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(54) SYSTEM AND A METHOD FOR EXTRACTING WAX FROM PULP FIBERS AND PAPER PRODUCTS

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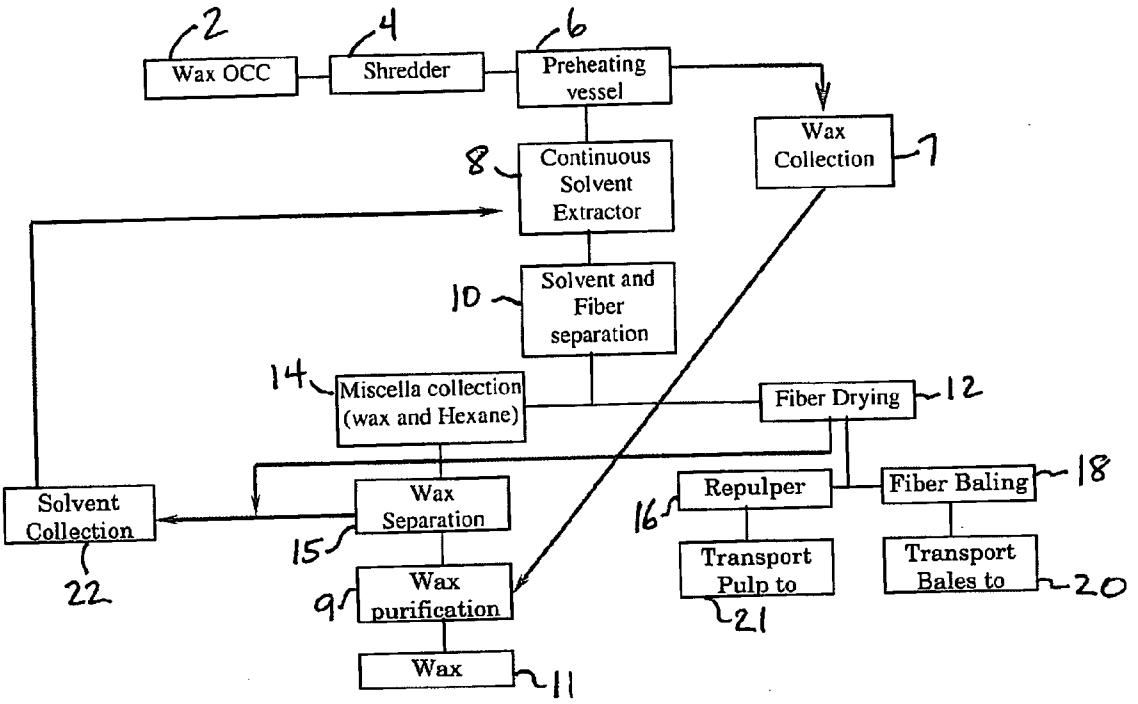
(57) **ABSTRACT**

A system and a method for extracting wax from pulp fibers and/or paper products are provided. The system and method may implement a continuous extraction vessel that can have one or more extraction stages. A single or multi-staged continuous extractor would provide solvent flow which counters the cellulosic materials within the vessel so that the solvent becomes more concentrated with the dissolved wax. This will reduce the volume of solvent necessary to achieve the same extraction efficiency and reduce the energy necessary to remove the solvent from the wax. In another embodiment, the temperature of the solvent can be increased by operating the extractor under a pressure greater than atmospheric pressure.

Figure 1


2
Wax OCC
4
Shredder
6
Preheating vessel
Wax Collection
7
8
Continuous Solvent Extractor
10
Solvent and Fiber separation
14
Miscella collection (wax and Hexane)
Fiber Drying
12
Solvent Collection
22
Wax Separation
15
Repulper
16
Fiber Baling
18
Transport Pulp to
21
Transport Bales to
20
9
Wax purification
Wax
11

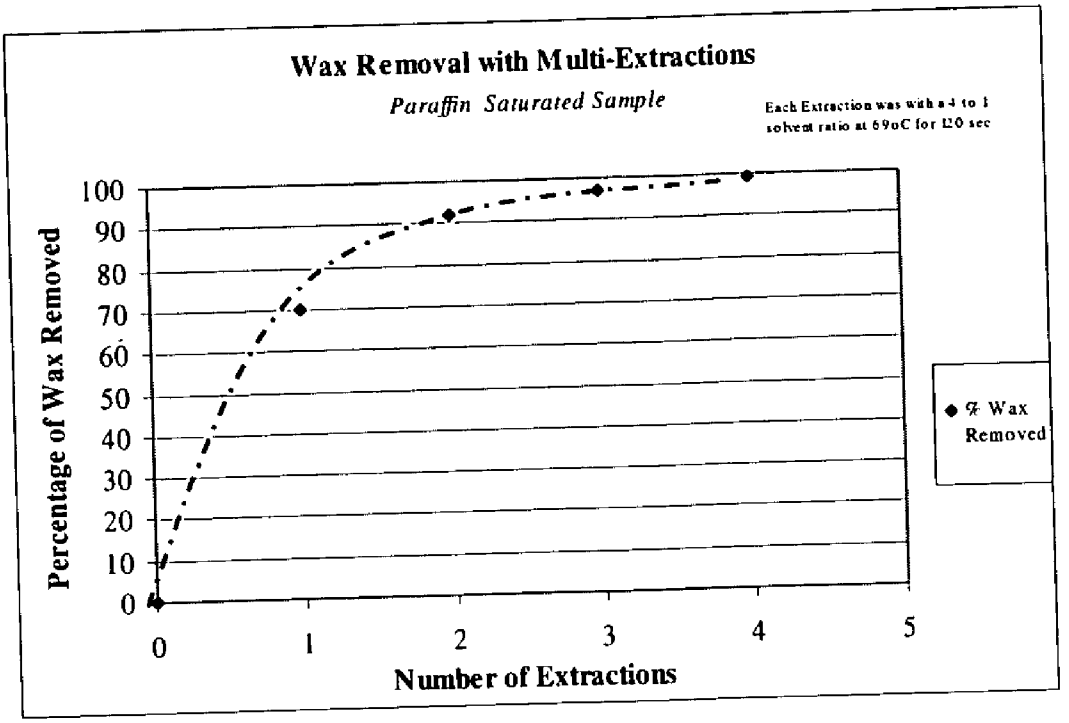
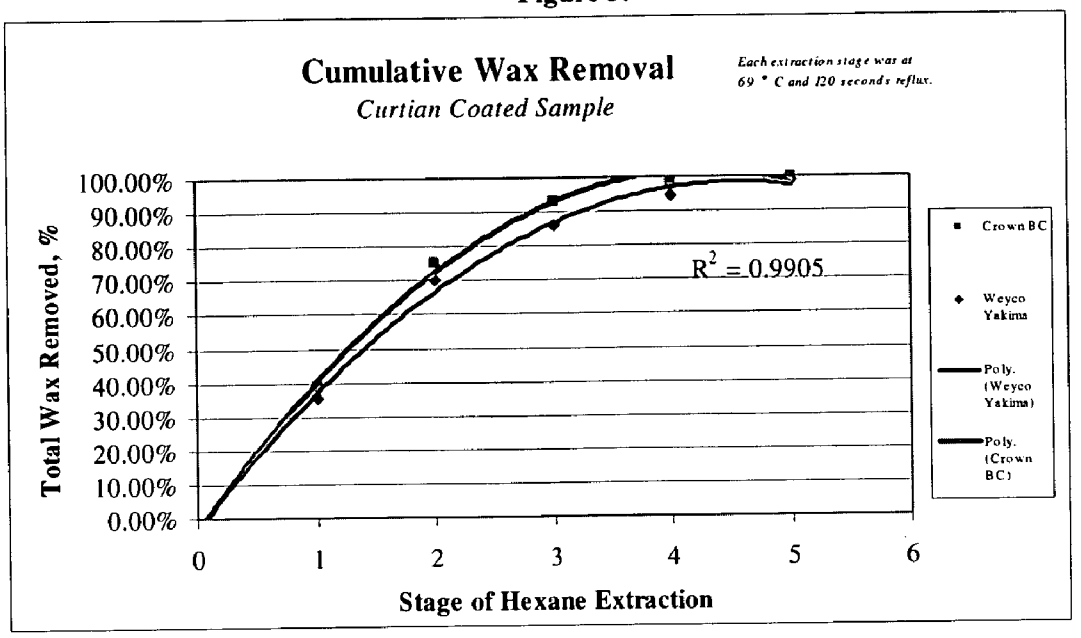

Wax Removal with Multi-Extractions
Paraffin Saturated Sample
Each Extraction was with a 4 to 1 solvent ratio at 69oC for 120 sec
Percentage of Wax Removed
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
Number of Extractions
% Wax Removed

FIGURE 2

Figure 3:


Cumulative Wax Removal
Curtian Coated Sample
Each extraction stage was at 69 ° C and 120 seconds reflux.
Total Wax Removed, %
100.00%
90.00%
80.00%
70.00%
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
0
1
2
3
4
5
6
Stage of Hexane Extraction
R2 = 0.9905
Crown BC
Weyco Yakima
Poly. (Weyco Yakima)
Poly. (Crown BC)

SYSTEM AND A METHOD FOR EXTRACTING WAX FROM PULP FIBERS AND PAPER PRODUCTS

FIELD OF THE INVENTION

[0001] This invention relates generally to a system and a method for extracting wax from pulp fibers and paper products.

BACKGROUND OF THE INVENTION

[0002] The ability to recycle Wax Saturated or Curtain Coated old corrugated containerboard ("OCC") has implications for current and future markets, product quality and manufacturing costs. One approach that was recommended comes from earlier work on the solvent extraction of wood chips.[1] In this work, a method was developed to remove pitch and wood extractives before processing in the pulp mill. A similar process could remove wax from fiber products. The result is that low wax content fibers are recovered and used through a normal OCC process. This process recovers the wax as a product for reuse in the box plants or sold for other uses. The result is nearly all of the WOCC[2] box material is processed into economic products and there are minimal losses or environmental impacts.

[1] U.S. Pat. Nos. 5,698,667; 6,364,999; 6,641,699 and 6,719,880

[2] WOCC means Wax coated or saturated OCC.

[0003] The concept of removing extractives with organic solvents is known. The paraffin wax used in WOCC is very soluble in a number of organic solvents. U.S. Pat. No. 5,891,303 describes the use of Hexane for the removal of paraffin waxes from recycled fiber products. A report[3] has been found that describes a similar approach in other paper products.

[3] Miyagi, Atsushi and Ishiwata, Yasuyuki; Ind. Res. Inst. Chiba Prefect., Japan, 264.; Chiba-ken Industrial Laboratory Research Report No. 8 (1994).

[0004] The problem of recycling wax saturated and coated boxes is that small amounts of residual contaminates can have large impacts on product quality. Methods of dispersion and surfactant washing produces a pulp that can have strength reductions of as high as 20% with less than 1% wax contamination. However, the wax contamination is much higher than 1% from these processes. Other disadvantages are process management, cost of removal, and treating of the process water to maintain productivity and environmental requirements. Both the mechanical and dispersive methods are prone to incomplete removal and process contamination.

[0005] The approach in which wax is dissolved and washed away has the advantage of minimizing the cross-contamination with, for example, the paper mill process water and presents the opportunity to recover the wax as a potential product for sale or reuse within the box making system. The environmental impacts are minimal and can be managed within the confine of the extraction process.

[0006] Two other approaches have been discussed in the literature[4] and they include removal under supercritical conditions using CO_2 or a combination of CO_2 and a hydrocarbon solvent like Pentane[5]. The advantage of this method is that the solvent can be easily removed and the wax recovered as a product. The disadvantage is the high energy and equipment cost of working at supercritical conditions. The other dissolving method is to use a solvent that can dissolve and remove the wax under or near ambient conditions. For example, U.S. Pat. No. 5,891,303 describes a method for Hexane removal of wax from waste paper and container products. The patent describes an extraction time of 20 to 60 minutes, repeated 3 to 5 times. This would require a minimum of 60 minutes to a maximum of 5 hours to extract the wax. The process as described would represent a very capital and labor intensive operation. In addition, the environmental impacts of opening the extraction vessel would not permit the process to be commercialized. The method of only heating the solvent to approximately 45° C. to 50° C. may cause the extraction to take a substantially large amount of time, and increases the number of extraction cycles, as well as increases the amount of solvent required.

[4] U.S. Pat. No. 5,009,746, S. U. Hossain and C. A. Blaney, Removal of stickies from secondary fibers using supercritical carbon dioxide solvent.

[5] Study of co-solvent effects on stickies removal. Part I: supercritical fluid extraction; Rong X; Qi D; Chateauneuf J; Abubakr S, 2005 Practical Papermaking Conference, Milwaukee, Wis., USA, May 2005, Session 8, 13 pp.

[0007] A need, therefore, exists for an improved system and method for wax removal from a paper product.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] The embodiments of the present invention are described in detail below with reference to the following drawings.

[0009] FIG. **1** is a diagram of a system for wax removal in an embodiment of the present invention;

[0010] FIG. **2** is a chart of the percentage of wax removal versus the number of extraction stages via one of the methods of the present invention; and

[0011] FIG. **3** is a chart of a weight-time curve based on wax removal in an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0012] The present invention generally relates to a system and a method for extracting wax from pulp fibers and paper products. The system and method can be designed in a number of ways. The design and operating conditions will change as the temperature is increased. Some embodiments would include a process that operates at ambient conditions, or a process that operates at elevated temperatures and pressures. The system and method may implement a continuous extraction vessel that can have one or more extraction stages. A single or multi-staged continuous extractor would provide solvent flow which counters the cellulosic materials within the vessel so that the solvent of the miscella becomes more concentrated with the dissolved wax. This will reduce the volume of solvent necessary to achieve the same extraction efficiency and reduce the energy necessary to remove the solvent from the wax. In an embodiment, the solvent is Hexane. However, other solvents are effective in dissolving wax. In an embodiment, the wax-solvent solution is sent to a system for separating the wax from the solvent. The solvent is then recycled back to the extractor. In an embodiment, the fiber is sent to a system for drying and possibly re-pulping. The extracted OCC can be, for example, rebated for shipment, or the fibers can be conveyed directly to an OCC repulper and a papermachine.

[0013] In an embodiment, the extraction process may be performed in a range from approximately five minutes to approximately 30 minutes. The operating temperature range would be approximately 60° C. or higher. The total amount of solvent required for this process would be a ratio of approximately 4 to 1 or less based on the bone dry cellulosic material weights. This reduction in solvent will significantly reduce energy requirements.

[0014] In the case where a process is operated at or near atmospheric conditions, the temperature may be limited to the boiling point of the solvent. In the case described using Hexane, operating temperature would be around 69° C. With the ambient conditions, the system would be closed to the atmosphere and a slight vacuum applied to maintain a closed system. All internal gases in the process are recovered and condensed with final exhaust gases passing through a carbon filter to remove VOC's[6] before final discharge.

[6] VOC means Volatile Organic Compound.

[0015] In another embodiment in which pressure is increased, the pressure within the extractor may be set to a pressure sufficient to raise the temperature of the solvent beyond the boiling point of the solvent at ambient conditions but maintain the solvent in the liquid state.[7] It should be understood that the extraction vessel described herein should be capable of operation at pressures above atmospheric and the pressure would be limited only by the design of the extraction vessel and operating economics. In another embodiment, the temperature of the solvent can be increased by operating the extractor under some pressure greater than atmospheric pressure. The higher temperature and pressure would increase the diffusion rates of the solvent and solubility of wax. This system and process would also allow for significantly lower extraction time and less amount of solvent required to perform the extraction.

[7] Ambient conditions assumes a pressure of 760 mmHg.

[0016] Referring to FIG. **1**, in a first step of the process, secondary fiber products **2** containing wax, are delivered through a shredder **4** to reduce size for optimum handling. The products **2** may be, for example, old corrugated containerboard ("OCC"). Secondary fiber may be defined as fiber which has been dried at least once. The OCC feedstock may be conveyed into a pre-heating vessel **6** prior to delivery to an extractor **8**. This may provide increased extraction efficiency by increasing diffusion and dissolution rates. In a next step, the feedstock is then conveyed into the extractor **8** where the WOCC ("wax saturated old corrugated containerboard") is heated and the solvent is added. In an embodiment, the extractor **8** is a continuous extractor. In an embodiment, the solvent is Hexane. Other solvents can be used and the choice is dependent on the effectiveness and economics. For example, some solvents which may be used include, but are not limited to, aromatic and alkane hydrocarbon. In fact, any solvents or any solvent that will effectively dissolve paraffin waxes and coating blends is contemplated. The residence time in the extractor would be about 15 minutes and the solvent is circulated in a counter flow direction to improve the washing effect. The extractor unit may have several stages or sections in which the solvent and wax can drain and be pumped towards a previous section. For example, the fresh solvent is introduced at the fiber discharge end of the extractor and flows or is pumped between sections or chambers until it is removed at the fiber addition end of the extractor. There are several commercial vessels that can be used or adapted to this process, and some of these are described further below. In this way, the solvent and wax is flowing in the counter direction to the containerboard. As the solvent removes the wax from the containerboard, the solution (commonly referred to as "miscella" in the industry) will get more concentrated as it moves toward the extractor inlet. This is where the miscella is removed from the vessel **10**. The solvent and wax blend is accumulated into a tank **14** that feeds the wax separation process. It can be filtered to remove any solid debris at this point. At the discharge of the extraction vessel, the free solvent is separated from the fibers by gravity, represented by box/vessel **10**. The fiber is then put through a dryer **12** to recover the Hexane, or the solvent, for reuse.

[0017] The wax-solvent solution is sent to a system having a distillation process **15** to recover and separate the Hexane and concentrate the wax as a product. More specifically, the wax may be purified **9** after the separation **15** to provide the end product **11**. The fiber may be sent to a system for drying the fiber. After drying the extracted OCC, may be, for example, baled **18** for transport **20**, or rewet with water. The fiber contains less than 1% residual wax and could be used, for example, as a feedstock for an OCC liner process. The wax may be in a condition for resale or may be further processed for use in, for example, box plants. The extraction process is designed to minimize the loss of solvent. A typical mill recovers 99.9% of the solvent. Final air treatment would be through a carbon filter to remove any volatile organic compounds ("VOC's").

[0018] Hexane has demonstrated an ability to avoid dissolving the starches and adhesives used in manufacturing containers and containerboard. Therefore, the wax product is free of such contaminates and can be economically processed for resale or reuse. Wax contamination in some cases has been estimated to be around 3% on average from OCC sources. This has a significant impact on product quality and process costs. As a result, this process would cause a significant reduction of wax entering, for example, a paper mill. The operating and environmental impacts of wax removal to the paper mill would be to reduce chemical requirements such as, for example, defoamers and strength additives. This would reduce the BOD and COD[8] in the mill effluent system and could allow for increase close-up of the mill.

[8] BOD is Biological Oxygen Demand and COD is Chemical Oxygen Demand both are indications of water quality.

[0019] Referring again to FIG. **1**, the Wax OCC **2** may be wax impregnated OCC and is indicative of the receiving and storage/supply process step in the system. This would be bale handling and process feed equipment. The equipment used for shredding cellulosic feed materials may be of the type appropriate to reduce the size for efficient extraction of wax and movement in an extractor.

[0020] With respect to the pre-heating step **6**, this can occur within an atmospheric or pressurized vessel used to get the wax and OCC up to extraction temperatures. Several embodiments are possible for this step and should not be limited to the following examples. In a first embodiment, the feedstock is heated with direct steam and the condensates are collected in container **7**. When these are cooled the wax is separated from the water phase and the accumulated wax would be removed. In a second embodiment, a solvent vapor

is passed over the WOCC feed material allowing it to be a heat sink and condense the vapor to a liquid. The solvent then starts the process of dissolving and removing the wax. In other embodiments, technologies such as ultrasonic, microwaves or radiowaves might be adapted in this stage or the extractor stage to enhance the process of mixing and solvent saturation of the feed material.

[0021] Several commercially available extractors or digesters could be adapted to this process. For example, in an embodiment, an atmospheric extractor which may be implemented is one used in the extraction of seed oils. This extractor is available through Crown Ironwork, Inc., [Minneapolis, Minn.]. The extractor has multiple stages with counter flow of the solvent. Models are available that can remove wax through percolation washing of the samples or immersion of the samples. These units are designed to operate at atmospheric or slight vacuum conditions up to the boiling point of the solvent.

[0022] Examples of pressure digesters that can be adapted to extract wax are the PANDIA by GL&V of Canada—a horizontal vessel design (usually inclined about 5 degrees) to operate under pressure. A large screw conveys the cellulosic material as solvent is washed or sprayed onto the feedstock. It can be designed to pulp, wash or solvent extract wax or other materials. Another horizontal vessel would be the STAKE digester from Stake Technologies, LTD., Norval, Ontario, Canada. Both are known in the trade for their use in pulping of recycled fibers. A third pressure vessel known in the pulping trade is the Messing-Durkee (M & D) Digester current manufactured by Andritz. This is a cylindrical vessel oriented at approximately 45 degrees. The cellulosic material is introduced at the top and it is conveyed down the top half of the vessel and back up through the lower half before being discharged. The material would be passed through the solvent as it moved through the vessel. The solvent would be introduce at the discharge end of the vessel and allowed to counter-flow in the vessel for removal at a point where the cellulosic material is introduced to the vessel. In another embodiment, the method of extraction would involve the Andritz Vertical IMPREGNATOR which is designed to receive compressed chips from a screw press, typically for chemi-thermo mechanical pulping applications; it can be adapted for a solvent extraction or impregnation process.

[0023] At the very end of the extractor, or after the cellulosic material has been discharged, a drainage zone is used to drain any excess solvent. This is due to the fact that the fiber has seen the purest solvent at the end of the extraction vessel before discharge. At this point in the process, the OCC will be saturated with solvent. The saturated fiber can be moved through a screw press or into a continuous dryer to remove and recover the residual solvent. A combination of these steps is also possible. After the fiber product has reached complete dryness, or all the solvent has been removed, the fiber product can be sent to a repulper **16** for blending into a linerboard furnish or baled **18** for shipment **20** to another location. The pulp slurry obtained from the repulper **16** would be pumped to a storage tank **21** and later may be blended with other pulps or chemicals to produce paper products like liner on a papermachine.

[0024] The miscella is distilled to recover the solvent for recycle to the extractor. The distillation equipment may be a solvent stripper, but other forms of solvent removal are possible. Vacuum distillation would reduce stripper temperature but may be limited by the melting point of the wax. The solvent would be condensed and flow to a storage tank **22**. Typically, the process can be designed to recover 99.9% of the solvent. The process will have an air management system for the complete removal of solvent from all process air streams. The final air treatment would be through a carbon filter to remove any VOC's. The wax product is removed from this stage as the distillation bottoms. The concentrated wax is further purified, if necessary. With respect to wax purification, wax, while it is still in liquid form, can be filtered and/or bleached to remove contaminates and color. It would then be cooled and packaged for delivery to, for example, a customer.

[0025] The present invention may be better understood by way of the following examples:

EXAMPLE 1

[0026] The method to estimate the rate of wax removal was to submerge a WOCC sample into a known volume of Hexane at its boiling point (69° C.). After a given amount of time, the sample was removed from the solvent and allowed to drain and air dry. The weight difference versus the time the sample was allowed to extract would be used to calculate the extraction rate of the wax. The total amount of wax was determined by a 24 hour Soxhlet extraction with Hexane on a separate set of representative samples. Table 1 illustrates the total wax removal as a percentage of the total wax available. This data is plotted in FIG. **2**.

TABLE 1

Wax Saturated OCC
Extraction removal experiments

Temp.	time, sec. 69° C.	Sample weight, g	Wt. Loss, g.	% wax Removed
T0	0	20.119	0	0
T1	120	15.514	4.605	74.9%
T2	120	14.464	1.05	92.0%
T3	120	14.125	0.339	97.5%
T4	120	14.012	0.113	99.3%
Final Wt.		13.97		
% Total Wax		30.6%		

EXAMPLE 2

[0027] A series of extractions were run in which the solvent to fiber ratio was changed to determine the optimum solvent volume. As can be seen in Table 2, the earlier stage extractions are improved with higher solvent ratios. However, within experimental conditions it does not appear that a ratio above 4 is required. These extractions were run at 69° C. for 120 seconds as described earlier. To test the impact of time, an extraction was done in 180 second periods instead of 120 second periods. In the last column of Table 2, a significant difference is seen in the extraction efficiency by this slight increase in time. Again, these tests were run at 69° C. Based on these results, it appears that a 4 or 5 stage extraction process would not require more than 12 to 15 minutes.

TABLE 2

Extraction Efficiency vs Solvent Ration and Time				
Extract #	3 to 1	4 to 1	5 to 1	4 to 1 @ 180 secs
1	49.4%	58.7%	57.5%	70.0%
2	74.7%	82.8%	82.1%	89.5%
3	88.6%	91.8%	91.7%	96.0%
4	93.9%	94.8%	95.7%	98.0%
5	96.3%	96.1%	97.8%	98.8%

[0028] The addition of pressure and temperature would improve these response times and extraction efficiencies.

EXAMPLE 3

[0029] A series of extractions were run on Wax OCC samples in which the solvent was recycled each time. The concentration of wax in the solvent was allowed to increase in order to determine the extraction curve. The extractions were carried out at approximately 69° C., the boiling point of Hexane. The extraction treatment was run for only 180 seconds. For each cycle a new sample was used. The solvent ratio was determined on a weight basis of solvent to sample. For example, for an OCC sample weight of 100 grams, 400 grams of solvent was used. This gives a 4 to 1 solvent ratio. In the OCC samples, wax accounts for 36.7% by weight percentage. The last column in the table is an estimate of the wax remaining in the sample after each stage of an extraction. It appears that a 3 stage extractor may be all that is needed. The following table, Table 3, shows the data for saturated boxes:

TABLE 3

Wax Saturated OCC			
Extraction cycle	% Wax Conc. In Hexane	% Wax removed this cycle	% wax remaining in the OCC sample
1	5%	80%	20%
2	9%	75%	5%
3	16%	72%	1%
4	21%	60%	1%
5	27%	49%	<1%

EXAMPLE 4

[0030] A similar set of experiments were run on a product having curtain coated wax, i.e., a lower wax weight and formulation. The results are shown in Table 4:

TABLE 4

Wax Curtain Coated OCC Cumulative wax removal		
	Test	
	Weyco	Crown BC
	Extraction Temperature	
	69° C.	69° C.
1	35%	39%
2	70%	75%
3	86%	93%
4	94%	99%
5	99%	100%

[0031] The samples used in this example had a wax weight percentage of 13%. In order to estimate the rate of wax extraction, a series of extractions were done at the boiling point of Hexane (69° C.). The actual process temperature could be higher in a pressurized process. Samples were placed into boiling Hexane for 2 minute periods. After each 2 minute period, the solvent was removed and the amount of wax was determined. The Hexane extraction was repeated using a new volume of solvent for each stage and the amount of wax removed was determined. The wax removed after several extractions were added together to arrive at the total removal efficiency. The results are shown in the FIG. **3** and show nearly 100% of wax can be removed in a 4 stage extractor. For all of these extractions, the solvent ratio averaged 3.8 to 1 and the temperature was 69° C. The determination of total wax in the board was done by a 24 hr. Soxhlet extraction with Hexane. This value was then used as the denominator for calculating the percentage of wax removed.

[0032] The following example was directed to a system in which the extractor **8** is operated at greater than atmospheric pressure:

EXAMPLE 5

[0033] A series of experiments were run with saturated and curtain coated OCC samples at elevated temperatures to show the impact on extraction efficiency. The procedure was to seal a sample in a calorimetry bomb with a measured amount of solvent. A screen was inserted in the container so the sample could be separated from the Hexane solvent at the end of the extraction period. This sample and vessel was suspended in an oil bath at 100° C. The sample and solvent were allowed to heat and sit in the oil bath for 120 seconds. At that time, the vessel was removed from the oil bath and inverted. This was done to drain the miscella through a condenser to capture the wax and reduce the pressure in the vessel. The amount of wax removed was determined and the extraction efficiency was calculated based on the total wax as determined by a Soxhlet extraction on a separate sample. Based on these results, the number of extraction stages and/or the solvent ratios can be reduced to provide significant cost savings. In order to maintain maximum liquid-solid contact, the pressure of the system is increased to keep the solvent in the liquid state.

TABLE 5

Wax Extraction with Hexane at Elevated Temperatures

Sample	Wax Saturated	Wax Saturated	Curtain Coated	Curtain Coated
Temperature	69° C.	100° C.	69° C.	100° C.
Partial Pressure of Hexane	766 mm Hg	1846 mm Hg	766 mm Hg	1846 mm Hg
1st Extraction, % wax removed	75%	93%	37%	59%
2nd Extraction, % wax removed	92%	>99%	70%	94%
3rd Extraction, % wax removed	98%	>99%	90%	98%

In all of these experiments the extraction period was 120 seconds and the solvent ratio was 4 to 1.

[0034] The following is an example of the reduction in contaminates resulting from solvent extractions.

EXAMPLE 6

[0035] Solvent extraction impacts on OCC contaminants known in the paper industry as "stickies" were evaluated. Three sets of handsheets were prepared and tested. These samples included an OCC box material that had not been wax treated. This sample was designated "Control OCC". The second sample was from the same sample box material as the Control OCC sample, however this sample was labeled "Wax OCC Unextracted". The third sample was from a wax saturated box and was extracted with Hexane to remove at least 99% of the wax. This sample was labeled "Extracted Wax OCC". Table 6 shows that the sample with wax has a higher contaminate level than the Control OCC sample. The removal of the wax with Hexane can reduce the contaminate level and reduce the variability.

TABLE 6

Waxed Box Extraction Study
Stickies in OCC Handsheets Results

Control OCC	4.37 # of stickies per gram +/− 0.8
Wax OCC Unextracted	5.61 # of stickies per gram +/− 0.5
Extracted Wax OCC	2.81 # of stickies per gram +/− 0.2

EXAMPLE 7

[0036] Several samples of OCC (without wax) and WOCC were repulped and made into handsheets. These were tested for typical Kraft Liner properties. Kraft liner is typically known as a paper that is the surface ply of a corrugated container box. The results are compared in Table 7:

[0037] The Control OCC and WOCC samples were from box panels that had not been used previous to testing. These provided a fair comparison because they were from the same box plant and the same production lot. The only difference is that one sample was treated with wax. So, the comparison of sample #1 and the blended sample #2 is the amount of wax that is in the blend. As can be seen, this has a significant impact on the OCC strength if the WOCC sample was not treated to remove the wax. Sample #3 is from a typical OCC mill with some contaminate control. It had better strengths than the blend sample 2 but a lower strength than sample 1, the lab OCC sample. The lab OCC sample #4 (no wax) was extracted with hexane (one 2 min. extraction) and it shows an improvement in strength over sample #1. This is mainly due to the removal of residual wood extractive that are known to reduce bonding.[9] However, this also points out that extraction with Hexane will not interfere with the paper quality and bonding properties.

[9] J. Brandal and A. Lindheim, Pulp and Paper of Canada, October, 1968, T 431-435.

[0038] Sample #5 is the WOCC board that had been extracted several times. It can be seen that a substantial portion of the original strength properties have been recovered (Sample #1 vs. Sample #5). It is not as great an amount as Sample #1 but is no worse than the mill sample. Sample #6 is a blend of the Control OCC #1 and a 4% blend of the extracted WOCC sample #5. This is a typical blended level found in recovered OCC. As the data shows, the strength of sample #6 is as good as the lab OCC sample #1 and better than the mill sample #3. Based on this it can be inferred that most of the original strength can be recovered with Hexane extraction of wax. In addition, a typical blend of extracted WOCC and OCC will have nearly the same quality.

TABLE 7

OCC and WOCC Handsheet testing

	Units	Density Kg/m^3	Gurley Porosity Secs.	Mullen at 42# BW Lbs.	STFI at 42# Lbs.in.	Comments
1	Control OCC	544.4	12.3	55	19.7	No WOCC, unused box
2	Control OCC/ WOCC blend	498.1	10.1	35	16.6	3.7% WOCC at 30% wax that would give a final product wax of 0.15%
3	Recyled OCC	525.8	11.0	48	17.7	Mill Sample
4	Extracted OCC	545.4	11.6	62	20.6	Hexane extracted
5	100% WOCC Extracted	528.2	11.2	50	18.8	Hexane extracted only 0.1% wax remained
6	OCC/WOCC Blend (extracted)	544.5	11.8	54	19.5	96/4% blend WOCC pulp extracted

[0039] While the embodiments of the invention have been illustrated and described, as noted above, many changes can be made without departing from the spirit and scope of the invention. Accordingly, the scope of the invention is not limited by the disclosure of the embodiments. Instead, the invention should be determined entirely by reference to the claims that follow.

What is claimed is:

1. A system for performing an extraction of wax from secondary fiber comprising:

an extractor;

a supply of the secondary fiber delivered to the extractor; and

a supply of solvent delivered to the extractor wherein wax contained within the secondary fiber is soluble in the solvent;

wherein a temperature of the solvent within the extractor is greater than 50 degrees Celsius and wherein the extractor is closed during the extraction.

2. The system of claim 1 wherein the extractor is a continuous extractor.

3. The system of claim 1 wherein a time period for the extraction is in a range from about 5 minutes to about 30 minutes.

4. The system of claim 1 wherein the solvent is hexane.

5. The system of claim 1 further comprising:

a system for separating the wax from the solvent.

6. The system of claim 1 further comprising:

a system for drying the secondary fiber after the extraction.

7. The system of claim 1 wherein a pressure within the extractor is approximately atmospheric pressure.

8. A method for performing an extraction of wax from secondary fiber, the method comprising the steps of:

supplying the secondary fiber to an extractor wherein the secondary fiber contains wax; and

supplying solvent to the extractor wherein the wax contained within the secondary fiber is soluble in the solvent;

wherein a temperature of the solvent within the extractor is greater than 50 degrees Celsius and wherein the extractor is closed during the extraction.

9. The method of claim 8 further comprising the step of:

separating the solvent from the wax.

10. The method of claim 9 further comprising the step of:

recycling the solvent to the extractor.

11. The method of claim 8 further comprising the step of:

drying the secondary fiber after the extraction.

12. The method of claim 11 further comprising the step of:

re-pulping the secondary fiber.

13. The method of claim 8 wherein the solvent is hexane.

14. The method of claim 8 wherein a pressure within the extractor is approximately atmospheric pressure.

15. The method of claim 8 wherein the extraction occurs in a range from about 5 minutes to about 30 minutes.

16. The method of claim 8 wherein the secondary fiber is pre-heated before the extraction.

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