Correspondence

The Wear of Magnetic Recording Tape and Solubility of the Binder*

The ability of magnetic recording tape to perform satisfactorily after repeated use is a characteristic of critical importance in computer service. Wear tests of tapes are time consuming and have not always shown good agreement in the rank ordering of tape between different transport mechanisms and different criteria of end of life. The ability to withstand repeated use is governed to a certain extent by the composition of the binder and its adhesion to the plastic backing. Since the solubility of the binder in various solvents depends on its composition, experiments were run to see how well solubility could be correlated with wear. This communication is to bring attention to this work which is reported in more detail in other reports.[1,2]

The experimental procedure was to use about an inch length of tape in about 10 ml of solvent. Six solvents were used: acetone, ethyl alcohol, benzene, toluene, carbon tetrachloride and trichloroethylene ($C\,cl_2{:}CH\,cl$). The tests were conducted at room temperature and 4 solvent classifications used based on the ease of binder dissolution.[2] The tapes used (85 in number) were obtained from three other government agencies. Specimens from the same reels had been subjected to wear tests based on dropout studies. The results obtained from these wear studies were classified into four groups depending on their degree of wearability, as measured by the numbers of dropouts.

A comparison was made between the two criteria of classification.[2] To this end a two-way table was constructed consisting of sixteen cells, each cell representing a combination of a solubility rating with a wear rating. Sixteen of the twenty-eight experimental points fell in cells occupying the principal diagonal of the table. All but two of the remaining points fell in cells that bordered on the principal diagonal.

Using this approach, more than 100 used tapes of various degrees of wear were tested. As was to be expected, this solvent-resistance test does not differentiate between degrees of wear. The tapes fell into the same solvent-resistance classifications as the new tapes of the same type. This test is restricted to differentiating between new tapes as to possible future wear properties. Though this is by no means a conclusive test the results seem to indicate that this rapid and simple procedure, with further development, might become useful as a tool in quality control.

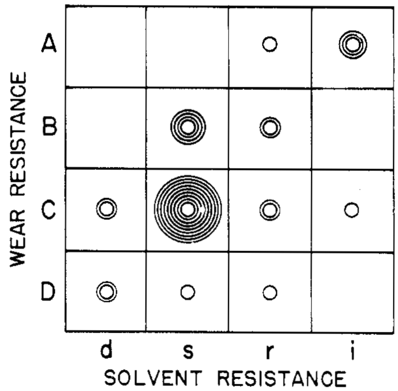

Fig. 1—Cross plot of wear resistance vs solvent resistance. *A*, *B*, *C* and *D* are classifications as to wear on recording equipment. *A* represents those tapes with the least number of dropouts for a given number of passes and *D* represents those tapes with the most dropouts for the same number of passes. The *i*, *r*, *s* and *d* classifications refer to binder solubility as follows: *i*, insoluble; *r*, dissolves only under the brush; *s*, dissolves on stirring; *d*, dissolves rapidly.

Work is under way at present in other laboratories to set up a carefully controlled study of tapes used on 13 different recorders, together with the corresponding solvent tests.

FLORENCE NESH
U. S. Weather Bureau
Washington, D. C.

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[1] F. Nesh and R. F. Brown, Jr., "A study of the chemical and physical properties of magnetic recording tape," IRE TRANS. ON AUDIO, vol. AU-11, pp. 70–71; May-June, 1962.

[2] F. Nesh and R. F. Brown, Jr., "Magnetic Recording Standards," National Bureau of Standards, Washington, D. C., ASTIA Rept. No. 277830; July, 1962.

Comment on "A Network Transfer Theorem"*

Mr. Montgomery[1] sets out a Theorem which I myself published, with an almost identical proof.[2]

I there pointed out the great practical advantage of the Theorem in allowing current ratios to be measured, without introducing the current-meters which would upset circuit conditions, by observing a voltage-ratio under reversed transmission conditions; this was not noted by Mr. Montgomery.

Inquirers will find that, by some accident, my contribution was not listed in the Index of the *Wireless Engineer;* my theorem has in consequence never been referred to in the standard texts. It follows that I cannot blame Dr. Hurtig for introducing it in 1956 as a novelty.

The derivation occurred, almost by accident, as far back as 1929–30 when I had observed that the open

* Received June 12, 1963; revised manuscript received June 19, 1963.

[1] G. F. Montgomery "A network transfer theorem," IRE TRANS. ON AUDIO (*Correspondence*), vol. AU-10, p. 88; May–June, 1962.

[2] E. Ramsay Wigan, *Wireless Engineer*, vol. 26, p. 409; 1945.

circuit voltage-ratio measured between the two ports of a network A and B could be expressed in terms of three impedances:

ZA, measured at A with B closed;
ZB, measured with B with A closed;
and ZAB, measured at A with B open,
or ZBA, measured at B with A open.

Then, writing ${}_Ae_R$ = ratio of open circuit positive definite at B due to a generator EMF at A,

$$ {}_Ae_B = \sqrt{\frac{ZB}{ZA}\left(1-\frac{ZB}{ZBA}\right)} $$

$$ \text{or} = \sqrt{\frac{ZB}{ZA}\left(1-\frac{ZA}{ZAB}\right)}. $$

I had also derived a similar sort of equation in terms of input currents and output short-circuit currents:

$$ {}_Ai_B = \sqrt{\frac{ZA}{ZB}\left(1-\frac{ZA}{ZAB}\right)} \text{ or etc.} \cdots $$

On glancing over these equations it was observed that, by reversing the suffices,

$$ {}_A{}^e{}_B = {}_B{}^i{}_A $$

which is the formal statement of my Theorem.

Later, of course, a simpler method of deduction was formulated.

E. Ramsay Wigan
"Kerry," Barnham
Sussex, England

Contributors

B. B. Bauer (S'27–A'39–SM'44–F'55), for a photograph and biography, please see page 153 of the September-October, 1962, issue of these Transactions.

Raymond G. Bayer was born in New York, N. Y., on June 9, 1935. He received the B.S. degree from St. John's University, New York, N. Y., in 1956, and the M.A. degree from Brown University, Providence, R. I., in 1959.

Since 1958 he has been associated with the Advanced Technology group of the General Products Division of IBM. He is currently a Senior Associate Physicist in the Physical Technology Department of that group.

Marvin Camras (S'41–A'42–SM'48–F'52), was born in Chicago, Ill., on January 1, 1916. He received the B.S. degree in electrical engineering from Armour Institute of Technology, Chicago, Ill., in 1942.

Since 1940, as a member of the staff at Armour Research Foundation, he has done research on projects in the electronics department, including remote control, high speed photography, magnetostriction, oscillators and static electricity. He contributed developments which are used in modern magnetic tape and wire recorders, including high-frequency bias, improved recording heads, wire and tape materials, magnetic sound for motion pictures, multitrack tape machines and stereophonic sound reproduction.

Mr. Camras is a Fellow of the Acoustical Society of America, and a member of SMPTE, AAAS, Eta Kappa Nu, Tau Beta Pi, and Sigma Xi. Offices held include PTGA Chairman and Editor of these Transactions and President of ITT Chapter Sigma Xi. He received the John Scott Medal in 1955, and the IRE PGA Achievement Award in 1958.

Paul R. Hinrichs was born in Tulsa, Okla., on July 17, 1928. He received the B.S.E.E. degree in 1960 and the M.S. degree in 1961 from the University of Oklahoma, Norman.

He served in the U. S. Marine Corps from 1952 to 1954. He worked for the Phillips Petroleum Company, Bartlesville, Okla., during the summers of 1960 and 1961, where he designed a substantial portion of a data collection system and co-designed a sequential analog computer. In the summer of 1963 he worked for the California Research Corporation, La Habra, Calif., where he tested and evaluated magnetic tape used in seismic recording. He is presently working toward the Ph.D. degree at the University of Oklahoma.

Mr. Hinrichs is a member of Tau Beta Pi, Sigma Xi, Pi Mu Epsilon and Eta Kappa Nu.