Comparative Study of a Few Commercial Antioxidants[1]

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THE PURPOSE of this study was to compare the primary antioxidant activity of the principal antioxidants that are available in France. In many comparative studies of antioxidants, a true measure of antioxidant activity is not obtained because, when a natural fat or oil is used as substrate, the results are complicated by the presence of natural inhibitors. A second factor limiting the value of many studies is the use of a high temperature, such as 100°C., and exposure to light to accelerate the testing. The comparative results obtained at high temperature are not necessarily valid for conditions of storage at room temperature and in total or partial darkness. To avoid the effects of these factors, carefully distilled ethyl esters of linseed oil fatty acids were used as substrate, and the tests were conducted at 30°C.

The ethyl esters were prepared by ethanolysis of commercial linseed oil, followed by distillation of the esters at 0.4 mm. of mercury pressure. The initial distillate and the residue were discarded. The center fraction, representing 90–92% of the total material, was collected between 140–170°C.

Four batches of esters, designated A, B, C, and D, were employed in this study. These showed small differences in saponification and iodine numbers but gave essentially the same stability values with any given antioxidant. The esters were stored in the dark in a freezer, sealed under nitrogen until used. The peroxide number was always 0 at the time the esters were taken for use in the experiment.

The autoxidations were carried out with 20 g. (±0.1 g.) of the ethyl esters in beakers that were 65 mm. in diameter. The beakers were placed, without covers, in an oven maintained at 30°C. (±0.2°C.). A control sample, containing no antioxidant, was included in each series of assays. The oxidation was followed by iodometric determinations of the peroxide number. The chemical designation, commercial name, and origin of the several commercial antioxidants tested are given in Table I.

SOLUBILIZATION of the antioxidant was carried out under nitrogen, with slight heating when necessary (45°C.), or by a solution of the antioxidant in an appropriate solvent. In the latter case the solvent was removed from the substrate esters under vacuum in a flow of nitrogen at a temperature not exceeding 30°C.

Ascorbic acid was dissolved in ethanol but precipitated again when the solvent was removed. Under these conditions its antioxidant effect was nil; therefore the data on ascorbic acid are not considered.

Gallic acid was dissolved in ethanol but showed the same antioxidant effect as if it had been added directly and incompletely dissolved. Morin was dissolved in ethanol and precipitated again on removal of the solvent. α-Conidendrine was dissolved in dichlorethane. TMTC was dissolved in a mixture of methanol and benzene. Ascorbyl palmitate was dissolved in ethanol.

The results are recorded in Table II, in the form of two stability values. The S value is a measure of organoleptic stability and represents the difference in time for the test sample and the corresponding control to reach a peroxide number of 20 mmoles/kg. (the approximate point of organoleptically-detectable rancidity). The S′ value is a measure of the induction stability and represents the difference in time required for the test sample and the corresponding control to reach a peroxide number of 100.

Examination of the results in Table II permits a number of conclusions. The several controls are very similar in their behavior, showing only slight differences. When the same antioxidant was used in two different series, the observed induction stabilities were in good agreement. Differences in organoleptic stabilities were somewhat greater.

For products that are the same chemically the antioxidant effectiveness may differ greatly, depending upon origin. This was found true for the various BHT's and for the two nordihydroguaiaretic acids, where the organoleptic stabilities were about the same but the induction stabilities were very different. The differences may be related to the purity of the industrial compounds, which may contain impurities having their own pro-oxidant or antioxidant action.

It should be observed that, for a given series of antioxidants, the organoleptic stability does not change necessarily in the same manner as the induction stability changes. For example, the organoleptic stability of α-naphthol and α-tocopherol is the same, but the induction stability of the former is twice that of the latter.

The effect of antioxidant concentration was studied in only two cases. Tocopherol acetate at 0.01% concentration appeared to be pro-oxidant rather than antioxidant whereas the same compound at 0.1% concentration was only very slightly antioxidant. Metophan, on the other hand, was a weak antioxidant at 0.01% concentration but was very effective at 0.1%. Qualitative tests indicated that the concentration at which the antioxidant effect of Metophan increased sharply was around 0.05%.

TABLE I

Antioxidant	Commercial name	Origin
α-Naphthol	....	Ets. Prolabo, Paris
Hydroquinone	....	Ets. Prolabo, Paris
Pyrogallol	....	Ets. Merck-Darmstadt, Germany, and Ets. OSI, Paris
Gallic acid	....	Ets. Prolabo, Paris
Propyl gallate	....	Heyden Chem. Corp., N.Y.
Octyl gallate	....	Chemische Fabriek-Naarden, Holland
Dodecyl gallate	....	Chemische Fabriek-Naarden, Holland
t.-Butyl-3-hydroxy-4-anisole	Sustane 1 F (85% BHA)	Universal Oil Prod., U.S.A.
Butylhydroxy-toluene or di-t. butyl-2-6-methyl-4-phenol (BHT)	Ionol	Shell Chemie, Paris
	DBPC tech.; DBPC pure	Koppers Co., Pittsburgh, and Ets. Seppic, Paris
	AC 1, AC 3 (food grade)	Catalin Corp., N.Y. and Cie. Rousselot, Paris
Nordihydroguaiaretic acid	NDGA	Nordigard Corp., Chicago, and N. Petel, Paris
	Antoxibyl	Ets. Byla, Paris
d. 1-α-tocopherol	....	Hoffmann-LaRoche, Paris
Tocopherol acetate	....	Ste. Serlabo, Paris
Tetramethylthiourane (TMTD)	....	Sharples Chem., Philadelphia, and Ste. Desmarais, Paris
Tetraethylthiourane (TETD)	....	Idem.
α-Conidendrine	....	Light Co., Great Britain, and Ets. OSI, Paris
Pentahydroxy-3,5,7,2′,4′ flavanol (Morin)	....	Ets. Prolabo, Paris
1 Ascorbic acid	....	Ets. Touzard and Matignon, Paris
1 Ascorbyl palmitate	....	Prepared from previous one (3)
m.-Hydroxydiphenylamine	Metophan	Sofragerm, Paris
Lecithin	....	Prepared at the laboratory (m.p. 113°)

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[1] From Oleagineux, pp. 243–48, February 13, 1958; translation and abstract prepared by W. O. Lundberg and Jean Labarrere.

TABLE II

Substrate	Antioxidant		Time to reach peroxide no. of 20 mmoles per kg.	Time to reach peroxide no. of 100 mmoles per kg.	Organoleptic stability	Induction stability
	Nature	Concentration				
		%	hr.	hr.	hr.	hr.
A	Control	......	18	59	......	......
	Tocopherol acetate	0.01	4	44	<0	<0
	Dodecyl gallate	0.01	130	328	112	269
	Octyl gallate	0.01	188	420	170	361
	Sustane	0.01	175	157	448	389
	Propyl gallate	0.01	225	540	207	481
	Gallic acid	0.01	240	728	222	669
	NDGA	0.01	390	>1000	372	>1000
	Tocopherol acetate	0.10	23	72	5	13
A	Control	......	12	50	......	......
	TETD	0.01	37	125	25	75
	Antoxibyl	0.01	356	480	344	430
	Propyl gallate	0.01	248	525	236	475
	Tech. DBPC	0.01	300	540	288	490
	Pure DBPC	0.01	300	610	288	560
	Ionol	0.01	300	630	280	580
B	Control	......	17	42	......	......
	Tocopherol acetate	0.01	15	38	<0	<0
	α-Conidendrine	0.01	24	32	7	10
	α-Tocopherol	0.01	116	228	99	186
	α-Naphthol	0.01	116	440	99	398
	Hydroquinone	0.01	430	752	413	710
C	Control	......	6	28	......	......
	Ascorbyl palmitate	0.01	7	34	1	6
	α-Conidendrine	0.01	8	36	2	8
	Morin	0.01	44	92	38	64
	TETD	0.01	38	120	32	92
	TMTD	0.01	56	168	50	140
	AC 1	0.01	174	362	168	334
	AC 3	0.01	180	398	174	370
	Gallic acid	0.01	136	734	130	706
D	Control	......	4	30	......	......
	Lecithin	0.01	6	34	2	4
	Octyl gallate	0.01	144	440	110	410
	Pyrogallol	0.01	660	>1200	656	>1200
D	Control	......	12	34	......	......
	Metophan	0.01	42	94	30	60
	Metophan	0.10	800	>1000	788	>1000

TABLE III

Compounds with antioxidant effect	Classification based on induction stability (S′)			Classification based on organoleptic stability (S)		
	Limits of S′	Antioxidant	S′	Limits of S	Antioxidant	S
None	<15	Tocopherol acetate	<0	<10	Tocopherol acetate	<0
		Lecithin	4		Ascorbyl palmitate	1
		Ascorbyl palmitate	6		Lecithin	2
		α-Conidendrine	8–10		α-Conidendrine	2–7
		Tocopherol acetate (0.1%)	13		Tocopherol acetate (0.1%)	5
Weak	15–200	Metophan	60	10–100	TETD	25–32
		Morin	64		Metophan	30
		TETD	75–92		Morin	38
		TMTD	140		TMTD	50
		α-Tocopherol	186		α-Tocopherol	99
					α-Naphthol	99
Medium	200–500	Dodecyl gallate	269	100–250	Octyl gallate	110–170
		AC 1	334		Dodecyl gallate	112
		Octyl gallate	361–410		Gallic acid	130–222
		AC 3	370		AC 1	168
		Sustane	389		AC 3	174
		α-Naphthol	398		Propyl gallate	207–236
		Antoxibyl	430			
		Propyl gallate	475–481			
		DBPC, techn.	490			
Strong	500–800	Pure DBPC	560	250–400	Ionol	280
		Ionol	580		DBPC, techn.	288
		Gallic acid	669–706		DBPC, pure	288
		Hydroquinone	710		Antoxibyl	344
					NDGA	372
Very strong	>800	NDGA	>1000	>400	Hydroquinone	413
		Pyrogallol	>1200		Sustane	448
		Metophan (0.01%)	>1000		Pyrogallol	656
					Metophan (0.1%)	788

In Table III the several antioxidants are classified in two ways, based on organoleptic stability and induction stability. Among the products without activity are some for which antioxidant effects have been reported previously, when the substances were tested in natural products, such as cottonseed oil, peanut oil, or lard. Substances like lecithin, α-conidendrine, and ascorbyl palmitate, which are quite effective in natural oils, are much less effective in their pure substrate, indicating that their effectiveness is based upon a synergism with other natural antioxidants. TMTD and TETD showed relatively weak antioxidant activity, and it was found that their effectiveness was related to temperature, being higher at lower temperatures. This emphasizes again the need, in describing the effectiveness of an antioxidant, to specify the nature of the substrate and the conditions of autoxidation.

Among the antioxidants found to have great activity were NDGA, hydroquinone, and pyrogallol at concentrates of 0.01%, and Metophan at 0.1%. They gave long organoleptic stabilities and induction stabilities. If one considers only induction stability, gallic acid also was effective; and Sustane was effective if only organoleptic stability is considered.

It was recently announced that the Diversey Corporation of Chicago has purchased Deosan Ltd., London, England.

TASK GROUP ON 36-T—Left to right (*seated*) are W. F. Bollens and George Quandee, Swift and Company, Chicago; A. E. MacGee, Skelly Oil Company, Kansas City; Rex Wingard, Davidson-Kennedy Company, Chicago Heights; and N. H. Witte, Central Soya Company, Decatur, Ind.; (*standing*) F. P. Parkin, Borden's Soy Processing Company, Waterloo, Ia.; Harvey Marxhausen, Cargill Inc., Minneapolis; and P. R. Sheffer, Corn Products Company, Argo, Ill. Not in the picture were Ralph P. Hutchins, French Oil Mill Machinery Company, Piqua, O., and Miles Woodworth, N.F.P.A., Boston.

Consider 36-T Fire

To consider tentative standards for solvent-extraction plants for the National Fire Prevention Association, a special task group of the Technical Safety Committee of the American Oil Chemists' Society was held at the Corn Products Company, Argo, Ill., December 15, 1958, with Paul R. Sheffer as host, N. H. Witte as leader, and A. E. McGee as general chairman.

In spite of severe weather 10 were present, representing six study groups for consideration of basic rules, bulk solvent unloading, storage, and handling, preparation process, extraction process, and the like. Two of the 10 were from the N.F.P.A.: Miles Woodworth and George Quandee.

From the suggestions of the group a letter to the N.F.P.A. has been prepared, and the findings will be presented to the Technical Safety Committee at the annual meeting of the Society in New Orleans in April. There have been a few points of controversy, but complete agreement among persons of such varying experience could not be expected, according to Mr. Sheffer, who is chairman of the solvent extraction subcommittee.

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Cites Causes of Fires

Fire Record Bulletin FR 58-3, published by the National Fire Protection Association, is an analysis of the principal causes of laboratory fires and recommendations for their prevention along with actual case histories. More than a dozen causes are listed, ranging from electrical wiring and misuse of flammable liquids to spontaneous ignition and open flames. There was failure to provide automatic sprinklers in almost 90% of the cases. It may be obtained for 50¢ from the Association at 60 Batterymarch street, Boston 10, Mass.

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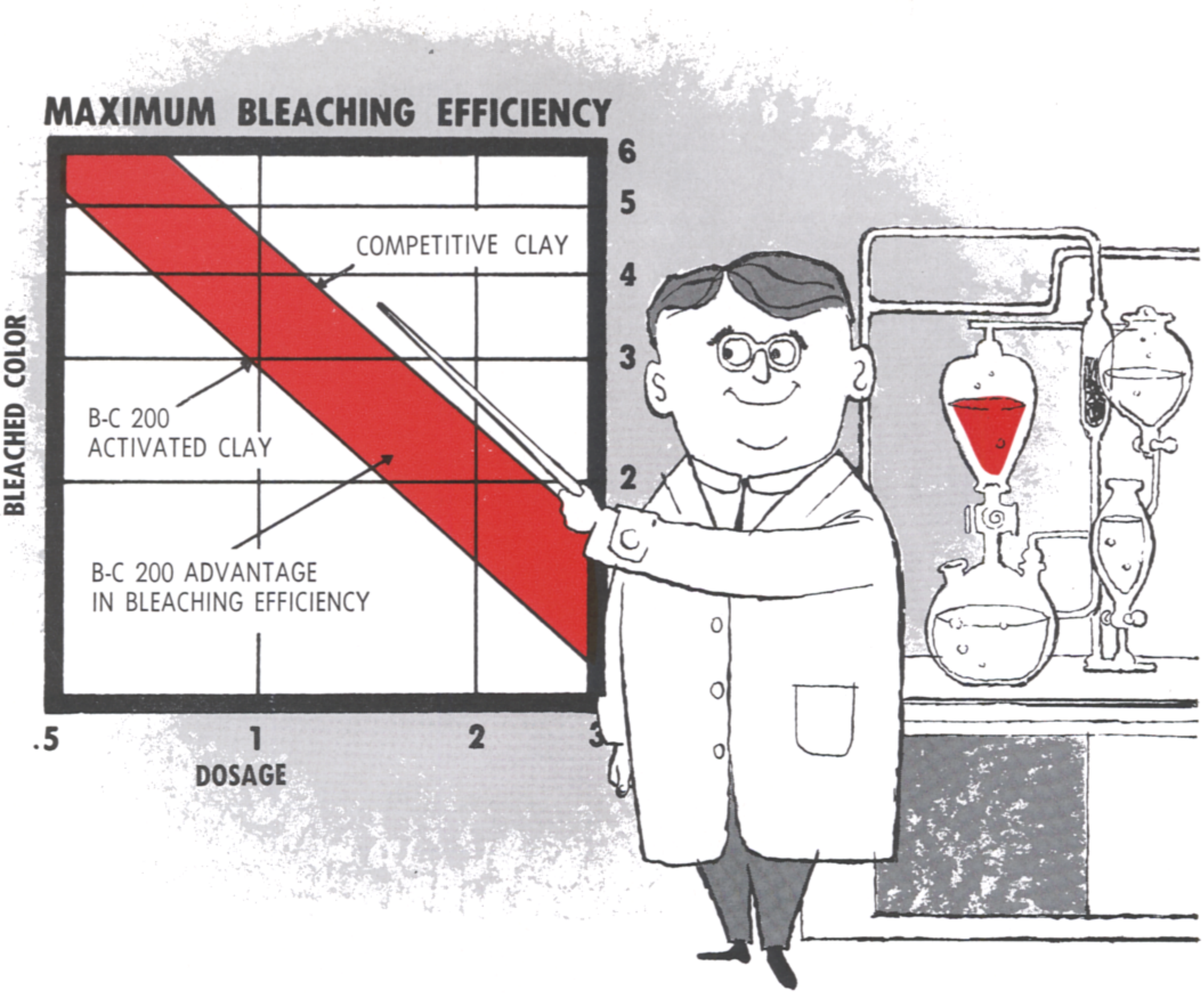
Publish Fire Codes

IMPORTANT CHANGES in fire safety standards are incorporated in a new and revised edition of the National Fire Codes, just published by the National Fire Protection Association, 60 Batterymarch street, Boston 10, Mass. The six-volume 1958 edition sells for $7 a volume and is a compilation of the 170 standards in flammable liquids and gases, combustible solids, dusts, chemicals and explosives, building construction and equipment, extinguishing equipment, electrical, transportation, and miscellaneous operations.

◆

International Minerals and Chemical Corporation opened its new administrative and research center in Skokie, Ill., in September, 1958, with its own heliport.


MAXIMUM BLEACHING EFFICIENCY
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B-C 200 ADVANTAGE
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DOSAGE

• *New Books*

Vol. I. Separation and Purification of Materials, by Rolt Hammond (Philosophical Library Inc., 327 pp., 1958, $10); Vol II. Dispersion of Materials, by Rolt Hammond (Philosophical Library Inc., 230 pp., 1938, $10). These books, written for process engineers and technicians in industry, give a very complete review of the known methods used in process engineering. Each type of process is described briefly and concisely.

In Vol. I the methods of separation are discussed under the headings of "Separation of Solids from Liquids," "Separation of Solids from Gases," "Distillation," "Centrifugal Separation," "Separation of Gases," and "Separation and Purification in Nuclear Engineering." Under each are discussed briefly all of the processes used today for accomplishing each one of these separations.

Treated in Vol. II are Crushing and Grinding, Classifying Materials, Fluidization, Flotation, Liquid Dispersion, Dispersion of Gases, and Atmospheric Pollution. Each chapter consists of a brief discussion of the main commercial methods of accomplishing each of these physical dispersions or fluidization.

These books would seem to be especially valuable to chemical engineers who are interested in making some type of physical separation and dispersion. Outstanding is the brevity of treatment of each process; however the author covers enough ground so that it is a good source book for those interested in alternate methods of handling solids, liquids, or gases. The author's English background adds to the book in that some of the physical processes or equipment used in Great Britain are not commercially used in this country. The books should provide an excellent review and memory refresher for engineers, especially chemical engineers who have been out of school for some time. They also should be of great interest to engineers in process development work who are searching for new or different means of separating or dispersing solids, liquids, or gas. They should be suitable for school textbooks to give chemical engineering students a wide background on processes with which he will be dealing when he enters industry.

Noel W. Myers, A. E. Staley Manufacturing Company, Decatur, Ill.

Scientific Glassblowing, by E. L. Wheeler (Interscience Publishers Inc., New York, 478 pp., 1958, $9.75). This is one of the better books on glassblowing, with a different and very interesting approach to glassblowing. The book is very well written and is easy to read, with an adequate amount of tables and drawings. The author is to be congratulated for this excellent book, which has great value for beginners as well as those who are already in glassblowing.

The book is divided into 16 chapters, including history, glass and its working characteristics, blowing equipment, basic and sealing operations, practice piece, grinding, sealing of different glass with metal, mercury purification, fractional and molecular distillation, high vacuum techniques, metal working and use of lathe, electric heaters, and miscellaneous equipment and procedures. The book would be helpful not only to amateur and professional glassblowers but also to research and development scientists who desire and use special equipment. Its use could be most helpful in designing specific equipment to effect a given objective. It describes the cross-fire technique of glassblowing as well as other standard and better known techniques. It is an excellent working tool and reference book for the experimental scientist, particularly physical, physical-organic, and organic chemists.

F. J. Castle, Northern Utilization Research and Development Division, Peoria, Ill.

Polymer Reviews. Vol. I. The Effects of Ionizing Radiation on Natural and Synthetic High Polymers, by Frank A. Bovey (Interscience Publishers Inc., New York, N. Y., XIII + 287 pp., $8). The present volume marks the start of a series of moderate-sized reviews of current developments in polymer science designed to focus attention on the horizons. Radiation chemistry of high polymers seems to be a rather specialized and unsettled subject for the first volume. On the other hand, the choice serves to emphasize the current nature and speculative purpose which are to be embodied in each volume in the series.

The first two chapters carefully summarize the various types of radiation, their basic properties and effects on various systems. The general background of both the beneficial and detrimental effects on polymers is given in the third chapter. The fourth chapter (with the aid of A. R. Shultz) presents a clear exposition of the statistical treatment of cross-linking and scission. There follow six chapters discussing the effects of radiation on each type of polymer in turn; the last of these, devoted to the life of natural polymers, appropriately perhaps, is the longest. A summary Appendix on the effects of Radiation on Polymers should become even more useful as it is expanded and more details are filled in.

Strong motivation for research along these lines comes from the desire to encourage toughening of synthetic high polymers at the expense of detrimental reactions and to learn how to protect living cells. While only limited progress has been made, the author sets forth the present status ably and well. And the format and printing are excellent. The rapid pace in radiation chemistry will make this book one to compare, with especial interest, with future revisions which are bound to come.

A. C. Zettlemoyer, National Printing Ink, Research Institute, Bethlehem, Pa.

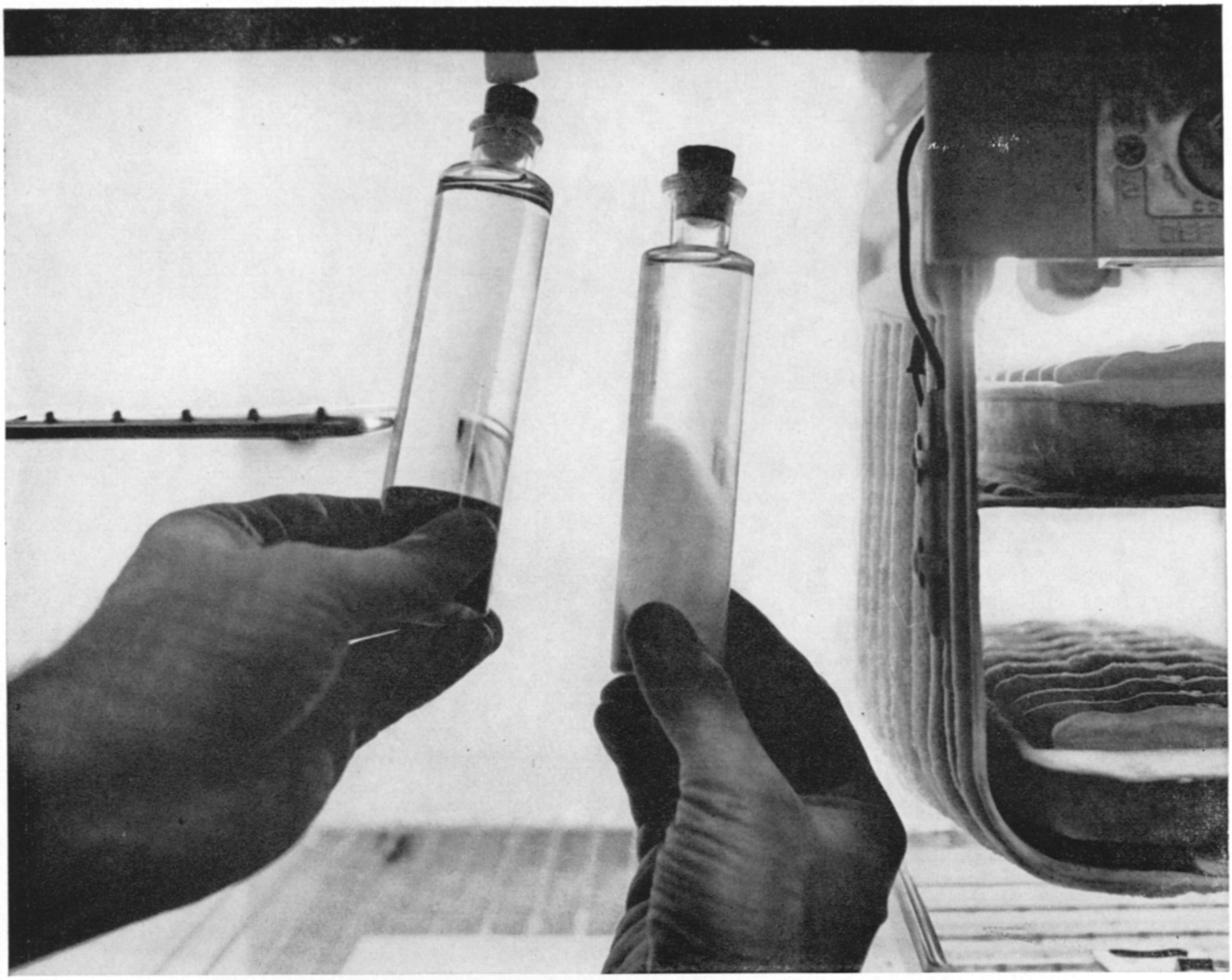
Ion Exchange Resins, 2nd ed., by Robert Kunin (John Wiley and Sons Inc., New York, N. Y., 466 pp., 1958, $11). Since the first edition of "Ion Exchange Resins" appeared in 1950, the annual rate of publication of papers on ion exchange technology has almost doubled. Therefore a second edition has become necessary to provide the latest information to the increasing number of scientists who have become interested in ion exchange. The book is also designed to help those who are working in a narrow area of ion exchange technology and wish to gain knowledge of its over-all aspects.

The scope of the second edition is comprehensive and should provide valuable information on the theoretical and practical aspects of the natural silicate and synthetic resin exchangers. The latter and probably more important group consists essentially of two types of crosslinked high polymers: the first contains such fixed polar groups as sulfonic and carboxylic anions; the second, quaternary ammonium and polyamine groups. Dr. Kunin describes synthetic procedures for such resins, provides techniques for measuring chemical and physical properties, and outlines their utility in the fields of agriculture, biology, medicine, and chemistry.

Those interested in the theory of ion exchange processes will find the author's treatment of mechanisms satisfying. The phenomenon of ion exchange is interpreted on the basis of the crystal lattice theory, the Helmholz double-layer theory, and the Donnan membrane theory in such fashion that the theories appear complementary rather than conflicting. To complete his presentation on mechanisms, Dr. Kunin offers a set of empirical rules for ion exchange to fill in where the theories and equilibrium formulations are not adequate.

The book should prove especially valuable to those wishing to delve deeper into the nature of ion exchange. Like all books however, certain elaborations might have been effected to improve the second edition. The information on catalysts of organic reactions by exchange resins perhaps could have been made more comprehensive. The oil chemist will note particularly the absence of information on the use of cation exchange resins in the epoxidation and hydroxylation of fatty oils and esters. The reader should bear in mind however that the largest use for ion exchange resins at the present time is in the field of water treatment. A more detailed presentation of the much smaller, newer area of catalysis may not have been deemed completely within the scope of this book.

According to statements received from experts on ex-



Superiority of GROCO 2 RED OIL revealed in unretouched photograph of low temperature test. Samples of GROCO 2 (left) and competitive red oil (right) were refrigerated at 36°F. for 24 hours side by side. No solids separated out of GROCO 2 RED OIL—it remained so transparent that technician's fingers and steel tray are clearly visible through vial. On right, solid acids separated in large amount.

TITRE IS LOWEST IN GROCO 2 RED OIL

The unretouched photo above shows the results of a recent low temperature test between GROCO 2 and a competitive red oil. The GROCO 2 RED OIL (left) remained crystal clear to the bottom of the vial. The other material became heavily opaqued with frozen saturated acids.

GROCO 2 RED OIL's exceptionally low content of saturated fatty acids—titre 3°C.—is advantage enough in itself to make it top choice for many processors. More than one producer of a liquid shampoo, for example, prefers GROCO 2 RED OIL because it gives a formulation that stays liquid at low temperatures.

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INSIDE SCIENCE

The Vital Story Of MARGARINE FORTIFICATION

How They Made Margarine a Better Food

by Science Writer

The "Basic 7" Good Foods

Over a hundred million pounds of margarine are used a month as a table spread and in cooking and baking. Included in the "Basic 7" food list, margarine serves as one of the finest and most concentrated energy foods. It is a shining example of a food which has been repeatedly made better.

In the original product, invented more than 80 years ago, beef fats were used. Later lard and vegetable oils came into use. When unpurified these have several drawbacks: unpleasant odor and taste, low melting point and unsatisfactory color. These have been overcome by scientific refining methods, hydrogenation and the use of officially-approved food colors. Strictly phrased Federal Definitions and Standards of Identity assure maintenance of very high quality, uniformity and nutritional value.

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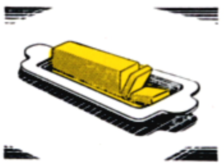
.re some of the benefits that vitamin A supplies. Scientific evidence is available showing that it helps to maintain normal vision and to overcome night blindness; that it increases the body's resistance to infections; that it promotes physical and mental development; and that it aids in maintaining normal glandular function.

Soon after the Second World War several processes were developed to produce vitamin A synthetically. One of the most successful, announced in 1947, was evolved by the Roche research team headed by Dr. Otto Isler.

Vitamin A produced by the Roche synthesis has many positive advantages for food processors. Among these are light, clear color; complete absence of any "fishy" odor, taste or after-taste; reasonable and stable price; stability, purity and uniformity; and the assurance of a steady, economical supply.



It is interesting and important to margarine manufacturers that the Hoffmann-La Roche synthesis of vitamin A led to another synthesis and then the commercial production of the closely related pro-vitamin A (beta carotene).

Beta carotene is the *natural, non-toxic* yellow color found in butter and other dairy products. It is *naturally* safe for coloring foods such as margarine, shortening, edible oils, yellow baked goods and many others. In addition to its value as a safe coloring agent, beta carotene contributes vitamin A potency—for better health and well-being.

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standardized purity,
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a multi-million-dollar plant at the huge Hoffmann-La Roche operation in Roche Park over 500 pieces of large-scale chemically engineered equipment are working constantly to produce superior **Roche*** vitamin A which is built up into a molecule identical with Nature's own. Other highly complex equipment delivers beta carotene **Roche***

Again, developments by the Roche people, who manufacture not only vitamin A and beta carotene but many other essential vitamins, *by the tons,* have contributed to the making of more nutritious foods—and thus to the public welfare.

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change resins, the book "Ion Exchange Resins" fills a need of long standing. Perhaps the 1,170 references, 90 tables, and 234 figures featured by the second edition provide sufficient justification for such statements.

JOHN G. WALLACE
E. I. du Pont de Nemours and Company
Wilmington, Del.

THE PETROLEUM CHEMICALS INDUSTRY, 2nd ed., by Richard F. Goldstein (John Wiley and Sons Inc., New York, N. Y., 458 pp., 1958, $16.50). This is the second, revised, and enlarged edition of a volume first published in 1949; rapid progress in the field warrants the revision. The general format comprises introductory chapters on the history of the petroleum chemicals industry and sources of petroleum hydrocarbons, followed by a series of chapters on specific classes of petroleum processes and chemicals. Economics and statistics are presented in the final chapter and Appendix. An extremely useful index is included, material being indexed by Name, Patent Numbers, and German Intelligence Reports as well as by Subject.

Chapters 3–6 deal with the basic petroleum chemical processes, e.g., synthesis and reactions of carbon-monoxide-hydrogen mixtures, oxidation of paraffins, etc. Chapters 6–10 present the principal industrial reactions of olefins, and in Chapter 11 some other reactions are described. Chapters 12–15 discuss other important hydrocarbons. In Chapters 16–20 specific classes of organic chemicals, including acids, anhydrides and esters, nitriles and amines, etc., are considered. Basic reactions and mechanisms are given for the manufacture of all important petroleum chemicals.

While there are probably better sources of information on many of the individual processes and petroleum chemicals, it is doubtful that any other single volume presents such a broad picture of petroleum chemical synthesis and manufacture.

This volume will very likely be of most interest to those dealing with the synthesis of organic chemicals other than petroleum chemicals and seeking information on the latter, or to the chemist using petroleum chemicals in the synthesis of other materials. Research chemists working in the fields of detergents, resins, paints, waxes, etc., will find the volume of value in understanding the chemicals they work with and in the application of analogous reactions to their own field of interest.

R. L. TERRILL
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CARATTERI SPECIFICI DEI PRINCIPALI OLI VEGETALI DEL COMMERCIO, by G. Balestrini and G. B. Martinenghi (Allegrati di Campi, Milan, 1958, 71 pp., cloth-bound, size 12 x 17 cm., 1,000 lires). This pocket-size book would hardly merit the attention of those who use Eckey and Hilditch and is of no wide appeal. Incidentally Prof. Martinenghi is the same one whose extensive volume on the "Chemistry and Technology of Oils, Fats, and Derivatives" was reviewed in 1948 and is undoubtedly one of the best in its field.

The value of the booklet lies in its special value to the commercial chemist; and since the price of approximately $1.60 is so modest, it is well worth the having. It is of particular benefit to those engaged in passing on shipments of oil under Public Law 480 or similar governmental agency, to the suppliers, banks, and others in the understanding of what constitutes "sana, leale, mercantile" and whether specifications of a contract have been met.

Twenty-nine oils of commerce are herein dealt with, showing physical and chemical characters which follow so closely those tabulated by this reviewer in Section I of the A.O.C.S. Book of Methods as to constitute a flattering endorsement. In addition, the authors give specifications for both crude and refined grades of oil, data usually kept apart and contained in the rules of the various trade organizations such as the N.C.P.A. and the N.S.P.A.

As their own special feature, a "test of four temperatures" is introduced, designed to show the behavior of an oil in chilling to turbidity and solidification and then warming to pour- and melting-points.

There is little to criticize. Although some of their characteristics do not agree with those of other chemists, this is understandable since the so-called constants are in reality variables. Where given, the peroxide values are much too high; the turbid and solid temperatures for peanut oil are much too low, and apparently Italians are not familiar with our grades of cottonseed oil inasmuch as their refined is assumed to be winterized oil only. Also, too much emphasis seems to be placed on a qualitative Halphen hexabromide (esabromuri) test.

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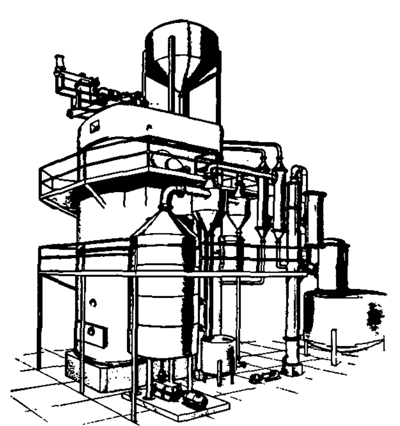
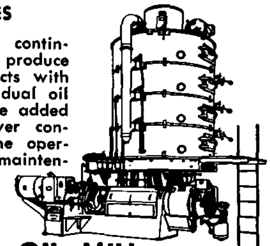
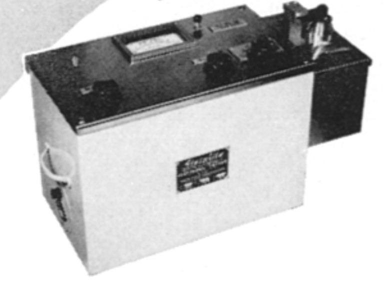
ORGANIC SYNTHESES WITH ISOTOPES, in two parts, by Arthur Murray III and D. L. Williams; Part I, Compounds of Isotopic Carbon (Interscience Publishers Inc., New York, X + 1146 pp., 1958, $25). This is the first book in nine years which gives a comprehensive treatment to the synthesis of compounds labelled with isotopic carbon. Literature coverage includes all isotopic carbon-labelling syntheses by chemical means reported through 1955. It should be noted that the index will appear in Part II.

Arrangement of the material is based on compound classes. A critical survey with an excellent bibliography is given for each compound considered. Much of the presentation is factual copy of published work, which includes the introduction, followed by the synthesis of isotopically labelled acids, acid derivatives, amines, carbonic acid derivatives, carbonyl compounds, ethers, heterocyclic compounds, hydrocarbons, hydroxy compounds, onium compounds, sugar and sugar derivatives, steroids, and vitamins.

The authors demonstrate well their acquaintance with the methods and problems involved in the synthesis of labelled compounds. Their excellent discussion of isotopic organic nomenclatures, specialized techniques, health haz-







ards, and miscellaneous topics is the subject of the introduction. Throughout the text the authors present useful notes, some degradation procedures, and other methods employed for preparation of a given compound.

Examination of the text reveals efficient techniques and procedures whereby isotopic carbon is incorporated into organic compounds in both high yield and purity. This requires the development of novel methods of synthesis and adaptation of known methods to the scale required for the synthesis.

The reader should pay particular attention to the radiochemical methods employed for the establishment of purity of the isotopic compound in question. Since the proof of complete purification is empirical, one must not rely on any one procedure for establishing radiochemical purity but must employ a number of trustworthy radiochemical methods. Finally the purity of volatile carbon-14 labelled compounds can now be determined by gas chromatographic techniques in conjunction with radioactivity detecting devices.

The text is well written. This volume is recommended to all chemists interested in either the synthesis of compounds labelled with isotopic carbon or the small-scale synthesis of organic compounds.

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An Introduction to the Chemistry of Fats and Fatty Acids, by F. D. Gunstone (John Wiley and Sons Inc., New York, 161 pp., 6 x 10 in., 1958, $6). This rather brief but well-written book is intended, as declared by the authors, to be an introductory textbook on fats and fatty acids. As such, it is a very worthy addition to the literature. There are six chapters in the book.

Chapter 1, The Fatty Acids, covers nomenclature, structure, and synthesis quite well.

Chapter 2, The Chemical Nature of Fats, covers classification of lipides, analytical methods, and component glycerides of fats. The very important method of vapor phase chromatography is given very scant note (p. 51), and the improved isomerization techniques with stronger alkali better to analyze for tetra-, penta-, and hexa-enes is barely suggested (p. 45). The treatment of the question of even *versus* random distribution of triglyceride structure appears to be somewhat prejudiced toward the Hilditch even-distribution theory. Table 14 (p. 73) however gives the observed mole % of fully saturated triglyceride and the mole % calculated for random distribution but not that calculated or estimated for even distribution.

Chapter 3 on Physical Properties covers melting points, boiling points, solubility and spectra as well as polymorphism and molecular structure remarkably well, considering the short space devoted to it.

Chapter 4, The Chemical Properties of Fats and Fatty Acids, is divided into four sections: I. Hydrolysis and esterification, II. Hydrogenation, III. Oxidation, including nonscission, scission, and autoxidative reactions (The newer methods of obtaining high yields of epoxy esters *via* peracetic acid is not recognized in this section [p. 103]), IV. Other Chemical Properties, including thermal polymerization, halogenation, and carboxylic derivatives, are covered quite well.

Chapter 5, The Synthesis and Utilization of Fats in Living Organisms, covers biosynthesis and metabolism of fats.

Chapter 6, The Chief Technical Applications of Fats, covers edible fats, soaps, glycerides, paints and varnishes very briefly but generally very well. Alkyds (p. 153) are perhaps slighted, in view of their great industrial importance, in comparison with blown oils and heat-bodied oils.

The text as a whole is well written and well organized. It will fill the need which exists for an introductory text for courses in colleges and universities and for industrial chemists to whom the field is new. It is a good introduction to the larger reference books, such as those of Hilditch, Eckey, Markley, and Ralston.

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