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Palm Oil Based Wax Material for Prototype Application

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ABSTRACT

At the moment, different ferrous and non-ferrous materials, industrial blue wax are used for prototype models, training purposes by different industries, educational and training organizations. However, the price of such material is very expensive. Hence, an attempt is made to substitute these materials by the palm oil based wax produced in Malaysia. With it, engineers can generate prototypes to evaluate even minor design changes without breaking the budget. This paper gives the approaches taken in this direction.

INTRODUCTION

Palm oil's unique composition makes it versatile in its application in food manufacturing and in the chemical, cosmetic and pharmaceutical industries, while its technical and economic superiority makes it preferable as base material in the manufacture of various non-edible products. The importance of materials - related problems in product development is seen to be increasing and the current focus on manufacturability and life - cycle issues in design means that, increasingly these are problems with existing, rather than with new, materials. Hence, there is a growing interest in the correct use of materials information as well as in developing new materials. Industries may be able to produce a low cost prototype that could be assembled to check dimensions and verify their CNC program for production. Many people, such as the Production Engineer, the Process Engineer, the Plant Engineer and the Quality Engineer, may assist in converting the specifications into the desired finished Product. Success in machining, as with other processes, is largely measured by its economy. Generally, the separate items of machining cost may be apportioned among equipment, tool wear, breakage, waste material and time .The two primary objectives of "significantly reducing prove out time" and "keeping prototype evaluation costs to a minimum" are very important for any manufacturing industry.

THE DESIGN PROCESS FOR PROTOTYPE APPLICATION

An individual component made from a single material with a specified set of required behavior is taken as the basic item on which materials selection techniques are practiced. We have to consider the entire course of the design of an engineering component. The design passes through many hands. Typically, it is initially designed on a CAD system and then passed to a numerical analyst who meshes the geometry and runs a series of finite element analyses to assess its fitness for the use to which it will be put. e.g. stress and temperature analyses, creep, thermal expansion, and perhaps some attempt to predict fatigue life. The analyst passes the design back to the designer in an interactive loop that refines the geometry and modifies materials selection. When the design becomes stable the complete set of component drawings is passed to the manufacturing engineer who assesses the part for ease of manufacture and ideally makes only fine tuning adjustments to the geometry and selected material. Finally, maintenance issues and the environmental factors of disposal and recycling may be considered.

MANUFACTURING TECHNOLOGY

Manufacturing is the essential basic strength of any industrialized nation. Although increasingly larger segments of any population may be employed in service industries, it is manufacturing that produces the wealth of the nation. The fact is that a big step in integration of design and manufacture has been brought about by the computer in Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM) leading to Computer Integrated Manufacturing (CIM). With all these aids, the task of Engineers becomes easier and the manufacturing processes become much faster.

Machining Operation

A large volume of machining is still performed manually by machine operators who rely both on technical knowledge and skills developed by training and practice. Machine tools are being developed with innovations using computer control to increase productivity and improve the quality. Despite these improvements the basic nature of machining remains the same, to use machine tools and cutting in combination to reduce a piece of material to some specified shape and dimensions in a economical and practical manner while maintaining the quality and reliability requirements for functional application.

Making a Prototype

Ever increasing advances in the sophistication of CAD/CAM systems have yet to clear one persistent hurdle where designers rarely know with true confidence whether the design viewed on their CAD screen accurately represents the concepts in their mind. Although CAD tools are at the designer's disposal to minimize errors and maximize design quality such as photo realistic visualization, assembly analysis, kinematics and stress analysis techniques and even emerging virtual reality, the design still remains intangible and in question until an actual physical model is produced. The demand of translating the CAD drawing quickly and accurately into solid object leads to the idea of making a prototype. By this method, the designer can see and hold their creations before investing considerable time and money in the construction of a working prototype. Traditionally, design engineers have used costly and time - consuming fabrication processes that are similar to actual production techniques to built prototypes of their creations. Most design budgets and deadlines allowed for only a few prototypes to be built. The designers could not afford to have prototypes made to evaluate every small design. Working under these limitations, engineers frequently had to send parts into full production, before they could thoroughly test and perfect the design. However, with suitable materials, the cost of each prototype can be reduced. With it, engineers can generate prototypes to evaluate even minor design changes without breaking the budget. This also makes it possible for designers to make prototypes at each stage in designer's evolution, to determine whether or not the changes they introduce are beneficial to performance. Not only should the cost be taken under consideration, the ability of the material to perform as the actual applications of the working prototype will add to the advantages of prototype making.

WHY INDUSTRIAL WAX

Materials used for the purpose for training and making prototype normally are ferrous and non-ferrous materials and their alloys. Prototypes normally are mild steel and aluminium, but there are other material used such as alloy steel, cast iron, copper alloys, phosphor bronze, magnesium alloy, plastic, and other composite materials. Computer controlled machining and designing methods have revolutionized manufacturing worldwide. With these advancements has arisen a growing need to evaluate data "up front" more economically and safely, in less time and with accurate results. Because of these concerns the material used in the "prove - out" phase has become a major factor. Unlike metal, plastic and wood, wax is very machinable, dimensionally stable, safe to work with and very economical because it is reclaimable and remachinable. (Figure.1). It is not only realized significant time savings in the prove-out project, but able to produce a low-cost prototype that could be assembled to check dimensions and verify the CAD/CAM program for production.

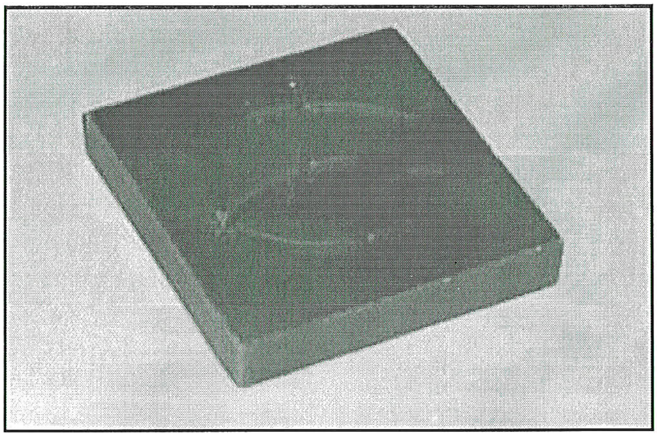

Figure 1. Industrial Blue Wax.

FATTY ACIDS

Fatty acids are the most important of the basic oleochemicals. They can be subjected to various chemical modifications to produce different types of fatty acid derivatives. Fatty acids are also known as the "gate-way" to other oleochemicals. Fatty acids are industrially produced from splitting of fats at high temperature and pressure carried out by the oleochemical companies. The fatty acids mixture produced is separated into broad cuts or pure fatty acids by simple or fractional distillations. They can be further processed to customer-tailored products such as single, double and triple pressed stearic acid. Triple pressed stearic acid is suitable for cosmetic and pharmaceutical application.

PALM OIL BASED WAX

The oil palm was first introduced to Malaysia as an ornamental plant in 1870 and has now become the main corner stone of the country's agriculture sector. Currently in Malaysia, palm oil based waxes are used extensively as candles for decorative purpose and for food warming. Present day candles are made from blends of paraffin wax and stearic acid, usually referred to as "Stearin" in trade. Commercial stearic acid is really a mixture of palmitic and stearic acid, a major source of which is palm oil. The physical and chemical properties of Malaysian crude palm oils have been determined with great thoroughness by Palm Oil Research Institute.

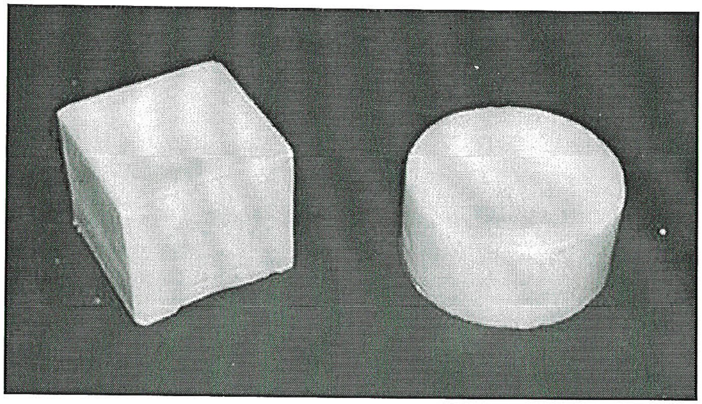

Figure 2. Palm Oil Wax.

The Production of Wax

Palm oil based wax is produced by a combination of stearic acid and paraffin wax with approximate composition 70%/30%. Stearic acid is a hard, white, wax like solid obtained from the palm oil. It also can be found in other vegetable and animal fats. Stearic acid has a specific gravity of 0.092 to 0.0935 and a melting point at about 60°C. It can be made by hydrogenation of oleic acid. Palm oil, which after hydrogenation gains a basic composition of 45% palmitic and 55% stearic acid, is a good source of the most important fatty acids and its increasing rate of production guarantees plentiful, supplies in the future. The stearic acid / paraffin wax blends is heated at a temperature of about 60°C and then poured into the mold and made available in standard sizes of blocks and cylinders as well as bulk for those who prefer to melt the wax and pour it into their own aluminium molds.(Figure. 2). If the standard size does not include the size then non-standard sizes can be made.

Properties of Palm Oil Based Wax

The mechanical properties of material may include tensile strength; yield strength, hardness, toughness, and ductility. Other property of material includes specific gravity, flash point, softening point, volumetric shrinkage at room temperature and colors. The preliminary studies with machining processes like turning, drilling and milling indicated that the palm oil wax might be used as machinable wax for industries in Malaysia.

SUITABILITY OF PALM OIL BASED WAX FOR PROTOTYPING

Machinable Material

One can easily machine the palm oil based wax, without the need for costly coolants or lubricants. Because of its self-lubricating characteristic, the wax is non-abrasive and hence, there is no tool wear and tear. When machined at high spindle speeds and feed rates, there is no built up edge formation.

Safe Material to Work with

The palm oil based wax has sufficient flash point and hence it is safe to work. It is formulated with non-toxic chemicals, will not release any offensive or hazardous dust particles or odors during or after machining. Palm oil based wax does not require coolants for machining. It will not produce sharp machine chips like metals, which otherwise could be unsafe.

Reclaimable and Reusable Material

The palm oil based machinable wax can be melted down after use and poured into an aluminium mold and remachined. The wax can be reclaimed with all its original properties and will not lose any of its original properties from reclaiming. It can be melted and poured to produce the required size pieces for machining. This will reduce the cost even further.

CONCLUSION

Palm oil based wax gives good dimensional accuracy during the machining operations such as turning, drilling and milling. There is no built up edge formation. Since the wax has its own lubrication, allows it to perform the machining without lubricant. Because of the self-lubricating properties, the abrasion did not occur during machining operation. Palm oil based wax is machinable within the specified tolerances that will provide a dimensionally accurate prototype that may be assembled for checking. There are more possibilities to substitute the paraffin based industrial wax with palm oil based wax after up gradation, for industries. At the moment, different ferrous and non-ferrous materials are used for practical training purposes by different educational and training organizations. However, the costs of such materials are very expensive. In the place of these expensive materials, the low cost palm oil based wax may be used for prototyping and other purposes. The wax may be recycled and the cost of palm oil based wax is very economical and lowest when compared with other wax and other materials available in the market. Further studies of the palm oil wax is required to improve the basic properties and it might be further improved and up graded similar to industrial blue wax.

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