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FINAL REPORT

of

FIELD WORK AT YEN MY RICE MILL

by

THE EXPERTS OF SUDHAGAD RUBBER INDUSTRIES PVT.LTD.

for the

PROVISION OF SERVICES RELATING TO THE
REPAIR AND MAINTENANCE CENTRE AND SPARE PARTS PRODUCTION
FOR RICE MILLS

in

THE SOCIALIST REPUBLIC OF VIET NAM

WRITTEN BY
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Dated

27TH APRIL, 1990.

SUDHAKAD RUBBER INDUSTRIES PVT.LTD.

BOMBAY

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SYNOPSIS OF ABSTRACT

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The field work, carried out by the experts, Mr. B.C. Shah, Mr. V.P. Limaye and Mr. T.M. Divekar of Sudhagad Rubber Industries Private Limited, Bombay, India is reported in this document. The work at Yen My Rice Mill, Vietnam involved improvement of manufacturing technology for natural rubber based rollers using available raw-materials and introduction of synthetic rubber based rollers. These rollers are being used on paddy dehusking machines in rice mills. The Indian Experts successfully developed new formulae based on natural and synthetic rubber. Required pairs of rollers were manufactured at the project site and were tested for actual field trials on paddy dehusking machines. The rollers performed satisfactorily and met with the required technical parameters. The counter parts were well trained by imparting the necessary material know-how and by establishing the appropriate norms of process and production technologies.

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INTRODUCTION

INTRODUCTION

Rubber rollers are now universally used on paddy dehusking machines for milling of paddy to obtain rice. Rubber, by virtue of its unique elastic properties, enables efficient milling of rice with minimum breakage of grain. Natural rubber rollers, which are currently made at the rubber shop of Yen My Rice Mill, required improvement in formulation design and manufacturing technology. The Indian Experts analyzed the current formulation based on natural rubber and studied the available raw materials. New formulations were designed, rollers were produced at the rubber shop and tried successfully in the rice mill for endurance test. Also formulation based on synthetic rubber was introduced, rollers were made and tried in the rice mill to satisfactory performance.

The present report describes the field work carried out by the Indian Experts which involved improvement of natural rubber based rollers with available raw materials and introduction of synthetic rubber based rollers.

PRELIMINARY SECTION

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Critical analysis of currently used oformulations based on natural rubber was carried out by the experts, followed by the available processing facilities. Two types of new formulations were introduced using the available raw materials, as listed under Appendix-3 and Appendix-4. Rollers were made using these formulations after carrying out necessary laboratory tests. The rollers were tried in the rice mill on paddy dehusking machines for performance test.

Rollers based on formulation as per Appendix-3 yielded an average life span of 122.296 tonnes of paddy per pair, whereas rollers based on formulation as per Appendix-4 yielded an average life span of 135 tonnes of paddy per pair.

New formulation based on synthetic rubber was also introduced, tried in the laboratory and rollers were made. The rollers when tried in the rice mill for performance test, yielded an average life span of 201 tonnes of paddy per pair.

During above trials in the rice mill the dehusking machines operated smoothly, recovery rate was higher and rate of broken rice was lesser.

It was concluded, from the results of above performance tests, that the rollers met with the required technical parameters.

BODY OF THE REPORT

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1. Material know-how

1.1 Currently used formulation based on Natural Rubber:-

The currently used formulation based on Natural Rubber was studied critically. This is listed under Appendix-1. It is based on a semi-ebonite tyre composition with 17 phr sulphur. Such a high dosage of sulphur is being used primarily for getting high hardness value, but technically it yields an interior product having lower physical properties, low abrasion resistance and poor ageing characteristics. Reinforcing filler i.e. HAF Carbon Black (45 phr) and semi-reinforcing filler i.e. China Clay (45 phr) are being used but they are not effective enough in the semi-ebonite matrix.

The available raw materials at Yen My Rice Mill are listed under Appendix-2. Some of these are available locally whereas the remaining materials are imported either from U.S.S.R. or Japan. The quality and consistency of these materials were examined and found to be satisfactory.

1.2 New formulation based on Natural Rubber:-

The experts were asked to develop a new formulation based on natural rubber using only the available raw materials as per Appendix-2. Accordingly two formulations were introduced, developed and tried. These are listed under Appendix-3 and Appendix-4.

The first formulation as per Appendix-3 is for obtaining hardness value of 80-85^{o} whereas the second formulation as per Appendix-4 is for hardness of 85-90^{o}. The ingredients were carefully selected from the available range and their combination ratios were critically designed so as to obtain required processing ease and optimum vulcanizate properties. Both these formulations have much higher physical properties, higher abrasion resistance

and improved ageing characteristics. These formulations are based on use of much lower sulphur compared to the currently used formulation. Hardness, high physical properties and high abrasion resistance are obtained by using reinforcing fillers like HAF Carbon Black. The vulcanizing system was carefully selected to obtain optimum vulcanization and required processing safety. Activaters like Zinc Oxide and Stearic Acid were used to obtain high state of cure.

Importance of proper mastication of natural rubber, order of addition of ingredients, over-night storage of pre-mixed compounds etc. were discussed and practiced. Master batching technique for small ingredients like accelerators was introduced.

1.3 New formulation based on Synthetic Rubber:-

Rollers with supreme heat and abrasion resistance can be produced by using properly compounded synthetic rubber of acrylonitrile butadiene (NBR) type. A new formulation based on such synthetic rubber was introduced. This is listed in Appendix-5. This formulation enables to make rollers of non-black colour and hence avoids blackening of rice.

The synthetic rubber NBR is reinforced using reinforcing fillers like precipitated silica and thermo-setting resins of phenolic type. Vulcanization system is judiciously designed to obtain highest possible processing safety together with high rate and state of vulcanization. Accelerators of sulphenamide type and activators like Zinc Oxide and Stearic Acid are used in proper combination ratio. Sulphur is used as a vulcanizing agent in required proportion. Processing aids like Dioctyl Phthalate, Wood resin are used for ease of mixing and winding operations. Proprietary ingredients like PA-900, P-4 are used for obtaining special effects like

highest state of cure, high reinforcement etc. Non-staining anti-oxidents of styrenated phenol type is used to improve ageing properties.

All above ingredients were formulated in appropriate proportions to obtain best balance of properties. Importance of their order of mixing was discussed and practiced. Master batching of small ingredients like accelerator was practiced. Ingredients like sulphur which is difficult to disperse in NBR was also master batched and the sulphur master batch was added in the begining of mixing cycle to obtain the best possible dispersion.

1.4 Training of Counter Parts:-

The counter parts were trained in following areas:

1.4.1 Formulation design based both on natural and synthetic rubber to suit the prevailing processing conditions in the rubber shop and in the rice mill.

1.4.2 Proper selection of elastomer types and chemical ingredients such as vulcanizing agents, accelerators, activators, processing aids, anti-oxidents, reinforcing agents etc.

1.4.3 Importance of selected ingredients in the formulation, their properties and effects in the processing and vulcanization.

1.4.4 Combination ratios of these ingredients with the base elastomer and its importance. The counter parts were also trained so that if required they can modify the combination ratio slightly to suit the processing conditions during different climatic conditions.

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1.4.5 Precautionary measures in the use of certain chemicals like accelerators to avoid processing problems.

1.4.6 Effect of the base elastomer, ingredients and their combination ratios on the physical properties, abrasion resistance and ageing characteristics.

1.4.7 Quality control steps to be exercised in the selection and use of ingredients.

2. Process Technology

2.1 Raw material storage:-

Norms for appropriate storage of raw materials were established to avoid contamination with foreign matters, spillages, fire hazards etc.

2.2 Weighing of raw materials:

Importance of accurate weighing and technique of master batching for ingredients required in smaller quantities were practiced.

2.3 Processing of Natural Rubber based compounds:-

2.3.1 Mastication:

Proper pre-mastification of natural rubber was practiced to achieve best dispersion of ingredients during mixing operation.

2.3.2 Master batching:

This operation was introduced to get (a) best dispersion particularly for those ingredients which are difficult to disperse (b) accurate weighing of ingredients required in smaller quantity like accelerators (c) batch to batch consistency.

2.3.3 Mixing of ingredients:

Norms were established for speedy and efficient dispersion of ingredients in pre-masticated natural rubber. Importance of proper dispersion of reinforcing fillers like Carbon Black and the method to achieve best dispersion was practiced. The ingredients were incorporated in a definite order so that mixing operation was easier, faster and efficient. Overnight storage of rubber compounds was advised and practiced. The addition of vulcanizing agent i.e. sulphur was carried out on the next day, prior to winding operation. This practice yielded best dispersion and improved processing safety. Precautionary measures such as avoiding contamination with old compounds stuck in the mixing mill guides, proper cooling and storage of compounds etc. were practiced and recommended.

2.4 Processing of Synthetic Rubber based compounds:-

2.4.1 Master batching:

Two types of master batches were practiced; (a) Master batching of sulphur was carried out so as to get best possible dispersion which is otherwise difficult to be dispersed in NBR type synthetic rubber; (b) Master batching of accelerator was practiced which enabled accurate weighing, better batch to batch consistency and improved dispersion.

2.4.2 Mixing of ingredients:

Proper method of mixing was established so that the ingredients get thoroughly dispersed. Addition of ingredients was carried out in a definite sequence. e.g. the sulphur master-batch was added in the begining. Addition of precipitated silica was carried out in two lots, the second half being mixed along with plasticizer D.O.P. Mixing of ingredients like accelerator in master-batch form was carried out just before winding of rollers and after overnight storage of the rubber compound. This enabled better dispersion and maximum processing safety. Wastages due to scorching of compounds was thus prevented.

2.5 Preparation of shells for bonding:-

Machining of used cast-iron shells or drums was carefully carried out so that fresh base metal is available for bonding. Defective shells were dis-carded. The approved shells were cleaned and degreased by wiping with petrol. For making ~~natural~~ natural rubber based rollers, the shells were then given three coats of Ebonite Solution. Care was taken to allow enough time for complete evaporation of the solvent after each coat. Ebonite sheet compound in 1-1.5mm thickness was then applied on the shells. Use of chemical bonding agent was established for synthetic rubber based rollers. In this case, the shells were first machined and degreased with petrol, followed by shot blasting using the shot blasting machine. The shells were then wiped

with petrol, followed by application of the bonding agent Unilock 205. Maximum care was exercised to obtain a thin, even coat, free from any contaminations. The shells were then allowed to dry and were stored in a clean environment.

2.6 Winding operation:-

This operation was carried out using the winding machine along with 14" size mixing mill. Maximum care was taken to avoid air entrappment and scorching. Use of an extruder instead of winding machine would have been faster and would have produced rollers free from defects like air entrappment, possible delaminations, scorching, wastages etc. This was discussed in detail with the counter parts and they all appreciated the point.

2.7 Pressing and clamping:-

The rollers duly wound were then put into the horizontal moulds which were pre-treated with dispersion of french chalk for easy mould release. They were then pressed using the hand press and clamped with bolts. The moulds were then transferred into the vulcanizer for curing.

2.8 Vulcanizing:-

This was carried out under open steam at 4 atm. steam pressure for four hours. Importance of parameters like vulcanizing time and temperature was discussed.

2.9 Machining of rollers:-

Machining of rollers, using appropriate cutting tool, job speed and correct fixtures was practiced so as to obtain faster machining with better surface finish.

2.10 Training of counter parts:-

The counter parts were properly trained in all the process functions detailed above. They all well understood and appreciated the importance of the process parameters and how to achieve proper quality control

during master batching, addition of ingredients in predetermined sequence, metal pre-treatment, winding, clamping, vulcanising and machining operations.

2.11 Test procedures:-

Required testing methods were established and the counter parts were trained satisfactorily in them. Each batch of rubber compound was tested prior to taking it into production. A small sample piece weighing about 200 grams was taken from each batch. From the sample piece blanks were cut to required size and were moulded at constant pressure for pre-determined time and temperature. The test slabs thus moulded were allowed to mature for 24 hours followed by testing of hardness by hardness tester and physical properties like tensile strength, elongation at break and modulus at 100% elongation using tensile testing machine. Only approved batches were then taken into production. Periodic testing of abrasion resistance was practiced using the abrasion resistance test machine.

3. Production Technology

3.1 Method of production:-

Technologies for production of rollers based on natural rubber and synthetic rubber were well established. This involved following production operations:

3.1.1 Preparation of shells:-

This involved proper machining of old, used cast iron shells so as to remove old rubber, corroded metal surface and to expose the fresh base metal. The shells were inspected. Defective shells were discarded. The exposed metal surface was then treated with petrol for degreasing. The shells were then applied with ebonite solution followed by coating with ebonite sheet for natural rubber rollers. For synthetic rubber rollers, the machined shells were shot blasted, wiped with solvent and applied with chemical bonding agent, as detailed earlier under 2.5.

3.1.2 Sheeting and winding:-

Rubber compounds after storage of minimum 24 hours were mixed with remaining curatives on two roll mill. Precautions were taken to keep the mixing mill rollers from being heated up excessively, by passing the cooling water continuously. However the supply of cooling water to the mill was not adequate. Methods of improvement were suggested. Using the smaller sheeting mill, the rubber compound was sheeted to about 1.5mm thick. The winding machine was used for winding up the sheeting on the prepared shells as per 3.1.1. In case of natural rubber based rollers, the surface of ebonite layer was fresheded up with petrol prior to winding. This was not necessary for synthetic rubber based rollers in which case the shells were applied with chemical bonding agent.

3.1.3 Moulding and vulcanizing:-

The shells duly wound with rubber sheeting were placed in the horizontal moulds after cutting the extra length

of rubber compound. The end cuttings were immediately used up for sheeting up and winding. The moulds were pressed and clamped using the hand pressing jig as detailed under 2.7. Precautions were taken to ensure that the mould cavities were fully filled up and flow of extra rubber had started from the sides. The clamped moulds were transferred into the vulcanizer and were cured as detailed under 2.8. The rubber seal for the vulcanizer head was of poor quality resulting in steam leakages and needed frequent replacement. The counter parts were advised to improve upon this problem. The rollers after vulcanizing were allowed to cool down to room temperature before machining and finishing.

3.1.4 Finishing:-

The vulcanized rollers were first machined up on lathe to a rough finish. Finishing was carried out in a second operation using a finer cut. Some of the rollers required excessive machining and hence got undersized by 2-3mm. This was due to damaged moulds which was well appreciated by the counter parts.

3.2 Training:-

The counter parts were well trained in all unit production operations. Methods for increasing the production whenever required, were advised. The counter parts were warned against all the possible causes which can lead to defective rollers. Norms for quality controls at various stages of production were established so that defects like bond failure, delaminations etc. can be minimized.

3.3 Testing of rubber rollers in Rice Mill:-

Both natural and synthetic rubber based rollers were tested on dehusking machines at Yen My Rice Mill. The rollers performed satisfactorily during the field trials. The machine operated smoothly, yielding higher recovery rate and less broken rice. The rollers met with the required technical parameters. This is

referred under Appendix-6. Precautionary measures as follows were suggested by the experts in order to achieve still better performence.

i) Foreign matters like pieces of stones, nails, worn-out parts etc. should be effectively separated before the paddy enters the dehusking machine.

ii) Provision of air blower in the dehusking machine so that the rubber rollers run cooler.

iii) Use of polisher machine equipped with rubber blocks to minimize breakages of rice during polishing operation.

TERMINAL SECTION

TERMINAL SECTION

The analysis of the currently used formulation based on natural rubber showed that it is technically interior because it is based on usage of high percentage of sulphur. The new formulations recommended by the Indian Experts are based on use of highly reinforcing fillers such as HAF Carbon Black. Sulphur percentage was restricted to a much lower value, just enough to achieve optimum state of vulcanization. The rollers based on these recommendations yielded improved performance on dehusking machines.

New formulation based on synthetic rubber was designed for rollers of non-black colour. These rollers also performed well and yielded much improved life span.

In this way, rollers based on recommendations of Indian Experts performed satisfactorily. They met with required technical parameters such as improved life span, lesser percentage of broken rice and higher recovery rate.

APPENDIX

Appendix - 1

Currently used formulation based on Natural Rubber

		Parts by weight
Natural Rubber	...	100.0
HAF Carbon Black	...	45.0
Magnesium Oxide	...	5.0
Zinc Oxide	...	7.0
Sulphur	...	17.0
Calcium Carbonate	...	10.0
Stearic Acid	...	2.5
Wood Rosin	...	3.0
Clay	...	45.0
Anti-oxidant D (PBN)	...	1.0

Appendix - 2

Available Raw-materials

1) Natural Rubber

2) HAF Carbon Black

3) Clay

4) Magnesium Oxide

5) Zinc Oxide

6) Calcium Carbonate

7) Stearic Acid

8) Wood Rosin

9) Anti-oxidant D (PBN)

10) Accelerator D (DPG)

11) Accelerator DM (MBTS)

12) Accelerator Thiuram (TMTD)

13) Red Iron Oxide Fe_2O_3

14) Petrol

15) French Chalk

Appendix - 3

First formulation based on Natural Rubber as per Indian Experts' recommendations

		Parts by weight
Natural Rubber	...	100.0
Zinc Oxide	...	5.0
Stearic Acid	...	1.0
HAF Carbon Black	...	90.0
Wood Rosin	...	4.5
Anti-oxidant B (PBN)	...	1.0
Accelerator DM (MBTS)	...	0.45
Sulphur	...	3.6

Appendix - 4

Second formulation based on Natural Rubber as per Indian Experts' recommendations.

		Parts by weight
Natural Rubber	...	100.0
Zinc Oxide	...	9.0
Stearic Acid	...	2.7
HAF Carbon Black	...	99.0
Wood Rosin	...	4.5
Anti-oxidant D (PBN)	...	1.8
Accelerator DM (MBTS)	...	0.45
Sulphur	...	3.6

Appendix - 5

Non-black formulation based on Synthetic Rubber recommended by the Indian Experts.

		Parts by weight
Synthetic Rubber (NBR)	...	95.0
Natural Rubber	...	5.0
Sulphur	...	4.5
Zinc Oxide	...	5.0
Stearic Acid	...	1.0
Precipitated Silica	...	63.0
Phenolic Resin (Pipeolite)	...	20.0
Titanium Dioxide	...	5.0
Anti-oxidant AW	...	1.2
Wood Rosin	...	2.0
Dioctyl Phthalate (DOP)	...	3.0
Accelerator CZ (CBS)	...	0.9
Activator P-4	...	1.2
Reinforcing Agent P-900	...	4.5

Appendix - 6

MINUTES

Review meeting on rubber Roller Manufacture between Sudhgaad Company, India and Yen My Rice Mill of Ministry of Agriculture and Food Industry, Vietnam.

The Review Meeting was held on August 2nd, 1989 at 14h00 at Yen My Rice Mill, Ministry of Agriculture and Food Industry.

Participants:

Vietnamese side:

1. Do Dac Phuc, Director, Yen My Rice Mill, Ministry of Agriculture and Food Industry.
2. Do Khac Chuong, Deputy Director, Yen My Rice Mill, Mill
3. Do Thi Kha, Chief of Quality Control Section, Yen My Rice Mill
4. Nguyen Thi Trieu, Chief of Technical Section, Yen My Rice Mill
5. Pham Thi Phuoc Hao, Expert, International Cooperation Department, Ministry of Agriculture and Food Industry
6. Ho Minh Chau, Programme Officer, International Cooperation Department, Ministry of Agriculture and Food Industry
7. Nguyen The Vinh, Officer, Laboratory or Controlling Rubber Roller, Yen My Rice Mill
8. Le Nguyen Thanh, Chief of Rubber Roller Manufacturing Workshop.

Sudhagad Company, India:

1. Shah Bharat Champaklal
2. Bhagye Vijay Purushottam
3. Divekar Tri Pak Madhu.

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<u>Content</u>

The Rice Mill Director review the situation on Rubber Roller manufacture based on Sudhagad Company's formula:

I. <u>Natural Rubber</u>: 8 Rubber Rollers were manufactured based on Sudhagad Company's formula.

II. <u>Formula 1</u> : 4 Rubber Rollers were assembled on Rubber Roller Dehusker and went through a test run from 20/7-26/7/89. The average life span is 122,296 ton of paddy/pair.

<u>Formula 2</u> : 4 Rubber Rollers were assembled on Rubber Roller Dehusker and went through a test run from 27/7-1-8-89. The averaged life span is 135 ton of paddy/pair.

II. <u>Synthetic Rubber</u>: 14 Rubber Rollers were manufactured. The averaged life span is 201 ton of paddy/pair

<u>Conclusion</u>

Generally speaking, the duration of test run is limited, hence, the data are not precise but the Rubber Roller Dehusker operates smoothly. Recovery rate is high, broken rate is less, Rubber Rollers meet technical parameter.

Attitude of experts in working: The Director highly appreciate the enthusiastic spirit and closed cooperation of the experts of Sudhagad Company with the workers and engineers of [illegible] Rice Mill. The Director also express his satisfaction on above mentioned result.

Representative of Sudhagad Company
Mr. [illegible]
Sd/-

Director,
[illegible] Rice Mill
[illegible]
Sd/-
Representative of [illegible]
[illegible] Thi Phuoc [illegible]
Sd/-