compressing and drying the combustion products of a gas or oil burner. Distribution of this gas to each storage tank may be controlled by flow orifices which limit the flow to each tank. The same inert gas system should be used to purge tank cars before loading.

Last, uniformity of product quality may be improved by providing good agitation in the storage tanks. This is particularly useful in the case of relatively large storage tanks, which are capable of holding several weeks' to several months' production.

The use of these procedures helps to insure a product in storage of much the same quality as that produced in the distillation columns.

Summary

The source of crude tall oil and methods to produce the oil have been described. These include acidulation of sulfate pulp, black liquor skimmings, and gravity settling as well as centrifugal means of separation to reduce the lignin content of the product.

Subsequent processing of the crude tall oil into fractionated fatty acids and rosin has been outlined with suggestions for consideration in all stages of the distillation section of the plant.

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The Nomenclature of Tall Oil Fatty Acids and Their Derivatives

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TALL OIL, a by-product of the Kraft paper industry, consists of a mixture of C_{18} unsaturated fatty acids, rosin acids, and relatively small amounts of saturated fatty acids, and unsaponifiables. Vacuum fractionation yields predominantly a fatty acid fraction and a rosin fraction; the saturated fatty acids and unsaponifiables are either almost completely removed in the overhead fraction or remain in the residue, which is called tall oil pitch.

We are concerned in this paper with the nomenclature of the fatty acid fraction and its derivatives. Although there is some geographical and seasonal variation in the ratio of fatty to rosin acid content, American tall oil fatty acid fractions can generally be considered to be a 1:1 mixture of octadecenoic (oleic) and octadecadienoic (linoleic) acids. Thus this fraction has an over-all unsaturation of 1.5 double bonds per molecule. It is this simplicity and consistency of composition which makes the tall oil fatty acid fraction different from most other natural source-derived fatty acids. Most others have at least three major constituents (Table I).

We believe therefore that for certain purposes it would be both desirable and possible to name this fraction, particularly its derivatives, in a manner which would be more indicative of their chemical nature than "tall oil fatty acids."

TABLE I
Major Components of Fatty Acid Fractions Derived from Natural Sources[a]

Acid	Coconut oil	Cotton-seed oil	Soybean oil	Tall oil
Caprylic	8			
Capric	7			
Lauric	47			
Myristic	18			
Palmitic	7	21	7	
Octadecenoic (oleic)	5	30	33	48
Octadecadienoic (linoleic)		44	51	50

[a] Percentages less than 5% have been ignored.

At present, no system of nomenclature is used consistently in this field. Generally tall oil fatty acids are either referred to as such or by trade names. Occasionally the term "TOFA" is used as an abbreviation. Derivatives are also either referred to by trade names or by derivation from "tall oil fatty acids."

As the use of the tall oil fatty acid fraction as a chemical intermediate increases, the need for a systematic nomenclature to describe its derivatives becomes increasingly evident. To many organic chemists the

TABLE II
Systems of Nomenclature for Tall Oil Fatty Acid Derivatives

"Tall Oil Fatty Acid" derived name	Trivial fatty acid derived name	IUPAC derived name	Octadeca (sesqui) enoic acid derived name
Tall oil fatty acid	Mixed oleic and linoleic acids	Mixed cis-9-octadecenoic and 9,12-octadecadienoic acid	Octadeca (sesqui) enoic acid
Tall oil fatty acid, metal salt	Mixed metal oleate and linoleate	Mixed metal cis-9-octadecanoate and 9,12-octadecadienoate	Metal octadeca (sesqui) enoate
Tall oil fatty amide	Mixed oleamide and linoleamide	Mixed cis-9-octadecenamide and 9,12-octadecadienamed	Octadeca (sesqui) enamide
Tall oil fatty amine	Mixed oleamine and linoleamine	Mixed cis-9-octadecenylamine and 9,12-octadecadienylamine	Octadeca (sesqui) enylamine
Tall oil fatty nitrile	Mixed oleyl nitrile and linoleyl nitrile	Mixed cis-9-octadecenenitrile and octadecadienenitrile	Octadeca (sesqui) enenitrile
Tall oil fatty alcohol	Mixed oleyl and linoleyl alcohol	Mixed cis-9-octadecen-1-ol and 9,12-octadecadien-1-ol	1-octadeca (sesqui) enol
Tall oil fatty aldehyde	Mixed oleyl and linoleyl aldehyde	Mixed cis-9-octadecenal and 9,12-octadecadienal	Octadeca (sesqui) enal
Hydrogenated tall oil fatty acid	Stearic acid	Octadecanoic acid	Octadecanoic acid
Hydrogenated tall oil fatty acid, metal salt	Metal stearate	Metal octadecanoate	Metal octadecanoate
Hydrogenated tall oil fatty amide	Stearamide	Octadecanamide	Octadecanamide
Hydrogenated tall oil fatty nitrile	Stearonitrile	Octadecanenitrile	Octadecanenitrile
Hydrogenated tall oil fatty amine	Stearylamine	Octadecylamine	Octadecylamine
Hydrogenated tall oil fatty alcohol	Stearyl alcohol	1-octadecanol	1-octadecanol
Hydrogenated tall oil fatty aldehyde	Stearyl aldehyde	Octadecanal	Octadecanal

term "tall oil fatty acids" does not adequately describe the simple chemical nature of the material with which they are dealing. Furthermore hydrogenation of these tall oil fatty acids yields octadecanoic (stearic) acid in a high state of purity; this product and any of its derivatives should certainly be named in accordance with this. In our own work we have found "tall oil fatty acids" names to be cumbersome when applied to many derivatives, unsuitable for modern chemical indexing, and inadequate for use in technical reports.

In an attempt to systematize the nomenclature, we are showing in Table II a comparison between a) "tall oil fatty acid" nomenclature, b) names derived from trivial fatty acid names, c) names based on an adaptation of IUPAC nomenclature, and d) an alternate system based on the use of the word "octadeca(sesqui)enoic acid" to describe the tall oil fatty acid fraction. The derivation of this word may be explained as follows:

$CH_3(CH_2)_{16}COOH$	octadecanoic acid (0 double bonds)
$CH_3(CH_2)_7CH{=}CH(CH_2)_7COOH$	octadecenoic acid (1 double bond)
$CH_3(CH_2)_7CH{=}CH{-}CH_2CH{=}CH(CH_2)_4COOH$	octadecadienoic acid (2 double bonds)
$R{-}(CH{=}CH)_{1.5}{-}R'{-}COOH$ (where R plus $R'{=}C_{15}$)	octadeca(sesqui)enoic acid

Octadeca(sesqui)enoic acid thus indicates an 18-carbon acid having 1.5 ethylenic double bonds. It lends itself readily to a succinct description of its derivatives, and it is shorter than any of the other systems, as can be seen from Table II.

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Monomer and Amino Resin Modified Tall Oil Fatty Acid Alkyds

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TALL OIL FATTY ACIDS have gained an increasing area of utilization in alkyd resins for surface coatings because of their low cost, high quality, and availability. The use of these materials with the newer polyols, such as trimethylolethane, has resulted in advantages in compatibility and resistance qualities over the more conventional resins. The High Polymer Alkyd Technique (1) has also contributed to the utilization of these acids, minimizing their previously experienced limitation of slower dry.

In general, the modification of alkyd resins for use in air drying and baking systems has extended the utility of these materials. Thus urea and melamine formaldehyde resins have been combined with medium and short oil alkyds for several decades to provide materials showing desirable color and gloss retention, chemical resistance, and improved durability in a variety of applications. More recently, alkyd resins have also been modified with vinyl monomers to result in compositions which have been termed copolymer or, in certain quarters, mixed polymer vehicles (2). Monomers of interest have included styrene, vinyltoluene, and methyl methacrylate. Through their use alkyd resins have led to vehicles showing light color, fast dry, good adhesion to metals, and resistance to water and chemicals.

The purpose of this paper is to describe the results of investigations of the use of tall oil fatty acids in medium and short oil resins based on trimethylolethane, prepared by a conventional and the High Polymer Technique. In turn, some of these systems were treated with styrene and methyl methacrylate monomers[1] or else mixed with urea formaldehyde or melamine formaldehyde resins.

Experimental Preparation and Evaluation Results

I. *Alkyd Resin Preparations.* All resins were prepared by the solvent (3) process in one liter, three-necked flasks with a thermometer, stirrer, and Dean Stark trap, surmounted by a water-cooled condenser attached. Heating was done with an electrical mantle connected to a variable transformer.

1. *High Polymer Technique. Medium alkyd—Molar ratio PA/TME/FA—1/1/0.7 (70% initial esterification level)* (4). To the flask were charged 222 g. (1.50 moles) of pthalic anhydride, 181 g. (1.50 moles) of trimethylolethane, 210 g. (0.73 moles) of low-rosin-content tall oil fatty acids, and 25 g. of xylol as azeotrope-former. The system was heated with stirring over a 2-hr. period to 245°C. and held for an acid number of 10.

An additional portion of tall oil fatty acids, 90 g. (0.31 moles), was introduced to the flask below the surface of the resin, and the system was again brought to 245°C. and maintained at this temperature until an acid number of 10 was reached. The resin was cooled to 140°C. and diluted to 50% nonvolatile content with xylol. The viscosity (Gardner Holdt) of the resin solution was B+. The viscosity-solids reaction for the various alkyds used in the study are summarized in Figure 1.

% Initial esterification	Gardner viscosity 50% NV in xylol	Acid number (on solids)
Medium oil (mole ratio = 1/1/.7 = PA/TME/FA)		
100	A	8.3
70	B+	10.0
50	A+	10.1
Short oil (mole ratio = 1/1/.42)		
100	U	9.7
70	V+	8.3
60	Z_3	7.7

FIG. 1. Tall oil fatty acid alkyds.

2. *Conventional Procedure Alkyd.* The conventional alkyd preparation, shown as the 100% initial esterification type in Figure 1, involved similar equipment and procedures except that all of the fatty acid was added at the beginning of the reaction.

II. *Monomer Modification (Styrene and Methyl Methacrylate).* Two hundred grams of the alkyd solution (50% nonvolatile) were charged to a one-

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[1] A previous paper by one of the authors (WMK) described the advantages of using trimethylolethane in monomer modified alkyd resins—ACS Division of Paint, Plastics, and Printing Ink Chem. Preprint Book, September, 1954.