. Any rubber product made out of this rubber now has a weak point where this dirt particle is. The failure of the product is initiated at this point. In some cases the failures could be very disastrous. For example in the manufacture of very long conveyor belts or hoses, a weak point like this will reject the entire product with several kilogrammes of rubber. It also could be very critical in small surgical products made out of pale crepe rubber. Therefore, the selection of the composition of the material to be used in the rollers should be made after careful consideration of both defects mentioned above and a balance composition should be worked out.

The material used in the other parts of the mill may not have a direct effect on the rubber. But if there is no uniformity in the material used by the different engineering firms for these parts such as bearings, journal box etc., then the wear and tare of these parts in mills from different suppliers will not be the same. Without any knowledge the factory staff may give the same treatment to all and unnecessary breakdowns could result.

Another important factor which has been overlooked very often is the internal cooling system in the mill. With continuous operation the mill gets heated up which causes the deterioration of the rubber specially when it is bleached. The effective working of the internal cooling system depends on the heat transfer coefficient of the material used in the rollers. Therefore, this also should be taken into account when deciding the material for the rollers.

It is important to obtain a uniformly thin crepe lace in the latex crepe manufacture. However, some factories find it difficult to achieve this. In many cases where more than one process line is available, the thicknesses of the laces obtained from the different lines are different. The figure 1 shows the effect of different lace thickness on the drying rate. This clearly indicate the practical difficulty encountered in the drying of laces of varying thickness. It is possible that rubber could end up either over dried or under dried. In either case the quality of the rubber is affected and will be down graded. If it is over dried then the rubber is tacky and the plasticity retention index will be low. This will result in difficult handling and inferior physical.

properties in the products. If it is underdried it will end up developing mould. Non-rubber substances present in natural rubber is food for mould and with moisture it provides an ideal condition for mould to grow. This will cause huge quality claims to the country. It must be mentioned here that most of the quality claims of rubber are due to mould and the government has to pay huge sums in foreign exchange as a result. The thick laces should be kept in the hot atmosphere for a longer duration than the thin laces. This can lead to more storage hardening of thicker laces. Storage hardening is a phenomena which irreversibly increase the hardness of rubber. In the rubber product industry the raw rubber has to be milled down before incorporation of the chemicals. Harder rubbers should be milled more thereby increasing the cost of manufacture for the consumers. In solution applications there will be more gel content in storage hardened rubbers making them unsuitable in such applications. Further this delay in drying can cause differences in maturation of rubber affecting the scorch time and the cure time of the rubber compound. Therefore, more care should be given to getting laces of uniform and required thickness and more attention to the nip adjustment system in the mills. The present system may damage the other parts of the mill. We should also place more attention and have dripping trays in our mills, since it is observed that it can reduce the drying time by nearly twelve hours.

In the laminators the pressure should be sufficient to seal the plies to avoid separation, but however, it should not be too high which will cause ruts on the surface giving uneven appearance. Such sheets will be rejected due to the difficulty in cutting soles from it.

It is relevant to discuss about the drying chambers as well. It is not possible to find a proper evaluation of the conventional drying towers. Perhaps it could be due to the difficulty in analysing the natural convention. As a result, there aren't any standardisation made. The building dimensions are different from one place to another. When the heat requirement is calculated, it is found that nearly 30% heat loss is through the walls and floor. Therefore, it is clear that the costs could be minimised if the towers are built on standard sizes.

## CONCLUSIONS

1. Machinery standardisation is necessary to maintain uniformity of the product and reduce costs.
2. It is important to study the material requirements and the compositions of the rollers to suit such requirements.
3. More attention should be given to maintain uniformity in gear ratios, water sprays, nip adjustment system and safety devices.

Table 1. Percentage of different types of rubber produced in major NR producing countries

Type of rubber	Country			
	Indonesia	Malaysia	Thailand	Sri Lanka
TSR	78.0	49.3	14.6	8.5
RSS	16.7	32.4	79.9	53.1
Crepe	1.8	1.3	5.3	37.8
Latex	3.6	14.6	—	—
Others	0.0	2.4	0.2	—

MOISTURE CONTENT (%)

