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Physio-Chemical and Mechanical Behaviour of (*Pinussylvestris*) as Binders on Foundry Core Strength

Fayomi, O. S. I^{1,2*}, Abdulwahab, M.¹, Gbenebor, O. P.² Popoola, A. P. I. ¹

¹Department of Chemical and Metallurgical Engineering, Tshwane University of Technology, Pretoria, P.M.B. X680, South Africa 0001

²Department of Mechanical Engineering, Covenant University, Canaan land, Ota, Ogun State, Nigeria

*Corresponding author: sunnyfayomi@yahoo.co.uk, popoolaapi@tut.ac.za

Abstract

The mechanical potential of sand core binders made with *Pinussylvestris* has been examined. Ota silica base sand bonded with 6% of cassava starch in admixed proportion of *Pinussylvestris* was tested for tensile, compressive strength and permeability to establish the binding efficiency. Tensile strength of the green baked core were oven baked at 50°C, 100°C, 150°C and 200°C. The cylindrically shaped permeability specimens were tested with permeability meter. Study revealed that *Pinussylvestris* showed an improve properties at 6% cassava starch at 200°C.

Keywords: *PinusSylvestris* foundry cores, cassava starch.

1. Introduction

Suitable molding raw materials for core making have been of great interest recently. Industries have shown interest in the use of locally sourcing binders for productions in order to boost the ailing economy¹⁻⁸. Cores are made of core sand mixtures from sand grains and binders⁶⁻¹¹. A proper and formulated admixture gives good green compressive strength and adequate baked strength to prevent premature collapse during usage. Binders are introduced into the molding and core mixtures in order to improve their properties especially the strength⁵⁻¹¹. The usage of *Manihotesculentacrantz* (Cassava Starch) for sand core processes has not been widely study in the literature, and hence the continue need to investigate its prospective with other binding additive such as pine oil in this respect is considered necessary. Cassava starch has therefore been chosen for the study because is easily sort for and cheap with excellent bonding features. Equally, cassava starch and pine oil has no negative health implication; they are environmental friendly for the production of sand cores and most importantly reduce the total addiction on foreign materials to promote the development of indigenous technology. This study aimed at producing sand cores locally using Ota silica sand, cassava starch and pine oil as binder and examining their suitability and behavior during casting process.

2. Experimental procedures

2.1 Materials

Base material used for this work was collected from Ota in Ado-odo Local Government in Ogun state, Nigeria. Binders which are cassava starch, was extracted from cassava tubers obtained from Arobieye in Ota, Ogun State, Nigeria. The pine oil was purchased from South Africa market. Equipment such as universal strength testing machine, weighing balance, mixer, measuring cylinder, specimen rammer, permeability meter, oven, shaker, sets of sieve, crucible furnace, hack saw machine, mould box, core box and wire brush were used.

2.2 Method

2.2.1 Preparation of *Manihotesculentacrantz*

Peeled and washed cassava tubers were grinded into pulp and water was added for extraction. The admixed particulate was left to stay for 180 minutes before the water above was poured. The starch residue was properly dried to white in line with (Popoola, 2011).

2.2.2 Sand preparation

The silica sand was collected from the Ota river side, washed to remove clay and dirt. The processed silica sand was dried and sieved using shaker of different meshes and aperture. The obtained and dried sand was studied with ED X-ray fluorescence analyzer for mineralogical composition is shown in Table 1.

Table 1: Mineralogical composition of the foundry sand used for the study



Composition	SiO ₂	Al ₂ O ₃	K ₂ O	CaO	TiO ₂	Cr ₂ O ₃	MnO	Fe ₂ O ₃	MgO	CuO	Na ₂ O
Wt%	Balance	0.58	0.08	0.34	1.60	0.02	0.02	0.45	0.16	0.04	0.04

2.2.3 Sieve Analysis

Standard sieve test of Bs 410 series to remove all coarse particles according to Popoola, 2011 was used. Weight of sieved sand sample values in Table 2 were used to calculate grain fineness number ($GFN = \frac{TotalProduct}{Total \% of retained grain}$) and fines (%).

Core mixture and core making

The mixtures constituent and % composition of the mixed oils are shown in Table 2 below.

Table 2: Composition of the mixed oils and starch

S/No	% Mixture
1	3% Starch + 2% pine oil + 3% water
2	3% Starch + 6% pine oil + 3% water
3	6% Starch + 2% pine oil + 3% water
4	6% Starch + 6% pine oil + 3% water

The blended admixed constituent was gradually put into 45 mm diameter by 50 mm height and immediately rammed with a rammer.

Subsequent to the ramming, the core specimen was ejected directly from the sleeve by a piston. Thereafter the ejected core was transferred to an electric oven with temperature of about 1200°C capacity.

3. Results and discussion

3.1 Sand mineralogy study

From the ED X-ray fluorescence analyzer for mineralogical composition during sand preparation it shows that the Ota sand contains 0.45%Fe₂O₃, 0.58% Al₂O₃ and 95.50% SiO₂. The silica content value is in line with the acceptable value suggested for moulding and core sands between 85% and 97%. According to Popoola, (2011) higher silica content is essential to resist the heat from molten metal during casting operation.

3.2 Comparative effect of baking temperature on foundry properties at various binders composition.

In Figure 1, the variation in foundry properties; CM, PM and B/SS as a result of the composition

admixture are compared along with baking temperatures. From the Figure, it is observed that these properties increased with change in composition at various levels of binder additions. Specifically, composition of 3% starch with 2%pine oil binder in all the baking temperature considered. While an increase in the starch content at 6% significantly improved the foundry properties for various levels of pine oil binders (see Figure 1 and 2). It can however be said that all investigated properties are favored at 150°C for most composition at all temperatures.

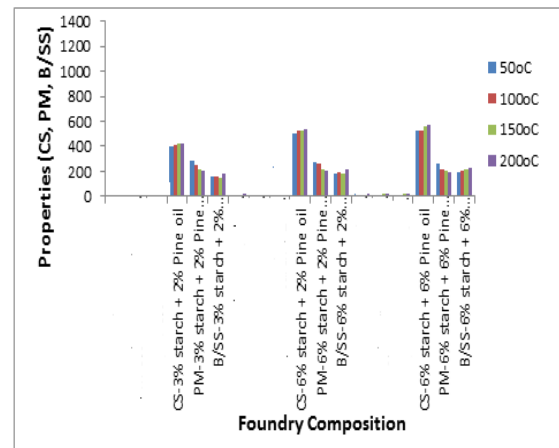


Figure 1: Comparative chart for combined foundry composition with 3%H₂O

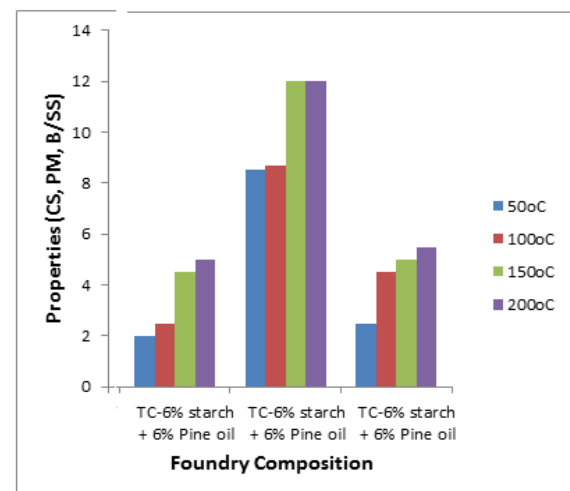




Figure 2: Comparative chart for TCs of different composition and at various temperatures

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4. Conclusions

1. The use of pine oil (*Pinussylvestris*) as potential binders on foundry core strength have been established to significantly improve foundry properties at different baking temperatures
2. The higher foundry properties can be obtained at 150°C baking temperature and that TC increases and decreases for some foundry compositions
3. It can be said that higher starch and oil additions favored PM value for pine oil in all admixtures. Higher TC for pine oil in all compositions is obtainable at 200°C baking temperature.

References

Fayomi, O.S.I, Ajayi, O.O, Popoola, A.P.I. (2011). Suitability of local binder compositional variation on silica sand for foundry core making. *Int. Jour. of Physical Sci.*, 6(8):1940-1946.

Paul, A., Jacob, J., Hamisu, M. (2007). The use of LP simplex method in the determination of the minimized cost of a newly developed core. *J. Mat. Sci.* 155–162.

Nuhu, A. A. (2010). Evaluation of the tensile strength of foundry cores made with hybridized binder composed of neon oil. *Inter. Journal of Physical Science*. Vol.5 (5):555-563.

Olakanmi, E.O., Arome, A.O. (2009). Characterization of the core binding properties of fatty based oil. *Inter. J. Physical Science* Vol.4 (11) pp, 623-628.

Silver, F., Maria, C. Z. (2007). Foundry waste reuse and recycling in concrete production. *Envi. J of Science*, 3(3):135-142.

Fayomi, O.S.I., Popoola, A.P.I., Ojo, O.I. (2011). Investigating Nigeria Ochadamu Silica Sand, Clay and Local oils for foundry core making. *Int. Journal of Physical Sciences*, Vol. 6(8):1894- 1904.

Abdulwahab, M., Gaminana, J. O., Bello, K. A. and Ochuokpa, E.O. (2008); Prospect of Local Core Binders in Foundry Industries. Proceedings of Nigerian Metallurgical Society. 25th Annual conference, Akure, Pp 210-213.

Ayoola, W. A., Adeosun, S. O., Oyetunji, A. and Olodoye, A.M. (2010). Suitability of Oshogbo Sand Deposit as Moulding Sand. *The Kenya Journal of Mechanical Engineering*, 6(1):33-41.

Charles, E. B. (2004); Advances in Core Making Technology. Penton media, Inc. Britain. P 2026. *Journal of Emerging Trends in Engineering and Applied Sciences (JETEAS)* 3(1):25-32

Tunji, A., Bankole, L.K. and Alhassan, A.O. (2009). Binding Characteristics of Mbushi and Ewekoro Clays of Nigeria in Foundry Moulding Sand. *Global Journal of Engineering and Technology*.2(4):509-514.

Popoola, A.P.I. 2011. Effect of molasses, cassava starch and arabic gum on mechanical strength of foundry core. *Journal of Scientific and Industrial Research*, 5: 1029-1032.