NOTES ON DEFECTS IN SMOKED SHEET AND CREPE RUBBER.

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In the following paragraphs a general account is given of the characteristics and the nature of commonly occurring defects in smoked sheet and crepe rubber, and of the principles underlying methods for their prevention as recommended for estate practice. Many of the defects referred to have no harmful effect on the quality of the rubber after vulcanisation, and in the majority of cases the only reasonable excuse for their classification as defects is the unsightly appearance which they impart to the raw product. Since, however, standards of quality at present imposed by the Market are based largely on appearance alone, methods have to be devised to prevent the occurrence of these defects.

A. Smoked Sheet.

1. Moulds.

Moulds and mildew are higher forms of fungi or micro-organisms which, by chemical changes essential to their growth, are capable under favourable conditions of acting on organic substances with which they are in contact. The changes themselves are complicated processes and they are influenced by external conditions such as temperature, moisture, and the presence or absence of oxygen, all of which conditions can be controlled by artificial means. Freshly machined sheet rubber is always rich in the spores of these organisms, and for their growth, adequate supplies of food materials are necessary, even the very small amount of proteinous serum substances which are always present in sheet rubber being sufficiently rich in carbon and nitrogen to foster the growth of mould. A certain amount of nitrogen is also assimilated from the air.

In view of the fact that their growth is influenced by the above mentioned conditions, methods for the prevention of the development of moulds in the first place aim at storage of the prepared sheet in as dry an atmosphere as possible. The temperature of the atmosphere during storage cannot well be regulated in ordinary practice, nor can the presence of oxygen be avoided since the sheets are always stored in the presence of air, and thus it has become

necessary in addition to treat the sheets with antiseptics which retard the development of the moulds. The practice of smoke-drying the freshly machined sheets is extremely beneficial in this respect, since a certain amount of antiseptic creosotic substances contained in the smoke is absorbed by the sheets, and, provided that a sufficiently long period of smoke-curing is employed, there is seldom any necessity for further antiseptic treatment. At present, however, there is an unfortunate tendency to work with shorter periods of smoking than were at one time employed, with the result that the maximum of benefit is not derived from the smoke-curing process, mouldy sheet is thus more in evidence, and additional treatment involving the expenditure of time and money has to be given. It is probable that if the majority of estates were to give the sheet an extra three to four days' smoking much of the present trouble with moulds would be avoided.

The additional treatment referred to consists of the use of para-nitrophenol as an antiseptic, there being two different methods whereby the treatment may be carried out. As the use of this substance is widely practised by estates in Malaya these methods are here described in detail.

(1) *Addition to Latex.*—Para-nitrophenol is soluble to the extent of 3 per cent. in water at 40°C. and hence in effecting solution sufficient time must be given for the substance completely to dissolve. A stock solution of 1 per cent. strength is made and the insoluble impurities which are always contained in the commercial product are removed by filtration through a fine cloth. This solution is then added to latex, standardised to a rubber content of $1\frac{1}{4}$ to $1\frac{1}{2}$ lbs. per gallon, at the rate of 1 volume to 60 volumes of latex. It may be mixed with the latex prior to the addition of the coagulant, or a mixture of the correct quantities of para-nitrophenol solution and coagulant may be added. It may be used in conjunction with acetic acid or with formic acid.

(2) *Soaking Method.*—According to this method a 0.1 per cent. stock solution of the antiseptic is made by dissolving it at the rate of $3\frac{1}{4}$ ozs. of the solid to 20 gallons of water, the same precautions being taken to effect a clear solution. The freshly machined sheets are then placed singly in the solution contained in a suitable receptacle and are allowed to soak for half an hour. They are then removed and allowed to drip for about two hours on racks placed in the open in a well ventilated and shaded site, before being transferred to the smoke-house.

Complete immersion of all the sheets may be ensured by placing boards or planks on top of them, and, by placing them

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singly in the solution, the whole of the surface of each sheet comes in contact with the antiseptic. Care must be taken, however, not to overcrowd the sheets during immersion merely to economise in space—3¼ ozs. of the solid para-nitrophenol dissolved in 20 gallons of water is sufficient for the treatment of two batches of sheet of 100 lbs. each. If only one batch of sheet is treated on one day, the solution may be kept for the treatment of a batch of the same size on the following day, the solution being then discarded and a fresh solution used for the treatment of further quantities of sheet.

Notes.—

(a) Para-nitrophenol is usually shipped in drums and is in the form of a cake containing a certain amount of moisture. The most convenient method of handling it is to place the cake in a suitable receptacle such as a Shanghai Jar for about two days, after which it can easily be crushed to a powder.

(b) Samples of sheet treated with this antiseptic may be sent to the Institute for tests for the development of mould. In doing so, the method of treatment should be described.

(c) The sheet should be packed as soon as possible after removal from the smoke-house, preferably after ten o'clock in the morning when the atmosphere is warm and less damp than in the earlier hours. Sheet which is stored in the open absorbs moisture more rapidly and to a greater extent than sheet which is packed, and moisture absorption increases the liability to mould development. All cases should be sun-dried before being packed and, after packing, should not be stored in direct contact with a cement floor. If sheet has to be stored on the estate and the store is badly sited, it may be necessary to adopt both methods of application of para-nitrophenol.

(d) The addition of para-nitrophenol directly to the latex before coagulation on certain estates seems to be associated with the production of bubbles in the prepared sheet. The reason for this is not yet definitely known and the subject is at present under investigation by the Institute.

(e) The results of recent experiments on the development of moulds in smoked sheet and in air-dried sheet are to be incorporated in a special Bulletin.

2. Bubbles.

Bubbles in sheet rubber are commonly spoken of as air-bubbles or as air-bells, but in the large majority of cases these bubbles

contain larger proportions of other gases such as carbon dioxide, nitrogen, and hydrogen than are normally present in air, and hence it is more correct to speak of them as gas-bubbles. The bubbles usually found in smoked sheet are very small, in some cases microscopic in size, and may be easily observed when the sheet is examined by transmitted light. They may be evenly distributed in the interior of the sheet or may occur in patches, sometimes only on one of the long sides of the sheet, and when examined by reflected light white patches are seen at those parts containing the bubbles, almost giving the impression that the sheet is not completely dry.

In nearly all cases gas-bubbles are formed as the result of fermentative changes which take place either in the latex or in the wet coagulum prior to machining. Rubber latex normally contains a large number of bacteria and other micro-organisms which are capable of acting on the serum constituents of the latex so as to produce changes which result in the formation of minute quantities of gases and in the appearance of bubbles in the prepared sheet. These changes may take place in the latex at any stage of the process from tapping of the trees to the stage which immediately precedes the machining of the wet coagulum, and hence it is essential that there is as little delay as possible in the collection of the latex, its transportation from the field to the factory, and thereafter in the addition of the acid coagulant. Fermentative changes are very liable to occur when the trees are tapped after heavy rainfall, as the latex then becomes infected with bacteria which are washed into it from the bark in the vicinity of the tapping cut, and the extent to which fermentation may take place in a latex depends, among many other factors, upon the locality from which it is obtained, the character of the soil in the locality, the season of the year during which tapping is carried out, the system of tapping followed, and the physiological characters of the tree. On some estates the unexpected appearance of bubbles in sheet which for a long time has been free of them, and the equally unexpected disappearance of the trouble, is not an infrequent occurence.

Methods for the prevention of bubble formation aim at producing in the latex a medium unfavourable to the action of the ferments by the addition of an anti-coagulant substance, in the use of which very satisfactory results have been obtained by the addition of an aqueous solution of sodium sulphite. A stock solution is prepared by dissolving 1 lb. of anhydrous sodium sulphite in 3 gallons of water and is used at the rate of 5 fluid ounces per 4 gallons of latex. This formula applies to its use both in the

field and in the factory. Its use serves a double purpose, as not only is it useful in the inhibition of fermentative changes, but it possesses in addition anti-coagulant properties, and thus makes possible the output of a crop consisting of the maximum amount of first grade rubber and the minimum of coagulated "lump". It cannot be too strongly emphasised that fermentation in a latex may begin very soon after tapping, and if these fermentative changes are allowed to proceed to a sufficiently advanced stage while the latex is in the field, the addition of sodium sulphite in the factory only will not prevent the formation of bubbles. In such cases it must be used in the field as described above, and a little of the anti-coagulant solution must also be poured into the cups and a few drops allowed to run down the tapping cut. The addition of a solution of formalin to the latex serves the same purposes as sodium sulphite and also gives very satisfactory results. In its use, however, precautions have to be taken to ensure that an excess is not added, as otherwise it has a harmful effect on the rubber.

It will be evident from what has been said above that all utensils used for the handling of the latex both in the field and in the factory must be clean, and that a plentiful supply of clean water for factory operations is essential. In this connection it may be pointed out that it is a matter of great difficulty to remove small pieces of coagulated rubber and fermentable serum products which lodge in the fissures of wooden coagulating tanks and partition boards, and this is the basis of one of the arguments which can be advanced in opposition to the use of such tanks. The same remarks apply with equal force to the case of tanks lined with glazed tiles unless the interstices between the tiles are filled in with a suitable cement. Particulars of such cements may be had on application to the Institute. When coagulation is carried out in large tanks it is often found that bubbles occur on only one of the long sides of the sheet. This corresponds to the side of the coagulum which was nearest to the bottom of the tank, and the bubbles are produced as the result of anaerobic fermentation—that is, fermentation which takes place in the absence of air.

In preventing bubble formation care must be taken to use the correct quantity of acid coagulant and to ensure that thorough mixing of the coagulant and latex is effected.

Reference may be made to what are commonly spoken of as "blisters", which are produced as the result of over heating in the smoke-house particularly in the early stages of the smoke-curing process.

3. "Rust".

It is sometimes found that on stretching a piece of smoked sheet rubber and allowing it to recover after stretching, a brownish coloured powder appears on the surface at the part which has been subjected to stretching, while in a few cases the powder may be observed on the surface even before the sheet is stretched. On account of its appearance this powder is commonly spoken of as "rust", and is probably formed as the result of the decomposition by micro-organisms of the serum substances which exude from the sheet after it has been machined. An investigation is at present being carried out by the Institute with a view to the isolation and the identification of the micro-organisms responsible for this decomposition and with the object of establishing the chemical nature of the constituents of the "rust".

It has already been shown that of a batch of sheets prepared on the same day and under the same conditions, those which were stored in a moist atmosphere for a period of two days after machining became covered with a thick coating of "rust", while those of the same batch stored in a moist atmosphere containing a little of the vapour of formalin were entirely free from this defect. This result and others already obtained indicate that the presence of moisture is favourable to the growth of "rust", and that its development may be checked by suitable antiseptic treatment of the freshly machined sheets. The temperature of the atmosphere usually maintained inside a smoke-house is also very favourable to its growth.

In the majority of cases, therefore, methods for the prevention of "rust" aim at rapid surface-drying of the sheet, and hence it is recommended that, after machining, they be hung to drip for about two hours on racks placed in the open air and in a shaded site, after which they should be transferred to the smoke-house, the temperature of which in the initial stages of smoke-curing should be higher than in the final stages. The temperature should be maintained between 110° and 120°F. In more severe cases an antiseptic must be used, and in this connection it has been found that soaking the freshly machined sheets for half an hour in an 0.1 per cent aqueous solution of para-nitrophenol, the treatment being the same as that used for the prevention of moulds, is effective in preventing the formation of "rust". After removal from the bath of para-nitrophenol solution, the sheets are allowed to drip in the open for two hours as outlined above before being transferred to the smoke-house.

B. Crepe.

1. "Spot" Disease.

Pigmented spots in crepe rubber are produced by the growth under suitable conditions of fungi, the spores of which are always present in abundance in freshly machined crepe rubber. These spots may be of different colours,—red, orange, yellow, blue, green, violet, and black—although violet spots are of the most frequent occurrence. As in the case of moulds on sheet rubber these fungi require suitable conditions of temperature and moisture for their development, although in the latter case simpler methods suffice to prevent their growth.

Bearing in mind that only in the presence of air and under favourable conditions of temperature and moisture will the fungi develop, it will be seen that the following factors will promote the production of coloured spots on crepe.

(a) *Delay in transferring the freshly-machined crepe to the drying sheds.*—It is necessary that there be as little delay as possible in this operation, and the crepe should be hung in the drying sheds on the day on which it is machined. The object should be to dry the crepe as quickly as possible in order to produce conditions inimicable to the growth of the organisms at an early stage. Very many cases of "spot" disease have been found to be due to neglect in this direction.

(b) *Inefficient ventilation in the drying sheds.*—Drying sheds are best constructed of corrugated iron which is a good conductor of heat, and the ventilation should be such as to ensure a good upward current of air within the drying chambers.

(c) *Excess of sodium bisulphite.*—In crepe manufacture sodium bisulphite is widely used in order to produce a crepe of pale colour. It is a hygroscopic salt, and if too large a quantity is added to the latex, it will absorb moisture from the atmosphere and retain it on the surface of the crepe.

(d) *Insufficiency of sodium bisulphite.*—Sodium bisulphite has an antiseptic action towards fungi and the correct quantity must be added to the latex before coagulation. The sodium bisulphite should be added at the rate of 1 lb. of the salt dissolved in 10 gallons of cold water to 100 gallons of latex standardised to a rubber content of 1½ lbs. per gallon in the case of pale crepe manufacture, and 2½ lbs. per gallon in the case of sole crepe manufacture.

(e) *Excessive thickness of the crepe.*—A thick crepe contains a higher proportion of moisture than thin crepe, and hence the coagulum should be machined as thinly as is consistent with the production of a crepe of good even texture.

(f) *Storage of the dry crepe under damp conditions.*—Storage in direct contact with a cement floor is frequently a cause of dampness of the finished crepe.

If the recommendations outlined above are followed there is seldom any necessity for further treatment. In special cases, however, an antiseptic substance must be used, an effective method being to soak the freshly machined crepe for half an hour in a bath of formalin of 1 per cent. strength before transferring it to the drying sheds. This treatment is not a sufficient safeguard in itself, and attention must be paid to the other details of manufacture to which reference is made above.

2. Tackiness.

Tackiness or stickiness in first grade rubber is very seldom met with at the present day, whereas a slight stickiness of the surface of lower grade crepes such as "compo" crepe and rather more severe cases of tackiness in "earth scrap" crepes are of frequent occurrence. Rubber which has become tacky is rightly regarded as defective, since tackiness involves changes in the chemical and physical structure of the rubber, which in severe cases are sufficient to affect detrimentally the quality of the rubber after vulcanisation. Such deterioration may be brought about in various ways but it is sufficient here to consider only those which occur in ordinary plantation practice.

In the case of the "earth scrap" and "bark shavings" from which lower grade crepes are manufactured, the rubber before arrival at the factory becomes infected with a large number of micro-organisms which are found in the soil and in the bark of the tree, and which are capable of producing fermentative changes in the rubber resulting in a condition of tackiness of the whole or part, depending on the extent to which these changes have taken place. Moreover, it is known that in the presence of air, exposure to the sun's rays and to heat produces this kind of deterioration, and it is evident that the raw material for the preparation of lower grades is so exposed while it is in the field. Hence, since rubber which is subjected to excessive mastication between the machine rolls is liable to become tacky, it will be appreciated that in dealing with lower grades the extent of the mastication treatment is a very important point indeed, the raw material on arrival at the factory having in the majority of cases already deteriorated to a consider-

able extent. Lower grade crepes should therefore be thicker than crepes of the first grade in order that the rubber may receive as little machining as is consistent with the production of a crepe of good appearance and uniform texture. In addition to the usual battery of crepeing machines, a scrap-washer is essential for the manufacture of these grades, and it is well to collect the raw material from the fields as frequently as possible, to cleanse it thoroughly on arrival at the factory, and, if machining cannot be proceeded with until some time afterwards, to store it under water, which must be changed periodically in order to keep it fresh and to remove dissolved putrescible substances. It is often found that if large piles of "bark shavings" are left standing exposed to the air for a few days the interior of the mass becomes quite hot, and this generation of heat may be sufficient to lead to tackiness in the final product. When practicable, the raw material should be converted to crepe form as soon as possible.

Tackiness may also be brought about by specific chemical agents, the presence of minute quantities of copper in the rubber being sufficient to bring about this deterioration. Contamination with copper is frequently brought about by brass filings carried by oil from worn bearings which accidentally comes in contact with the rubber while it is being machined. Again, acetic acid such as is used for coagulation occasionally contains traces of copper salts, since in the preparation of the acid of commerce it is usual to distil it from copper stills. Even as small a quantity as 0.01 per cent of a copper salt added to latex is sufficient to produce deterioration in the final product.

3. Yellow Crepe.

It is frequently found that the latex from young trees is of a noticeably yellow colour, while a yellow crepe is often produced from latex obtained during the early stages of tapping on a new cut. Again, in the periodic system of tapping the crepe may be yellow in colour for some days, when tapping is commenced after a period of rest. The yellow colour is due to the presence of a naturally occurring vegetable pigment in the latex, and it may be said here that investigations have been carried out by the Institute with the object of identifying this pigment and that the results will be published shortly in Bulletin form.

An increase in the amount of sodium bisulphite added to the latex will not reduce the depth of the colour, but by the usual methods of fractional coagulation adopted in the manufacture of sole crepe, most of the yellowing colouring matter may be removed in the first coagulum, a very pale coloured crepe being obtained from the second fraction.