PREVENTION OF FUNGAL GROWTH ON RUBBER EARPADS OF TELECOMMUNICATION EQUIPMENTS

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This paper recommends an addition of 10% zinc oxide to the rubber composition during its manufacture to effectively prevent fungal growth on the earpads without producing any adverse effect on its material/performance or the user.

The problem of fungal growth on the rubber earpad covers of head gear assemblies of telecommunication equipment was referred to the Defence Research Laboratory (Materials), Kanpur by the Chief Inspectorate of Electronics, Bangalore. Both natural rubber[1] and synthetic rubbers[2] are known to be attacked by microorganisms under favourable conditions of temperature and humidity. The degree of growth on the two types of rubber varies[3] considerably. In the earlier work on mould growth on respirator gas masks[4], carried out at DRL (M), Kanpur, as many as 18 fungi were isolated from infected respirators. Most of the isolated fungi belonged to the *Aspergillus* group, some of which are known pathogens causing infection of the human ear, lungs, liver and kidney[4]. Apart from the clinical aspect of the problem, the fungal growth on rubber/rubberised components of the telecommunication and electronic equipments create a demoralising psychological effect on the operators who begin to doubt the performance of the equipment. The mildewed appearance in itself becomes repulsive to the user.

EXPERIMENTAL PROCEDURE

Samples of four rubber earpads were obtained from M/s Indian Telephone Industries Ltd, Bangalore through the Chief Inspector, Chief Inspectorate of Electronics, Bangalore. One of these was charged with a mixed spores suspension of six test fungi (in accordance with UK Specification No. K-114). The charged specimen was kept inside a humid box and incubated (at a cyclic temperature of 25°C±2°C and 95% R.H. for 6 hr and 29°C ± 2°C and 90% R.H. for 18 hr a day) for 30 days. The test sample was then examined for fungal growth. It was covered with growing fungi [Fig. 1 (B)]. An additional piece of earpad was cut into four pieces and similarly tested and found overgrown with the test organisms on all sides including the cut surfaces.

To develop a suitable method for prevention of fungal growth, it was considered necessary to select such fungicides which are compatible with the chemical constituents of rubber, so that they may not adversely effect the quality of the product. There are three chemicals in the different rubber compositions which are fungicidal in action. However, their concentration is so low as to be ineffective for preventing mould growth. Two of these, mercaptobenzthiazole (Valcafar MBT) and dibenzthiazyldisulphide (Valcafar MBTS) are used as accelerators in concentrations of approximately 0·5% and the third zinc oxide is used as a filler in concentrations ranging from 5–10%. As is evident from the

available literature and the experiments conducted in this laboratory, the rubber products having these chemical constituents are susceptible to mould growth. Therefore, it was decided to increase the concentrations of these fungicidal chemicals to such limits which neither affect the quality of the rubber nor the higher concentrations become injurious to the user.

Among these, zinc oxide is considered harmless to human skin even at concentration of 20% and above as it is extensively used in skin ointments as base. The other two chemicals, i.e. Valcafar MBT and Valcafar MBTS may prove to be hazardous in higher concentrations. The following concentrations of the three chemicals were tried in the laboratory :

Zinc oxide—5, 10 and 15%
Valcafar MBT—0·5, 1·0 and 1·5%
Valcafar MBTS—0·5, 1.0 and 1·5%.

Evaluation of these chemicals was carried out by using the spore germination[5] and the agar plate methods. The chemicals in the required concentrations were mixed in PDA medium in 4 in. diameter petri dishes. The spores suspension was spread on the surface and incubated for 150 hr. Four replicates were taken for each concentration. With every batch a set of four petri dishes were kept as control without fungicide. Observations were recorded at 24, 48, 72, 96, 120, 144 and 150 hr. Germination of the spores was noticed on the control plates whereas the medium with the effective fungicidal concentrations did not develop any fungal growth even after 150 hr of incubation.

RESULTS AND DISCUSSION

Of the three chemicals tested in the concentrations mentioned earlier, it was observed that even at 1·5% concentration the two accelerator chemicals, i.e. Valcafar MBT and Valcafar MBTS were ineffective after 96 and 48 hr of incubation respectively, whereas 10% zinc oxide was found to be effective even after 150 hr of incubation. In view of the above findings, higher concentrations of Valcafar MBT and Valcafar MBTS were not tried. Zinc oxide could be used up to 20% or even higher in the composition without making any appreciable change in the texture and softness of the finished product. A higher concentration of 25% or above does not produce any adverse effect on the material except that it imparts slight hardness to the finished product. Besides this, zinc oxide is considered quite safe at the recommended concentration as it is used on a large scale and in much higher concentrations as a base in clinical ointments, tooth pastes and adhesive plaster tapes (zinc oxide tapes), etc. Even in close contact, it is not likely to cause any irritation to or produce any lesion on the human skin. Keeping in view the above facts it was decided to incorporate an additional 10% zinc oxide in the rubber composition so as to bring the minimum concentration of zinc oxide to about 15% and evaluate the prepared samples for mould growth (as per British Standard Specification K-114).

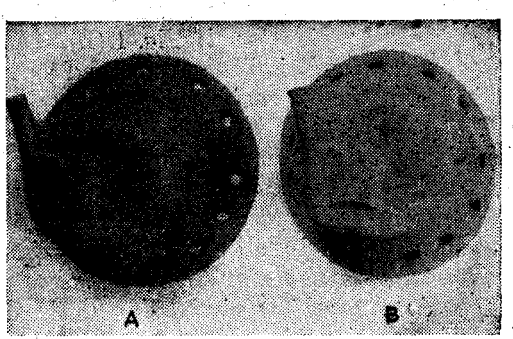

Fig. 1—Earpad (A) without fungal growth (B) with fungal growth.

M/s Indian Telephone Industries Ltd, Bangalore were requested to prepare the rubber sheets having a minimum of 15% zinc oxide in the rubber composition, (the original samples were having only 5% zinc oxide as filler), and forward to us for evaluation. Two such sample sheets measuring $12'' \times 12'' \times 1/10''$ and $6'' \times 6'' \times \frac{1}{4}''$ were prepared and forwarded to us by M/s Indian Telephone Industries Ltd, Bangalore.

The samples were cut into 1 in. square pieces. Six replicates were taken from each of the two samples. A sample piece of earpad obtained earlier was cut into six pieces to serve as control replicates. All the replicates prepared from the rubber sheets with 10% additional zinc oxide as well as of the control set were then charged with a mixed spores suspension of the fungi used earlier and then put for incubation in humid box placed inside the tropic room for a period of three months. Observations were made at intervals of 15 days. The control samples (with 5% zinc oxide) developed profuse fungal growth within 30 days but no such growth could be observed on test samples containing 10% additional zinc oxide even after 90 days of incubation. The findings were confirmed by repeating the experiment.

The addition of 10% zinc oxide in the basic composition, so as to bring the total concentration to about 15%, has been found to be adequate for prevention of fungal growth on rubber components. This amount of chemical is much below the concentration (25%) which imparts slight hardness to the material. Samples with 15% zinc oxide are quite soft and do not differ much in appearance, pliability and hardness from the rubber pieces prepared with lower concentration of the filler chemical.

On the basis of these findings, recommendations have been made to the Chief Inspectorate of Electronics, Bangalore and Indian Telephone Industries Ltd, Bangalore for incorporation of additional 10% zinc oxide in the rubber composition in order to prevent fungal growth on rubber components of electronic equipments like earpads for telecommunication sets, mine detectors etc.

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REFERENCES

1. "Fungus Growth on Rubber, Neoprene and Butadiene-Acrylonitrile Type of Synthetic Elastomer" [Du Pont de Nemours (E.I.) and Company, Wilmington, Del.], May 1942.

2. ZO BELL, CLAUDE E., & JOSEPHINE, D. BECKWITH, *J. Amer. Water Works Assoc.*, 36 (1944), 439–53.

3. BLAKE, JOHN T., DONALD W. KITCHIN & ORISON S. PRATT, *Elec. Eng.*, 69 (1950), 782–87.

4. **"The Control of Mould Growth on Respirators"- Technical Report No.Bio/53/80, by Technical Development Establishment Laboratories, Kanpur (Directorate of Technical Development Master General of Ordnance Branch, Army HQ, New Delhi), 1953, May.**

5. **"A rapid Method for the Assessment of Fungicides"- Technical Report No. Bio/53/81 by Technical Development Establishment Laboratories, Kanpur, (Directorate of Technical Development Master General of Ordnance Branch, Army HQ, New Delhi), 1953, Oct.**