Para Rubberseed Oil As a Substitute for Linseed Oil in Foundry Core Binders

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LABORATORY tests indicate that rubberseed oil from *Hevea brasiliensis* may be employed as a substitute for linseed oil in core binders. The high acidity characteristic of rubberseed oil apparently has no deleterious effect on its core binding properties.

Sand cores are frequently employed in the production of hollow metal castings, such as steam radiators, sewing machine heads, automobile and diesel engine parts, etc. In order to prepare a rigid core the sand is mixed with a binder and packed or "rammed" into a form of the desired shape. This "core box" is subsequently removed and the core is then baked (in the case of oil binders) until sufficiently hard to withstand the usual handling in the foundry. It is outside the scope of this paper to describe core making practice so the texts of Tate and Stone, Moldenke, Palmer, and Hartley[1, 2, 3, 4] on foundry technology should be consulted for details.

Undoubtedly linseed is the most widely used oil for core binding purposes and is generally considered to be ideal in this respect. The raw oil is employed in considerable quantities by the foundries in this country, both alone and mixed with rosin and mineral oil. Let us briefly review the more important requirements of an ideal oil binder:

1. *Mixing:* The viscosity of the binder should allow ready mixing and uniform distribution throughout the sand, each particle receiving a thin coat of binder.
2. *Oxidation:* The binder when mixed with sand must not oxidize so rapidly as to "gum up" the core box and mixing table or machine. After the box is rammed with the sand-binder mixture the core should leave the box clean.
3. *Green Bond:* The "green bond" or strength before baking should be such as to prevent the core from losing its shape when placed in storage or in handling when transferred from the core table to the oven.
4. *Baking:* The binder should not be susceptible to overbaking or burning but, from the standpoint of economy of heat and time, it should give a core of high strength quickly and at the lowest temperature possible. The gases produced on baking should not be offensive or highly inflammable.
5. *Core Strength:* The binder should produce a core of high transverse strength on baking so that it can be handled without breaking easily. The core should be sufficiently rigid to prevent the edges and details from crumbling on handling.
6. *Behavior in the Mold:* When the casting is poured the core should remain rigid until the metal in contact with it has set. The binder should burn out completely leaving no appreciable ash when the hot metal comes in contact with the core. The latter should be sufficiently porous as to allow the gases evolved to vent easily through it. The binder should not generate an unduly large volume of gas upon decomposition. The core should collapse readily to allow for the contraction of the casting and permit subsequent ease of cleaning.

We have gone to some length to detail these major requirements in order to trace the life of the binder from the initial mixing with sand to the final pouring of the casting. They will also serve to indicate what is expected of a satisfactory substitute for linseed oil.

Experimental

The rubberseed oil used in this work was purchased in Philadelphia and showed characteristics within the range given by Jamieson.[5] The oil was dark red in color and free from sediment. The acid number was found to be 39.0 which compares with 40.9 reported by Jamieson and Baughman.[6]

Clear, well-settled, raw linseed oil was used as the standard for comparison. The oil was taken from stock regularly employed in the manufacture of core binders.

If a drying oil is to compete with linseed for binding purposes it must produce a core which has a transverse strength comparable to that of the latter. Accordingly most of our work was devoted to the study of the strength of cores made with the two oils in a standardized procedure.

The technic developed for ramming and baking the cores and for determining the transverse strength has been described elsewhere by one of us.[7] Briefly, a sand-binder ratio of 50 to 1 was employed, using a high grade washed Ottawa sand. The cores were rammed by hand in a hardwood core box and were baked for 2 hours at 400° F. The cores thus produced were 12 inches long by 1 inch square. For the strength test the baked core was suspended on two uprights and the weight necessary to break the core at its central point was recorded as the transverse strength in pounds.

The cores were rammed and baked in series of three for each oil. The average strength of the three cores in the series was taken as the transverse strength given by each binder. The results are given in the accompanying table together with the strength of cores made from four other oils by the same procedure.

Series	Oil	Transverse Strength, Pounds	
1A	Raw Linseed	47.24	
1B	Raw Linseed	47.01	
1C	Raw Linseed	47.11	
	Average		47.12
2A	Rubberseed	46.96	
2B	Rubberseed	47.02	
2C	Rubberseed	46.90	
	Average		46.96
3A	Tung (Chinese Wood)		47.50
4A	Soy Bean		37.00
5A	Mustard Seed		33.25
6A	Cottonseed		31.00

The slight strength inferiority of rubberseed oil was not apparent in the ordinary handling of the cores. From the standpoint of binding properties we consider it equal to linseed oil.

Further experiments were conducted with a commercial binder composition of the following formula:

Raw Linseed Oil	40%
Rosin	15%
Paraffin Oil	45%
	100%

When rubberseed oil was substituted for linseed in this binder the strength of the baked core was inferior by about one pound. Even this difference could not be detected on general examination of the cores, particularly with regard to crumbling at the edges.

Attention is called to the high binding strength of tung oil. This oil was not seriously considered by us as the price differential usually favors linseed oil. Increasing production of American tung oil may change the aspect of this situation.

Aside from the binding properties rubberseed oil mixes easily with the core sand, does not gum up the core box, has good green bond and produces cores of satisfactory porosity. The baking time and temperature is the same as with linseed oil; in fact, other work seems to indicate that in the initial drying stages rubberseed oil absorbs oxygen at a faster rate than linseed. This will be made the subject of a subsequent paper. We could detect no adverse effects due to the high free fatty acid content of the oil.

The Availability of Rubberseed Oil

In a communication to the authors from the Chemical Division of the U. S. Bureau of Foreign and Domestic Commerce it is stated that certain quantities of the oil have been imported into this country, mostly for experimental purposes. There are, however, no official figures giving the amounts brought in.

Considerable interest has been manifested by the rubber planters and government agencies in Malaya, Dutch East Indies and Ceylon regarding the commercial exploitation of the oil. A large excess of seed over that required for replanting is now being produced and if a large commercial outlet is developed the oil could undoubtedly be produced in sufficient quantity. It should be procurable at a price substantially lower than that asked for linseed oil.

Our laboratory work leads us to the conclusion that para rubberseed oil may be substituted for linseed oil in foundry core binders. We hope that it will be an incentive for large scale foundry trials.

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Oil and Fat Analysis by the Thiocyanogen Method

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Introduction

THIOCYANOGEN $(SCN)_2$ behaves chemically much as a halogen midway between bromine and iodine in activity. Its reactions with certain of the unsaturated fatty acids are, however, unique. Those reactions peculiar to this reagent form the basis of a very convenient method of fat analysis first outlined by Kaufmann.

It has been rather well established that oleic, elaidic, erucic and brassidic acids add $(SCN)_2$ mol for mol exactly as they add the halogens. It is probable that their isomers and homologues do likewise. This addition takes place easily and quantitatively in the case of either the free fatty acids or their glycerides.

Linoleic acid takes up $(SCN)_2$ at only one of its two double bonds, while it absorbs halogens, of course, at both of them. Kaufmann has published evidence to prove the reliability of this reaction, though some others have disputed his statement that this reaction is truly quantitative for all the isomeric linoleic acids which may be present in a natural oil.

The behavior of linolenic acid when treated with $(SCN)_2$ has been a matter of some question. Kimura found that the methyl ester of a purified linolenic acid absorbed between 1 and 2 mols of $(SCN)_2$ per mol of acid. Kaufmann, however, has published data to show that the "isolinolenic" acid, as he termed it, occurring naturally in linseed oil adds two mols of $(SCN)_2$ per mol of acid, while the linolenic acid made by debromination of the hexabromide of this "isolinolenic" acid shows a totally different behavior. Kaufmann's thiocyanogen analysis of linseed oil, whether strictly accurate or not, seems to have given fairly consistent and reasonable results in the hands of several investigators.

The original method for the thiocyanogen analysis of fats was outlined by Kaufmann.[3, 4, 5] Some modifications of this method were suggested by Gerber,[21] Stadlinger,[6, 20] and Barbour.[8] Despite the fact that there are numerous references to the method in the literature, there has never been a detailed analytical method for the thiocyanogen analysis published in English nor does there seem to have been much attention given to standardization of the method. The method here outlined in detail is that of Kaufmann, including, however, all the suggested modifications which experiments showed to be desirable, and such other changes as were indicated by the experience of 18 months' continuous use of the method.

Analysis of a Fat by the Thiocyanogen Method

I. *Reagents*

1. Lead Thiocyanate
2. Anhydrous Acetic Acid
3. Bromine

1. *Preparation of Lead Thiocyanate* ($Pb(SCN)_2$)

100 g. of the finest C.P. Neutral Lead Acetate ($Pb(Ac)_2\,3H_2O$) is dissolved in 500 ml. of distilled water. Likewise 100 g. C.P. Potassium Thiocyanate (KSCN) is dissolved in another 500 ml. of water. The lead acetate solution is added slowly to the potassium thiocyanate solution with constant stirring. The precipitated $Pb(SCN)_2$ is filtered out in a Buchner filter and washed successively with distilled water, alcohol and ether. The $Pb(SCN)_2$ is dried as much as possible by drawing air through the filter cake, then it is stored in a desiccator over P_2O_5 for 8-10 days. This $Pb(SCN)_2$ should be a greenish or yellowish white crystalline product; if it is at all discolored, it must be discarded. Pre-