USING MAFURA NUT OIL IN THE MANUFACTURE OF METAL POLISHING PASTE

J.H.Y. Katima
Dept. of Chemical and Process Engineering, University of Dar es salaam
P.O.Box 35131, Dar es Salaam, Tanzania

ABSTRACT

A study was carried out to establish suitability of using mafura nut oil in the manufacture of metal polish paste. Preliminary results show that the paste made from 11% w/w sodium hydroxide solution 50% w/w mafura nut oil, 29% w/w abrasive material (emery powder in this case) and 10% by weight water glass gave a good metal polish. The surface produced could reflect light (a measure of good polish) and could resist rust than the original surface.

INTRODUCTION

Polishes are essentially used to restore the original lustre and finish of smooth surfaces. The polishes also clean surfaces to prevent corrosion or deterioration. Polishes are usually manufactured using emery powder (Al_2O_3), tallow, sodium hydroxide solution (NaOH) and sodium silicate, commonly known as water glass, ($NaSiO_3$). The objective of this study was to assess the suitability of mafura nut oil as a substitute for tallow in the manufacture of polish paste since the latter is imported and the former is locally available.

Previous studies e.g. Fupi (1980), Fupi and Knut (1984), Said (1989) and Mariki (1991) have concentrated on using the mafura nut oil in the manufacture of both toilet and laundry soaps. They all report positive results, although, because of dark colour and bad smell, the oil requires further treatment or purification and deodorization before it can be used to produce soap of acceptable quality. Table 1, compares the chemical composition of tallow and mafura nut oil.

Table 1: Composition of Mafura nut oil and Tallow

Fatty acids	Tallow % w/w[5]	Mafura oil % w/w[1]
myristic	3-6	-
Palmitic	25-37	38.3
Stearic	14-29	2.2
Oleic	26-50	48.5
Linoleic	1-2.5	10.4
Linolenic	-	1.0
Total		100.0

Oleic acid, which is present in both oils, is an important ingredient in the manufacture of polishes as it enhances stability, and hardness of the final product [1,2]. From this observation it was assumed that mafura nut oil also be used in the manufacture of polish paste.

LITERATURE REVIEW

Mafura oil: Mafura oil is extracted from seeds of mafura tree, *trichia ematica*, which grows about 2000 m above sea level and needs preferably 500 - 600 mm of rain per year. Here in Tanzania the mafura trees grow in South West (i.e. Kyela and Tukuyu in Mbeya Region). The mafura nut oil contains four fatty acids, namely; palmitic, stearic, oleic and linoleic fatty acids. The oil is pale yellow and fat (mainly from the kernels) is pale yellow to brown. Oil and fat and meal cake from the whole seed have strong bitter and emetic properties. During the years of commodity scarcity in Tanzania (i.e the late 70's and 80's) mafura nut oil was used to produce soap. Up to 100 tonnes of nuts (producing up to 40 tonnes of oil) used to be processed. However, as mentioned above the soap from mafura nut oil has bad strong emetic smell and dark colour which could not compete with influx of toilet and laundry soap after trade liberalisation of the late 80's. The plants which were producing soap from mafura nut oil (i.e. Kyela soap works in Kyela district, Nyemba soap works in Rungwe district and Ukonga Prison soap works in Dar es Salaam) are no longer processing mafura nut oil. Currently, the estimated 500 (plus) tonnes per year of mafura nuts have no useful purpose[1].

Tallow: Beef tallow contains mainly five fatty acids myristic, palmitic, stearic, oleic and linoleic acids. In addition it contains up to 48% characteristic branched and odd numbered fatty acids. Tallow also contains 6 - 10% of trans fatty acids, resulting from bacteria hydrogenation in the rumen. The stability of beef tallow and its products is relatively poor in the absence of an added anti-oxidant. Tallow which is mainly used in soap production is imported.

Metal Polish: In industrial metal finishing, polishing is an abrading process involving the use of coarse abrasives which remove significant amounts of metal from a surface leaving visible line pattern[5]. Buffing is the smoothening of the resultant surface and involves the use of fine abrasives to reduce the dimensions of the polishing patterns. The only requirement for metal surface to reflect light is the surface roughness to be small compared to the wavelength of incident light[5].

The polishing is done by wheels faced with abrasives and glue. The abrasive used are either emery or artificial alumina. There are three basic forms in which abrasives are used; loose, granular or powdered particles; particles bound with various agents into wheel, segmental or stick shape; and particles deposited with glue or synthetic resins on paper or cloth and known as coated abrasives. The abrading process is a term which covers the use of abrasive, either in loose form or bonded into grinding wheels[5]. If run at high speeds polishing wheels should be faced with lubricating binder such as tallow or a mixture of tallow and lard oil to prevent them from overheating. At times it might be necessary to remove grease from the surface of the metal. The common method of removing grease is by emulsification with alkaline solutions. However, tallow and other vegetable fats have surfactant (i.e. surface active agent) property and thus promotes emulsification and dissolution of oily and greasy substrates from the surface being cleaned[7]. From the foregoing discussion it can be seen that tallow serves three purposes in polish, namely; as a binder, as a lubricant and as a surfactant.

Emery is an intimate mixture of aluminium oxide (Al_2O_3) and magnetite (Fe_3O_4) with or without hematite (Fe_2O_3) and varying in hardness and toughness according to the iron oxide present. To produce specific grit sizes screening is used for coarse ones (> 50 μm in diameter).

Some metal polish paste in the market: Although the composition of polish paste differs depending on the application the following composition are given to show typical pastes available in the market.

Polish Paste "Bellit" nr. 40FS (used in glazing)[8]

Ingredients	Percentage % w/w
Stearin	39.0
Oil	2.5
Tallow fatty acids	5.0
Beef tallow	7.5
polishing element	
nr. 220	23.0
nr. 250	23.0
Total	100.0

Instead of stearin, tallow fatty acids and cow tallow, other animal fats may be used. For oil, colza oil (rape seed oil) or drilling oil is used. If paste is to be used for griding purpose oxide of alumina may be replaced by wanted emery.

Polish Paste "Bellit" nr. 41 (used in mirror finish paste)[8]

Ingredients	Percentage % w/w
Stearin	33.0
polishing element	
nr. 210	67.0
Total	100.0

Instead of stearin, tallow fatty acids and cow tallow, other animal fats may be used.

Pine metal oil polish[8]

Ingredient	Percentage % w/w
Tripoli powder (SiO_2)	20.0
Oleic acid	7.0
NaOH (100%)	0.5
Yamor oil	25.0
Water	47.5
Total	100.0

Paste Metal Polish[8]

Ingredients	Percentage % w/w
Hard soap*	10.0
Hot water	50.0
Fine silica	30.0
Kieselguhr	8.0
Pine oil	2.0
Total	100.0

* Hard soap produced using saturated fatty acids and sodium hydroxide)

Several other polish formulas may be found in reference 8.

EXPERIMENTAL PART

There are various formulas in the manufacture of both liquid and paste polishes as shown above. This depends on the type of metal to be polished, surface roughness desired, purpose of the polishing (e.g. glazing, buffing or oiling). In this research Tanzania Mechanical Engineering Co-operative Ltd. (TAMECO), Ubungo Farm Implements Ltd. (UFI), Mbeya Farm Implements (firms which manufacture hardened steel and stainless steel products with Mohr hardness of 4 and 4-7), who are the main users of polish paste were, targeted.

Experimental set A:
A mixture of Mafura oil and NaOH was heated to 100 - 130 °C until saponification took place. $NaSiO_3$ was added to the soapy paste to enhance binding action. While constantly agitating with relatively high speed stirrer, abrasive material (i.e emery powder) was added to the soapy paste. The stirring is essential to ensure homogeneity of the mixture. The soapy paste was left to set (setting time depends on the concentration of NaOH e.g. high concentrations of NaOH result into shorter setting times).

Experimental set B
Same procedure as explained above was used except that water glass was not used. However, because of very low viscosity higher agitation speeds have to be employed to ensure that the solid particles of the abrasive material do not settle down.

Since the objective of the research was to assess polishing process, particle sizes of range 150 - 180 μm, and > 180 μm (but < 200 μm) were used.

Polishing Process: A set of untreated knives, as well as standard treated knives were donated by TAMECO for polish performance test. Testing was done using two rollers rotating in opposite direction, as shown schematically in Fig 1, a method used by TAMECO in the polishing of knives.

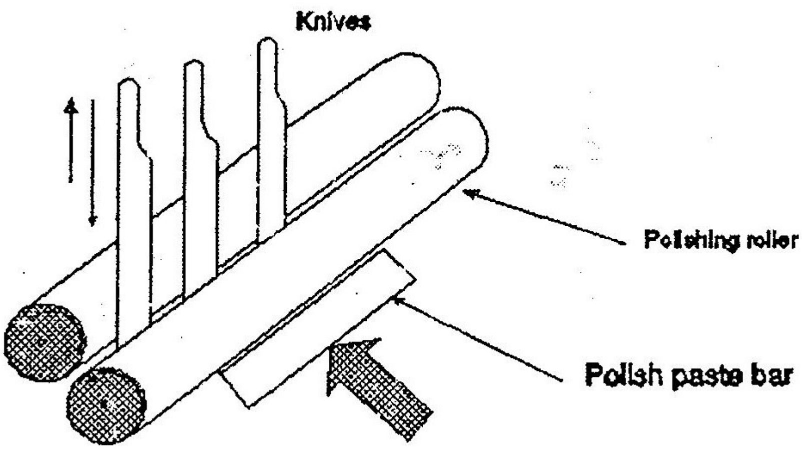

Fig. 1 Polishing arrangement

RESULTS AND DISCUSSION

General observation

Experimental set A

- Setting time (solidification rate) was found to be a function of NaOH concentration. With 10% w/w NaOH concentration setting time took between 2 - 3 hours, whereas with 40% w/w it took 30 - 60 minutes.

- The homogeneity of the product was also affected by NaOH concentration. 40% w/w NaOH gave a relatively poor homogeneity, probably due to high setting rate which has to be matched with high agitation rate if homogeneity is to be ensured. 10% w/w NaOH gave a product with fairly good homogeneity.

- Finer the particles(e.g. < 63 μm) better was the homogeneity of the mixture.

From a set of sample runs two sets of polish bars (made using 10% and 40% w/w NaOH) were manufactured for performance test.

Typical Ingredients	% w/w
NaOH (10% and 40% w/w)	11.8
Abrasive solids (particles 150 -180 μm, > 180 μm)	24.3
Mafura nut oil	40.5
Water glass	23.4
Total	100.0

Experimental set B

- The polish so produced had very low viscosity probably due to lack of $NaSiO_3$. As a result the abrasive solids tended to settle quickly. Constant mixing with high speed stirrer was essential to keep them in solution.

- Rate of solidification was very high, however, bulkiness was reduced.

One set of polish bars were made for performance test.

Performance results

Experiment no. A.1

- Particle size more than 180 μm.
- 40% NaOH concentration.
- The results were fairly satisfactory in terms of surface finish.
- The melting property of the paste was poor during application for a 40% NaOH solution. The paste was hard to wear which could result into danger of pitting and overheating and decreasing in lustre, however, the cutting quality increased.
- Polishing time, takes 3 to 10 minutes.
- A polished sample showed resistance to rust when exposed to atmospheric air compared to unpolished surface.

Experiment no. A.2

- Particle size between 150 - 180 μm.
- 10% NaOH concentration.
- The paste wear smoothly and melts easily.
- Polishing time takes 3 - 10 minutes.
- The lustre obtained was good but not of a mirror finish. However when the sample was polished three time a mirror finish was obtained.

Experiment no. B.1

- Particle size more than 180 μm.
- No water glass used.
- 10% NaOH concentration.
- It wear satisfactory on the polishing wheel.
- Final lustre was not good and the melting property was high due to absence of the binding material ($NaSiO_3$)
- Its resistance to rust was not as good as that obtained in experiment A.1.

Experiment no. A.3

- Particle size between 150 - 180 μm.
- 10% NaOH Concentration.
- Water glass ($NaSiO_3$) was reduced by 50% to increase softness and easy wear during polishing.
- Oil contact of the final product improves the melting properties.
- A smooth surface was obtained.

Although, it has been stated that there is no general procedure which can be given for all objects due to large number of factors to be taken into account, for the kind of metal used by TAMECO and UFI, the experimental results suggest the following composition for suitable results.

Ingredient	%w
10% NaOH	11
$NaSiO_3$	10
Mafura oil	50
Emery powder	29

Particle size of between 150 - 180 μm.

However, Only one type of abrasive (of a constant ratio Al_2O_3 to Fe_2O_3) was used. This affected the final lustre of the product by giving a unique pattern of results. This suggest that further studies are still needed to perfect the results.

CONCLUSION

Mafura nut oil can be used in the manufacture of metal polish paste. Preliminary results show that a mixture of 11% NaOH, 50% mafura nut oil , 29% emery powder and 10% water glass give good results. The suitable particle size for polishing operation ranges between 150 - 180 μm. The concentration of NaOH should not exceed 10% to avoid excessive hardness of the soap which affects melting properties and hence the performance of the polish paste. The melting properties can be enhanced by keeping the oil content in the final product to 50 - 55. The binding material should not exceed 10% w/w to decrease hardening of the final product. The results show that the resulting paste provides resistance to rust, short polishing time (5 - 15 minutes) and desired physical properties (e.g. easy to melt).

RECOMMENDATION

The final lustre obtained was not the best compared with standard specifications or samples from TAMECO. It is thus recommended that more experiments, using different kind of abrasive material and different ingredient composition be carried out done to establish the suitable combination. Since it has been shown that it is possible to produce polish paste from mafura nut oil, it is hopped that local entrepreneur would come forward and collaborate with the Department of Chemical and Process Engineering to further develop and commercialise the product.

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