NEED TO DEVELOP CANE WAX PRODUCTION BY THE WORLD SUGAR INDUSTRY

P. J. Manohar Rao
Ministry of Agriculture & Irrigation
Government of India
New Delhi, India

ABSTRACT

Sugarcane is the single largest source of vegetable wax. Extraction of sugarcane wax from press mud (filter cake) needs the attention of the world sugar industry to perfect the process and the product (cane wax), which is of immense use in many industries.

Sources and properties of different types of mineral waxes, vegetable waxes and animal waxes and their industrial uses are given in order to compare the sugarcane wax with other waxes, particularly Carnauba wax, which is considered to be the best vegetable wax widely used in many industries.

Laboratory scale, as well as commercial scale trials conducted in different countries to extract sugarcane wax from press mud are briefly touched. The process and plant along with flow sheets entirely developed in India and being used by a sugar factory in India for the extraction of sugarcane wax from press mud have been described in detail for the benefit of the world sugar industry. The lines on which further research work should be conducted for the development of cane wax industry are indicated.

INTRODUCTION

Waxes are being used since time immemorial in many countries for various purposes. For instance, even before the birth of Christ, Egyptians used waxes for making mummies. The use of wax for the manufacture of candles, models and as coating material has been known for a very long time.

In the natured different kinds of waxes are available from minerals, plant material, insects and animals. In addition to these, waxes are also produced synthetically and as mixtures of the different varieties of natural waxes. Perhaps no other material can be obtained from such a wide variety of sources as the wax.
Some of the important varieties of waxes obtained from different sources are as follows:

A  MINERAL WAXES
Paraffin wax  Fir wax
Montan wax  Japan wax
Lignite wax  Uricury wax
Ozocerite wax  Palm wax
Ceresin wax  Rice oil wax
Utah wax  Sugarcane wax
Peat wax  Ucuhuba wax
Cocoa butter wax

B  VEGETABLE WAXES
Bay Berry wax  Bees wax
Candelillia wax  Chinese wax
Carnauba wax  Shellac wax
Cotton wax  Spermaceti wax
Esparto wax  Wool wax

C  ANIMAL WAXES

There are many other varieties of synthetic waxes, which may not require elaboration in this paper.

The form in which some of these important waxes are obtained in the nature is explained briefly in the following paragraphs:

**Mineral waxes**

Paraffin wax, which is the most important of the mineral waxes, is obtained from the high boiling fractions during the refining of the petroleum crude. The refined paraffin wax, which is very commonly used for various industrial purposes has a melting point of 50 to 51°C. From the petroleum crude itself another variety of waxes known as micro-crystalline waxes are also obtained from the residual fractions in the still along with heavy residual lubricating oil and asphalt. Both the paraffin wax, as well as the micro-crystalline waxes are long chain compounds but the latter have higher molecular weight.

Montan wax’s is obtained by the solvent extraction of low grade coals like lignite, brown coal, etc. This wax is more similar to vegetable waxes as compared to paraffin wax and contains approximately 79% Carbon, 12% Hydrogen, 0.3% Sulphur, etc. It is brownish black in color and melts at 84°C. When the color is not of importance in any industrial product, Montan wax is a good substitute for Carnauba wax. Other mineral waxes which are of less importance require a brief mention. Lignite wax is obtained from low grade coal known as lignite and has a melting point of 70-84°C. Ozocerite wax is obtained from earthy materials obtained mostly in U.S.A. Ceresin wax and Utah wax are similar to Ozocerite wax. Peat wax is obtained from low grade coal known as peat in England.
Vegetable waxes

In the vegetable kingdom, waxes are found as coatings on the leaves, and, fruits or as envelop of many seeds. Wax is also obtained from the cuticles of many plants. The presence of wax in the vegetable kingdom, particularly in the tropical countries in nature's arrangement to reduce the rate of evaporation of moisture from the different parts of the plant. The extraction of wax from any vegetable materials is more or less similar in all cases, i.e. scraping as much wax as possible from the portions of the plant, either in the green stage or dried stage and later on boiling the plant material in water when the wax melts and floats to the top, which is removed and purified further. The form in which some of these important vegetable waxes occur is explained in the following paragraphs.

Bay Berry wax is obtained from berries of a shrub. The wax is greenish white in color. Candellila wax is obtained as scales on the reed like plant grown widely in Mexico and Texas. Caruaba wax, which is a very important and widely used vegetable wax, is obtained from the leaves of Brazilian Carnauba palm known as the "Tree of Life" (Copernica Cerifera). The palm tree grows to a height of 12 to 15 meters in a period of 50 years; each leaf produces an average of about 4 to 7 gms. of wax. The leaves are cut during the period September to March and are tied to long bamboo poles and dried in the sun. The scales of dried wax from the leaves are removed by beating and shaking the leaves. The rest of the leaves are boiled in hot water when the wax melts and floats, which is removed and mixed along with the scales of wax obtained earlier and the whole mass is re-melted and further purified by bleaching etc. Carnauba wax is the world's most valuable wax as it is the hardest natural wax with highest melting point and therefore used for increasing the hardness, toughness and luster of other kinds of waxes. It has a color varying from yellow to brown and a melting point from 82.5- to 86°C. The composition of average kind of Carnauba wax is as follows:

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alkyl wax acid esters</td>
<td>84 to 85 %</td>
</tr>
<tr>
<td>Wax acid (free)</td>
<td>3 to 3.5 %</td>
</tr>
<tr>
<td>Alcohol s</td>
<td>2 to 3 %</td>
</tr>
<tr>
<td>Lactides d</td>
<td>2 to 3 %</td>
</tr>
<tr>
<td>Hydro-Carbons</td>
<td>1.5 to 3 %</td>
</tr>
<tr>
<td>Resins (Alcohol soluble)</td>
<td>4 to 6 %</td>
</tr>
<tr>
<td>Moisture and inorganic content</td>
<td>0.5 to 1 %</td>
</tr>
</tbody>
</table>

Cunha Bayma indicated the details of cultivation of Carnauba Palms process for extraction of carnauba wax, types of carnauba wax, industrial application of wax, substitutes for carnauba wax, trade in wax etc.

Esparto wax is obtained as a coating on Esparto grass found in North Africa and Spain. This grass is used for the manufacture of paper and during the process, the wax is separated by initial dusting and subsequent boiling of the grass with a volatile solvent. Fir wax is obtained from the bark of Douglas Fir Tree. Japan wax is obtained as a coating on the berries of Japanese Sumac tree. Ouricury wax is obtained from the leaves of Ouricury Palm grown in Brazil.
Animal waxes

In nature, some of the waxes are present in certain portions of the bodies of different land and marine animals and on the hairs of some animals. Similarly, waxes can also be obtained from the cellular fabrications of bees (honey Combs) and some insects.

Bees wax is the secretion of the honey-bees for building their combs. It is composed of Myricyl Palmitate, Ceric acid and Homologous Acids with small amounts of Hydro-Carbons etc. Bees wax has a color varying from yellow to deep brown with a melting point of 62 to 70°C. This kind of wax is widely used for various purposes. Chinese wax is obtained as a secretion of certain insects in China on the branches of a species of Ash tree, Shellac wax is obtained as a secretion of the scale insect "Coccus Ceriferus" deposited on the branches of certain spices of the trees. Thus kind of wax is also similar to Carnauba wax in hardness and luster. Spermaceti wax is obtained from the head cavities and the blubber of the Whale. This wax is present in the Whale Oil and is separated by chilling the oil at 0°C for several days before pressing the solidified mass in a hydraulic press. The spongy mass obtained in this way is the crude wax which is further purified by boiling it with dilute alkali solution and thereafter washing it free from alkali and moulded into cakes. Wool wax is extracted from crude sheep's wool. Wool wax, when refined and properly blended, is known as Lanolin, which is one of the few greasy substances that are absorbed by the skin for softening of the skin and therefore widely used in a skin food preparations.

COMPOSITION OF THE WAXES

Waxes are chemically esters of the high molecular weight monohydroxy alcohols and high molecular weight carboxylic acids. The physical characteristics of some of the natural waxes which are commonly used for various industrial purposes are given in Table 1.

**TABLE 1.** Physical characteristics of different waxes.

<table>
<thead>
<tr>
<th>Name</th>
<th>Specific gravity 15/15°C</th>
<th>Solidification point</th>
<th>Acid Value</th>
<th>Saponification value</th>
<th>Iodine value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ANIMAL WAX</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spermaceti (Kogia)</td>
<td>0.905-0.960</td>
<td>41.49</td>
<td>0.5-3.0</td>
<td>121-135</td>
<td>2.5-8.5</td>
</tr>
<tr>
<td>Spermaceti (Physeter Catodon)</td>
<td>0.908-0.945</td>
<td>42.47</td>
<td>0.8-2.8</td>
<td>126-136</td>
<td>3.8-9.8</td>
</tr>
<tr>
<td>Wool Fat</td>
<td>0.970-0.973</td>
<td>38.40</td>
<td>59.8</td>
<td>82-130</td>
<td>17-29</td>
</tr>
<tr>
<td><strong>INSECT WAX</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bees Wax (Indian)</td>
<td>0.953-0.970</td>
<td>61-67</td>
<td>5.0-67</td>
<td>87-117</td>
<td>4-10.5</td>
</tr>
<tr>
<td>Bees Wax (Ordinary)</td>
<td>0.953-0.970</td>
<td>62-66</td>
<td>17.0-21.0</td>
<td>88-100</td>
<td>8-11</td>
</tr>
<tr>
<td>Chinese Insect wax</td>
<td>0.960-0.970</td>
<td>80-85</td>
<td>1.9-8.9</td>
<td>78-93</td>
<td>1.0-2.5</td>
</tr>
</tbody>
</table>
This data will facilitate the comparison of the properties of cane wax with other waxes, particularly the famous Carnauba wax which is widely used for industrial purposes. The average physical characteristics of the Refined Cane Wax, as determined by a number of research workers are as follows:

<table>
<thead>
<tr>
<th>Property</th>
<th>Carnauba (Crude)</th>
<th>Carnauba (Refined)</th>
<th>Carnauba (Yellow)</th>
<th>Candelilla</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific gravity</td>
<td>0.994-1.010</td>
<td>0.990-0.996</td>
<td>0.990-0.996</td>
<td>0.981-0.994</td>
</tr>
<tr>
<td>Solidification point</td>
<td>86-90</td>
<td>86-89</td>
<td>86-88</td>
<td>73-77</td>
</tr>
<tr>
<td>Acid value</td>
<td>3.0-8.5</td>
<td>3.0-8.5</td>
<td>1.5-2.5</td>
<td>-</td>
</tr>
<tr>
<td>Saponification value</td>
<td>76-85</td>
<td>76-85</td>
<td>75-88</td>
<td>55-64</td>
</tr>
<tr>
<td>Iodine value</td>
<td>75-88</td>
<td>75-88</td>
<td>75-88</td>
<td>64-73</td>
</tr>
<tr>
<td>Japan wax</td>
<td>0.970-0.998</td>
<td>49-56</td>
<td>4.0-16.0</td>
<td>-</td>
</tr>
<tr>
<td>Quricury</td>
<td>0.990-1.010</td>
<td>86-89</td>
<td>12.0-16.8</td>
<td>75-79</td>
</tr>
<tr>
<td>Specific gravity</td>
<td>0.900-0.920</td>
<td>56-82</td>
<td>0.0</td>
<td>0.99 - 0.98</td>
</tr>
<tr>
<td>Solidification point</td>
<td>56-82</td>
<td>56-82</td>
<td>0.0</td>
<td>4.0-8.0</td>
</tr>
<tr>
<td>Acid value</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>-</td>
</tr>
<tr>
<td>Saponification value</td>
<td>12.0-16.8</td>
<td>12.0-16.8</td>
<td>12.0-16.8</td>
<td>22.0-27.0</td>
</tr>
<tr>
<td>Iodine value</td>
<td>88.0-95.8</td>
<td>88.0-95.8</td>
<td>88.0-95.8</td>
<td>22.0-27.0</td>
</tr>
</tbody>
</table>

It may be seen from the data in Table 1 that of the natural waxes, Carnauba wax has the highest solidification point, which makes it a hard wax under normal conditions. This hardness combined with the other properties like luster, light color, etc. has made it a very important wax for industrial purposes. In order to make the other waxes, particularly cane wax, comparable with the Carnauba wax, it would be necessary to modify the composition in such a way as to match the properties and physical characteristics of Carnauba wax.

**INDUSTRIAL USES OF WAXES**

The different types of natural waxes obtained from mineral, vegetable and animal sources are used for various industrial purposes, depending upon the properties of the natural waxes and the purpose of the industrial product. Wherever the properties of the natural waxes are not suitable for producing a particular industrial product, synthetic waxes or blended natural waxes with synthetic waxes are used for producing the required industrial products. In general, the different types of waxes are used for the manufacture of the following industrial products:
Adhesives
Candles
Coatings for preserving food material, protective and decorative coatings, coatings for preserving fruits, etc.
Electrolytic condensors
Printing inks, carbon paper inks, duplicating inks, etc.
Leather finishes, shoe polishes, etc.
Water-proof papers, finishes, Stencil paper, etc.
Pharmaceuticals, like ointments, skin lotions, etc.
Photo mechanics
Plastic products
Polishes, like floor polishes, car polishes, emulsion polishes, etc.
Pyro-technics
Rubber
Textile processing.

SUGARCANE WAX

Sugarcane, which is mostly a tropical crop, has an outer rind which is very hard, perhaps nature's protective wall for arresting the evaporation of water from the plant material which consists of about 80% water and 20% cellulose. In addition to this hard rind, thin, layers of wax are present on the rind, particularly at the internodes, which is perhaps another natural phenomenon to reduce transpirational losses. The percentage of wax on sugarcane has not been estimated precisely by any research worker so far, though Patara\(3\) and other authors have indicated that the wax forms about 0.12% on the weight of cane. Thus, sugarcane is the single largest source of vegetables wax. Perhaps, if there is a mechanism of treating the entire cane with a hot solvent, it may be possible to extract more wax. However, when sugarcane is normally crushed in the milling plants in the sugar factories, more than 50% of the wax contained on the rind finds its way into the bagasse which is subsequently burnt in the boilers as fuel. The remaining portion of the wax finds its way into the cane juice and as wax is water insoluble, it gets precipitated and accumulates in the filter cake or press mud.

Research work conducted in many countries, particularly in India by different Organizations has revealed that the wax content of the press mud obtained in the sugar factories following double-sulphitation process is more than that obtained in the factories following double-carbonation process. Therefore, the press mud obtained in the sugar factories following double-sulphitation process is a better raw material for the extraction of wax. On an average, the press mud obtained in the sugar factories contains about 75% moisture and the wet cake % cane is of the order of 2.5 to 3.5% which again depends upon many factors. On an average, the production of press mud on dry basis is about 1% on the total quantity on sugarcane crushed. The wax content of the press mud depends upon many factors like the variety of sugarcane crushed, the climatic, soil and agronomical conditions under which the sugarcane is grown, the milling and the clarification process adopted, etc. K.A.N. Rao\(4\), M.N. Rao\(5\) Sane\(6\), Mukherjee\(6\) and many others in India have done considerable work on the analysis of press mud to
determine the wax content and extraction of wax from press mud. On the basis of
the research work done by these scientists, the average crude wax content of press
mud obtained in different countries is shown in Table 2.

Many organizations in different countries have also conducted considerable
research work on the exact type of solvent required for extracting cane wax from
press mud in a most economic way. Solvents like Benzene, Alcohol, Carbon Di-
sulphide, Carbon Tetrachloride, Petroleum, Mineral Turpentine were used and of
all these solvents, mineral turpentine were found to be most economical and
effective solvent.

**TABLE 2. Wax content of press mud in different countries**

<table>
<thead>
<tr>
<th>Name of the country</th>
<th>Crude wax % dry press mud</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td>8.0 to 18.0</td>
</tr>
<tr>
<td>Louisiana (USA)</td>
<td>4.37 to 17.94</td>
</tr>
<tr>
<td>Puerto Rico</td>
<td>12.0 to 14.0</td>
</tr>
<tr>
<td>Hawaii</td>
<td>9.55 to 11.00</td>
</tr>
<tr>
<td>Philippines</td>
<td>10.52 to 11.00</td>
</tr>
<tr>
<td>Cuba</td>
<td>12.42 to 22.00</td>
</tr>
<tr>
<td>Java</td>
<td>5.0 to 15.0</td>
</tr>
<tr>
<td>South Africa</td>
<td>6.92 to 14.6</td>
</tr>
<tr>
<td>Argentina</td>
<td>11.9 to 15.5</td>
</tr>
<tr>
<td>Brazil</td>
<td>8.9 to 17.8</td>
</tr>
</tbody>
</table>

**COMMERCIAL SCALE EXTRACTION OF SUGARCANE WAX FROM PRESS MUD**

Paturau\(^7\) indicated that though sugarcane wax was isolated from press mud
and purified as early as in 1841 and a solvent extraction process was patented in
1909, sugarcane wax was being produced on a commercial scale in South Africa
and Java by 1918. He further indicated that in 1958, 3 plants were producing
sugarcane wax from press mud - 2 in Cuba and 1 in Australia - and the Australian
plant at Nambour was closed down in 1960 and only one Cuban plant was work-
ing. Most of the early plants were based on “MERZ System” of solvent extract-
ion supplied by Rose, Downs & Thompson, Ltd., England; which is now known
as the Simon Rosedowns, Ltd., Hull, England.

The different methods adopted for the extraction of cane wax from press
mud and the flow sheets of the process have been described in detail by Paturau.
The different suppliers of solvent extraction plants in various countries also have
described the plant and process along with flow sheets and considerable published
literature is available on this subject.

A study made in this direction by the author revealed that no commercial
scale plant is working in any country except in India. Somehow or the other, the
sugar technologists all over the world did not concentrate on the commercial
production of cane wax from the press mud all these years and the plants already established in other countries had to be closed down due to low recovery of hard wax, suitable for industrial use and high loss of costly solvent. Further, the quality of crude wax and refined wax obtained was not consistent as to make the industrial consumers to standardize the process of manufacturing various products depending upon the quality of the wax obtained. Further, the availability of other waxes, particularly Carnauba wax did not induce the manufacturers to use the cane wax and suggest developments to be made therein.

WORKING OF CANE WAX PLANT IN INDIA

A solvent extraction plant entirely designed and fabricated in India for the extraction of sugarcane wax from press mud has been working in India continuously since 1950. This plant is attached to a sugar factory known as the Ravalgaon Sugar Farm Ltd., Ravalgaon (Maharashtra State, India). This sugar factory belongs to Walch and Group of Industries, which is a progressive firm in India managing two sugar factories and having many other activities including sugar and cement machinery manufacturing activity. This group has been responsible for supplying plant & machinery for the establishment of many new sugar factories and expansions in the existing sugar factories and also for establishing a few new sugar factories in other countries. This particular sugar factory which has a cane wax extraction unit attached to it has a daily cane crushing capacity of 1200 tons, following double sulphitation process of clarification.

In the first instance, the press mud obtained either from vacuum filters or plate & frame filter presses containing about 75% moisture has to be dried to about 10% moisture to reduce the loss of extractable matter through fermentation and to avoid the abnoxious smell of the end product due to the presence of moisture. Though the drying of press mud can be effected by different methods.
and equipment, the most economical method is sun drying, which is adopted in this sugar factory. The press mud obtained in the sugar factory is spread in thin layers in open area and thereafter carried manually to the nearby plant. The dried press mud is found to contain about 6 to 10% wax in this particular factory. After a number of trials, this factory has found that the most effective and economical solvent is mineral turpentine, which is a petroleum product having a boiling point ranging from 150 to 195°C.

The dried press mud is charged to the vertical batch extraction vessels (Nos. 1, 2, 3, & 4) through their respective man-holes (Nos. 18, 19, 20, & 21). The man-hole doors are closed and the extraction vessels are now ready for starting extraction operation. These vessels have false bottoms on which the press mud rests. To begin with, the extraction vessel (No. 1) is first operated. The solvent from storage tank (No. 7) is pumped to the pre-heater (No. 13) by pump (No. 42), where the solvent is heated to 99°C (30°C). The hot solvent is then taken into the extraction vessel through pipeline (A-A) and inlet valve (No. 31) till the level of the solvent in the extraction vessel comes up to the sight glass (No. S-1). The press mud gets soaked in the solvent which is allowed to stay for 1 hour during which time the waxy portion from the mud dissolves in the hot solvent. The concentrated solution thus obtained is drained into storage tank (No. 6) through the discharge valve (No. 26). A weak solution of wax from the tank (No. 8) is pumped to the pre-heater (No. 13) for heating the solution to 98%, as in the earlier case, and the same is discharged into the extraction vessel (No. 1) and allowed to remain for 1 hour and the solution thus obtained is drained into storage tank (No. 7).

This process is repeated with weaker solutions from storage tanks (No. 9 & 10), the idea being to extract as much wax as possible from the press mud. In this way, the press mud from extraction vessel (No. 1) is subjected to 5 extractions and the extracts are collected in the storage tanks (No. 6, 7, 8, 9 & 10) in the descending order of wax concentration. After this process, the extraction vessel (No. 1) is ready for solvent recovery.

Then the extraction vessel (No. 2) is now brought into line and in a similar way, the extraction takes place five times and the extract collected into storage tanks (No. 6, 7, 8, 9 & 10). In a similar way, the extraction vessels (Nos. 3 & 4) are operated and the process continued in a cyclical order. The extraction vessels (Nos. 2, 3, & 4) are also fitted with sight glasses (No. S-2, S-3, and S-4) and manholes (Nos. 23, 24, & 25), inlet valves (No. 32, 33, & 34) and discharge valves (No. 27, 28, & 29), respectively.

**SOLVENT RECOVERY FROM THE EXHAUSTED PRESS MUD**

The discharge valve (No. 26) of the extraction vessel (No. 1) from which the wax solution has been drained is now closed and its vapor valve (No. 36) is opened. Live steam at a pressure of 65 lbs./sq. in. is introduced at the bottom of the extraction vessel opening a steam valve (No. 43) through a perforated pipe. As the steam rises through the bed of press mud soaked in the solvent, it carries the solvent vapors along with it. The mixture of steam and solvent vapors is fed through the vapor pipeline (B-B) to a surface condenser (No. 14), where the
vapors are cooled by cold water and thereby condensed to a mixture of water and solvent. The mixed condensate is fed to a separator (No. 16) where the solvent being lighter floats on the water. The line of separation of solvent and water is visible through the sight glass (No. 49). The water is drained to the spray pond and the solvent is taken to the storage tanks (No. 11 & 12). The solvent is used once again for extraction purposes. The inlet of steam into the extraction vessel is stopped when no solvent visible in the sight glass. The extraction vessel is then cooled for about half an hour and the exhausted press mud is removed from the manhole (No. 22) at the bottom of the extraction vessel and transferred to the trucks and carried into the fields where it is used as manure in the usual way. The manhole (No. 22) is again closed and fresh dried press mud is filled in the extraction vessel through manhole (No. 18) and the extraction process repeated as mentioned earlier.

In a similar way, the solvent is recovered from the extraction vessels (No. 2, 3 & 4) by letting the steam through the valves (No. 44, 45 & 46) and carrying the vapors of water and solvent through valves (No. 37, 38 & 39) to the surface condenser (No. 14), and thereafter to the separator (No. 16). The exhausted press mud is discharged from manholes (No. 23, 24 & 25).

### CONCENTRATION OF WAX SOLUTION

The solution of wax in the solvent obtained from extraction vessel (No. 1) stored in storage tank (No. 6) is pumped by a pump (No. 41) to the distillation pot (No. 5) through the valve (No. 35). This distillation pot is fitted with open as well as closed steam coil, the solution is heated to attain the required temperature and thereafter live steam at a pressure of 65 lbs./sq. inch is bubbled through the perforated coil by opening the valve (No. 48). The steam carries the solvent vapors along with it through the valve (No. 40) vapor pipe (C-C) to a surface condenser (No. 15) where they are cooled to a mixture of water and solvent. This mixture is conveyed to a separator (No. 17) where the solvent through a sight glass (No. 50) and the solvent separated. The water is sent to the spray pond. The recovered solvent is sent back to the storage tanks (No. 11 & 12).

When the solvent is completely removed in the distillation pot, the wax remains behind in a molten state. This is tapped by opening the valve (No. 30) and is collected in galvanized trays, wherein the wax is cooled and solidified. This process is repeated from the concentrated extracts obtained from the extraction vessels (No. 2, 3 & 4).

### LIME TREATMENT OF WAX

The crude cane wax which is obtained in the above process is treated with slaked lime \( \text{Ca(OH)}_2 \) to impart some special properties to the finished wax.

The plant for this purpose consists of steam jacketed vessels (No. 51, 52 & 53). Out of these three vessels, vessels (No. 51 & 53) are glass lined and the vessel (No. 52) is lead lined. These vessels are fitted with steam stop valves (No. 57, 58 & 59) and discharge valves (No. 61 & 62) for vessels (No. 52 & 53) only. These vessels are also equipped with pressure gauges and steam traps. The steam used is at a pressure of 50 lbs./sq. inch.
Adequate quantity of crude cane wax is taken into the vessel (No. 52) and melted by steam admitted through the control valve (No. 55). The temperature of the molten wax is raised to 120°C. Slaked lime is taken into the vessel (No. 51) and heated to a temperature of 105°C. This hot slaked lime powder is added to the molten hot wax in the vessel (No. 52) in small quantities at intervals and the entire mass is kept stirred by a wooden stirrer. After the addition of the slaked lime powder, the temperature of the molten wax is raised to about 140°C and kept on stirring for about 4 hours at this temperature. Subsequently, the entire mass is cooled to 120°C and thereafter tapped into the galvanized trays through the discharge valve (No. 61). The vessel (No. 53) is a standby unit and used only when the vessel (No. 52) is under repair. This is how the crude cane wax is obtained.

VENT CONDENSERS

The four extraction vessels (No. 1, 2, 3, & 4) the pre-heater (No. 13), the distillation pot (No. 5) and all the storage tanks (No. 6, 7, 8, 9, 10, 11 & 12) are connected by a vent line (No. D-D) to the two vent condensers (No. 63 & 64) for recovering even the traces of solvent spacing from these vessels and condensing the same. All the four extraction vessels and the distillation pot are provided with individual safety valves (No. F-1, F-2, F-3, F-4 & F-5) which are also connected to the vent line (No. D-D).

The crude sugarcane wax obtained in the above manner is black in color and rather soft in nature and possesses an unpleasant odor. This black color and unpleasant odor are mainly due to the presence of liquid like material coming from the sugarcane. The approximate weight of crude wax, on dried press mud fed to the extraction vessels is about 4 to 5%. This kind of crude cane wax is

**Figure 2.** Flow sheet showing the flow of solvent, water, steam, vent vapor and mixture of solvent and water.
not in demand by the various industrial users of wax, mainly on account of the reason that in addition to the deep color and unpleasant odor the crude wax is soft and has poor oil retention and oil penetration inks etc. The composition of crude wax varies widely. The soft portion of the crude wax contains lipids derived from the sugarcane and are responsible for the undesirable properties. There is, therefore, a need to further refine the crude wax so as to make it attractive to the industrial users of waxes.

REFINING THE CRUDE CANE WAX

The refining of crude cane wax by separating the soft portions of the wax from the hard portion, which has an industrial use, can be effected by several methods like vacuum distillation or fractional distillation with solvents etc. Refining of crude wax can also be done by chemical methods which are considered to be very costly. Therefore, the refining of crude wax in the plant working in India is done by the solvent process.

![Figure 3: Flow sheet showing the refining of crude cane wax.](image)

After many trials, it has been found out that the most suitable solvent for refining of crude cane wax is the isoprophyl alcohol. The crude cane wax is reduced to thin flakes or ribbons in a specially designed flaker (No. 1). These flakes are dried and the dried flakes are transferred to the cold extractor (No. 2) to which sufficient solvent is added and the mass is stirred. Thus, the flakes are subjected to cold extraction during which only the soft portions of the wax dissolve in the cold solvent. The extract is drained to the distillation vessel (No. 4) where the extract is distilled. The solvent is recovered by passing the solvent, vapors through the condenser (No. 5). After the solvent is distilled off from the extract, the soft wax remains in the liquid from at the bottom of the distillation vessel and is tapped into a suitable container.

The mass of wax in the vessel (No. 2), which is now free from soft portion of the wax, is transferred to the vessel (No. 3) in which sufficient quantity of sol-
vent is added. This vessel is equipped with a steam jacket and a stirrer. The mass is heated to the boiling point of the solvent and kept on stirring till all the waxes dissolve in the solvent. The solution thus obtained is then allowed to cool to room temperature (25°C to 30°C), when the pitch falls out leaving the true wax portion in the solution. This solution is transferred to the vessel (No. 4) where the solvent is evaporated and the true wax is obtained in the liquid form. Subsequently, this is bleached by bubbling air through this molten mass.

NEED FOR FURTHER R & D WORK

Industrial concerns manufacturing carbon Papers, Polishes, Coated Papers and Fabrics etc. in India normally use Carnauba wax. Some of these units used small quantities of crude cane wax and refined cane wax also produced in India. The general comments of some of these firms which used both Carnauba wax, as well as sugarcane wax in regard to the properties of both these waxes are indicated below:

<table>
<thead>
<tr>
<th>Property</th>
<th>Carnauba Wax</th>
<th>Sugarcane Wax</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color and smell</td>
<td>Pale grey with sweet smell</td>
<td>Dark chocolate with unpleasant smell</td>
</tr>
<tr>
<td>Action of heat</td>
<td>Melts satisfactorily</td>
<td>Forms froth on melting</td>
</tr>
<tr>
<td>Melting point</td>
<td>80 to 84°C</td>
<td>78 to 80°C</td>
</tr>
<tr>
<td>Acid value</td>
<td>0 to 2</td>
<td>4 to 12</td>
</tr>
<tr>
<td>Oil retention and</td>
<td>Very good</td>
<td>50% less</td>
</tr>
<tr>
<td>penetration</td>
<td></td>
<td>60% less</td>
</tr>
<tr>
<td>Pigment wetting</td>
<td>Very good</td>
<td></td>
</tr>
</tbody>
</table>

A visit to these industrial units which used both Carnauba wax and sugarcane wax and discussions with the technical experts revealed that there was a need to improve the properties of sugarcane wax to make it comparable with the famous Carnauba wax and to make sugarcane wax more useful in the industrial products. The true wax thus obtained has a light green to dark green color and has slight unpleasant odor. This is taken into the vessel (No. 6) where the bleaching and decolorization operations are carried out. This vessel is a team jacketed open pan fitted with perforated coil for blowing air. The oxygen present in the air bleaches the color of the wax to yellow. The bleaching process is continued till a desired product is obtained.

In this process, about 35 to 40% of refined wax, 25 to 30% of soft wax and 28 to 32% of pitch are obtained from the crude cane wax.

The selling price of crude cane wax produced in India is around $3 per kg and that of refined cane wax is around $8.5 per kg as compared to the landed cost of imported Carnauba wax which is around $9 per kg.

In addition to this plant, another plant worked in India for about 5 years in a sugar factory known as the K.C.P. Ltd., Vuyyuru (Andhara Pradesh - India). The plant was supplied by Rose, Downs & Thompson Ltd., England. This plant had a capacity of 1.7 tons of dried press mud per charge and two such charges could be
handled in a period of 24 hours. The solvent used for extraction of cane wax was
Hexane. However, as the demand for cane wax could not be developed, this plant
had to be closed down in 1965.

following modifications are very essential:

1. The hardness and fracture of the cane wax has to be improved.
2. The oil retention property of cane wax has to be improved.
3. The pigment wetting property has to be improved.

In order to develop the cane wax production in the entire world sugar indus-
try, research and development work has to be intensified on the following
lines:—

1. Equipment for the quick and complete drying of wet press mud has to
be developed instead of adopting sun-drying of press mud.
2. The most effective and cheapest solvent for the extraction of cane wax
from press mud should be found out.
3. Effective and economical process for extraction of crude wax from
press mud and refining of crude wax, separating the soft portion of the
wax and improving the color and odor have to be further developed.
4. All the properties of the refined cane wax should be improved in order
to make them equal with those of Carnauba wax to find more and more
industrial application of sugarcane wax.

CONCLUSIONS

The sugarcane wax extracted from press mud obtained in sugar factories has
very good properties as compared to many natural waxes obtained from minerals,
vegetables and animals in the nature. However, the properties of sugarcane wax
compared fairly well with those of Carnauba wax which is the best vegetable wax
widely used in the manufacture of different kinds of polishes, carbon papers,
protective coatings, etc. The raw material for producing sugarcane wax is the press
mud obtained in the sugar factories and hence the collection of the raw material
does not pose any problem.

Sugarcane wax is being produced successfully in an Indian sugar factory
since a long time and is being used to some extent in place of Carnauba wax in the
various industrial products. But there is a need to improve the extraction process
in a most economical way and modify the properties of cane wax to make it
comparable with Carnauba wax so that it can find more industrial application.
Therefore, concerted efforts of the research organizations and commercial scale,
trials in the world sugar industry are very much required at this stage, as they
would go a long way to develop the cane wax industry further and make another
valuable contribution of the sugar industry for the development of wax based
industries and at the same time improving the economics of the sugar factories.
The extraction of wax from press mud does not affect in any way the nutritional
value of the press mud for the plant material and the residue after the extraction
of wax can still be used as a manure in the sugarcane fields.
REFERENCES

5. Rao M.N. Sponsored research work in the Indian Institute of Technology, Kharagpur (India).

NECESIDAD DE DESARROLLAR LA PRODUCCION CERA DE CAÑA POR LA INDUSTRIA MUNDIAL

P. J. Manohar Rao

RESUMEN

La caña de azúcar es el único origen más grande de cera vegetal. La extracción de la cera de caña de lodo prensado (filter cake) necesita la atención del mundo de la industria de azúcar con el fin de perfeccionar el procedimiento y el producto (cera de caña dulce), que es de uso inmenso en muchas industrias.

Orígenes y propiedades de diferentes tipos de cera mineral, cera vegetal y cera animal y sus usos industriales se dan con el propósito de comparar la cera de caña dulce con las otras ceras, particularmente cera Carnauba, que es considerada de ser la mejor de las ceras vegetales de uso amplio en muchas industrias.

Pruebas con escalas de laboratorio, así como comerciales se hicieron en diferentes países para extraer la cera de caña de azúcar de lodo prensado se discuten brevemente. El procedimiento y la planta así como también los "flow sheets" totalmente desarrollados en la India y usados por una fábrica de azúcar en el dicho país para la extracción de uso de caña dulce de lodo prensado se describen en detalle para el beneficio de la industria azucarera del mundo. Las líneas donde más trabajos de investigación científica se debería hacer para el desarrollo de la industria de cera de caña están indicados.