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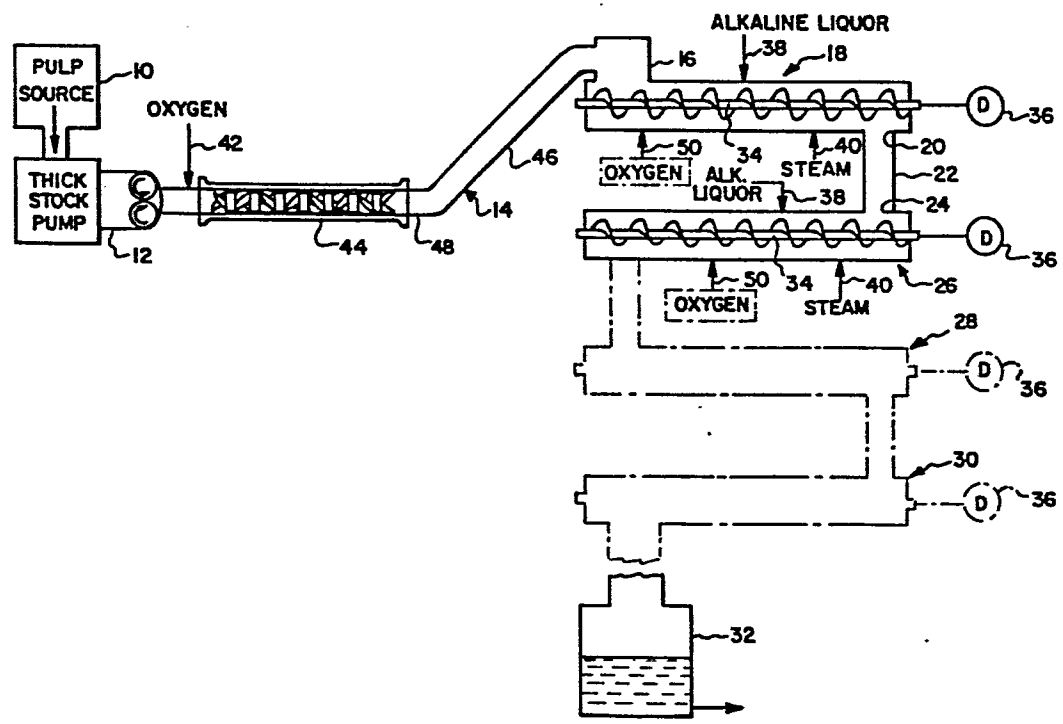
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(54) **Improved method and apparatus for oxygen delignification.**

(57) An oxygen delignification method and apparatus is disclosed of the type in which fibrous materials are pumped by a thick stock pump (12) through a conduit (14) to a substantially horizontal tubular reactor tube (18) in which the fibrous materials are mixed with oxygen, steam, and an alkaline solution is improved by the introduction of oxygen to the fibrous materials as they are pumped through the conduit (14) to the horizontal reactor tube (18) and the agitation of the fibrous materials within the conduit to mix the oxygen with the materials as they flow to the reactor tube, thereby initiating an oxygen delignification reaction within the conduit and accelerating the rate of oxygen delignification of the materials within the horizontal reactor tube (18). An alkaline solution and steam are also introduced to the fibrous materials within the conduit (14) and the materials are agitated to effect mixing of the steam and alkaline chemicals with the materials. The mixing of the fibrous materials with oxygen, alkaline solution or steam is effected by an in-line, motionless mixer (44).

FIG-1



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IMPROVED METHOD AND APPARATUS  
FOR OXYGEN DELIGNIFICATION

This application is related to European application Serial No. 80304340.5, entitled "Apparatus and Method for Medium Consistency Oxygen Delignification," filed December 2, 1980; European application Serial No. 81304078.9, entitled "Process and Apparatus for the Oxygen Delignification of Pulp," filed September 7, 1981; European application Serial No. 82301826.2, entitled "Method and Apparatus for Oxygen Delignification," filed April 6, 1982; and European application Serial No. 82305445.7, entitled "Method and Apparatus for Controlled Addition of Alkaline Chemicals to an Oxygen Delignification Reaction," filed October 13, 1982.

15

The present invention relates to oxygen delignification of fibrous materials, and more particularly to the oxygen delignification of medium consistency bleachable grade pulp and other fibrous materials utilizing substantially horizontal tubular reaction zones.

In oxygen delignification of fibrous materials, it is desirable to produce rapid yet uniform delignification of the pulp stock. Uniform delignification of the pulp stock results in higher pulp strength. It is also desirable to introduce alkaline chemicals to the pulp stock to maintain the pH level within an optimum range. In order to heat the mixture of pulp stock, oxygen and alkaline chemicals to a temperature at which the

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delignification reaction begins, steam typically is introduced to the mixture.

- It is preferable to perform the oxygen delignification reaction on pulp at medium consistency, that is, 8-20% consistency. Such a delignification system would be compatible with much existing mill equipment, including pulp washing and thickening equipment, since that equipment is designed to operate in a medium consistency range.
- 5 Delignification systems utilizing medium consistency pulp are desirable over delignification systems utilizing low consistency pulp (i.e., 1-5% consistency), since the latter require a large reactor volume to maintain an acceptable retention
- 10 time for the pulp and have large power demands for pumping large volumes of pulp and for steam to heat the pulp in the reactor. Delignification systems utilizing high consistency pulp (i.e., 20-30% consistency) are also less desirable since they
- 15 require special dewatering equipment to attain the higher consistency.
- 20

- An efficient and relatively low-cost apparatus for performing oxygen delignification on medium consistency pulp consists of at least one but
- 25 preferably two or more substantially horizontal tubular reaction zones, each having an agitating and conveying means such as a screw extending along at least a portion of its length which is driven by a motor. The reaction zones have an inlet through
- 30 which the pulp enters, an outlet through which the delignified pulp exits the reaction zone, and preferably include a plurality of orifices through

which alkaline liquor, steam, and oxygen enter the reaction zone. The screw may have a number of different configurations, but a commonly utilized screw consists of a central shaft about which  
5 extends a helical flight which acts both to agitate and convey the pulp.

In such reaction zones the temperature is maintained at from 80° to 160°C, alkaline chemical charges from 1-20% calculated as Na<sub>2</sub>O on moisture  
10 free material are added, and oxygen partial pressures are maintained at from 30-200 psi. Appropriate retention times have been found to be 5-120 minutes. Such an apparatus and process are more fully described in European application Serial  
15 No. 80304340.5, filed December 2, 1980.

The first horizontal reaction zone of such an apparatus typically receives the stock in a somewhat compacted form from a thick stock pump which pumps the stock through a conduit that is  
20 substantially full of the stock during the pumping operation. This is in contrast to the reaction zone which typically is operated to provide a space at the top of the zone for gas to collect along its length. As a result, a portion of the horizontal  
25 reaction zone is needed to break up the compacted pulp to expose the mass of the pulp to the oxygen so that the delignification process may be initiated. Thus, the delignification reaction is not initiated until the pulp stock has traveled a portion of the  
30 length of the reaction zone, and the screw has had an opportunity to agitate and break up the mass of pulp. Consequently, longer reaction times are

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required to delignify the pulp. These longer reaction times result in the need for larger, and hence more costly, reactor equipment.

Various reactor designs had been suggested  
5 for the oxygen delignification of pulp in which oxygen is combined with the pulp stream prior to a reaction zone. For example, Richter U.S. Patent No. 4,093,511, teaches a reaction system in which pulp and oxygen gas are intensively mixed by a defibrator  
10 type mixer which forms a gas and pulp emulsion which then flows upwardly through a vertical reaction zone. Kleppe et al, TAPPI, June 1981, pages 87-90, and Sherman, U.S. Patent No. 4,161,421, teach similar systems which utilize high shear mixers to  
15 create gas and pulp emulsions prior to a vertical reaction zone. Renard, TAPPI, August 1981 pages 51-54 teach a similar system. Finally, Kirk et al, U.S. Patent No. 4,198,266 in one embodiment of the invention teach the use of a high shear mixer to  
20 combine oxygen with a pulp stream prior to a reaction zone.

However, in all of the foregoing oxygen reactors, high shear mixers are required to disperse or emulsify oxygen gas in the pulp. This has  
25 several disadvantages. High shear mixers require considerable horsepower to achieve an adequate dispersion of oxygen gas. Furthermore, high shear mixing in the presence of oxygen and alkali at high temperatures can result in damaged pulp fiber which  
30 reduces the pulp strength. A further disadvantage of the foregoing systems is that high intensity dispersion of oxygen gas in the pulp can sometimes

result in a foamy condition which reduces washing efficiency as the dissolved solids are washed from the fiber subsequent to delignification.

Accordingly, there is a need in the art to  
5 deliver pulp stock to the horizontal reaction zones in a form which is already somewhat broken up so that the pulp mass is more readily accessible to the oxygen within the reaction zone. Furthermore, there is a need to be able to initiate the delignification  
10 process prior to the pulp entering a horizontal tubular reaction zone so that the length, and hence the cost, of the reaction zone may be reduced and the reactor made more efficient. Finally, there is a need for a system which will achieve adequate  
15 mixing of oxygen and pulp without generating high shear forces which are detrimental to pulp strength.

According to one aspect of the present invention, an apparatus and process for the  
20 continuous oxygen delignification of fibrous materials is provided including at least one substantially horizontal tubular reaction zone having an inlet and an outlet, means for agitating and transporting fibrous materials through the  
25 reaction zone to the outlet thereof, a pump for pumping fibrous materials to the reaction zone, and a conduit for conveying fibrous materials from the pump to the inlet of the reaction zone, the conduit having means for introducing oxygen therein to  
30 initiate the delignification reaction and a motionless mixer located in the conduit for mixing the oxygen and fibrous materials.

The present invention provides an improved apparatus for the continuous oxygen delignification of fibrous materials such as medium consistency pulp, which utilizes one or more reaction zones, but  
5 in which the pulp stock enters the reaction zones after having been mixed with oxygen and alkaline chemicals so that the delignification process has already been initiated and the compacted state of the pulp has been diminished. This improves the rate  
10 of oxygen delignification within the reaction zones and thereby increases the efficiency of, and reduces the size and capital cost of the equipment required. Another advantage of the delignification system of the present invention is that oxygen is  
15 added to the pulp mass at a point immediately adjacent the thick stock pump, rather than in the reaction zones only, where the operating pressure is substantially greater than the operating pressure within the reaction zones. Therefore, the solubility  
20 of the oxygen is at a higher value and the delignification reaction proceeds at an increased rate. An additional advantage of the apparatus of the invention is that use is made of the time the pulp mass is retained within the conduit joining the  
25 pump with the first reaction zone. Yet another advantage of the invention is that adequate mixing of the pulp and oxygen is accomplished without the use of high intensity mixers.

Although the present invention will be  
30 defined and is best suited for oxygen delignification of medium consistency pulp, i.e., 8-20% consistency, it is to be understood that the apparatus may also



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be used for the delignification of fibrous materials of low consistency, i.e., between about 3-8%.

Additionally, although the invention will be defined for use in conjunction with one or more

5 substantially horizontal tubular reaction zones, it will be understood that other reaction vessels such as vertical towers may be utilized.

The present invention provides an apparatus for the continuous oxygen delignification of fibrous  
10 materials of the type having at least a first substantially horizontal tubular reaction zone having an inlet and outlet, a screw for agitating and transporting the fibrous materials through the reaction zone to the outlet, a thick stock pump for  
15 pumping the fibrous materials to the first reaction zone, and a connecting conduit for conveying the materials from the pump to the inlet of the first reaction zone. The improvement consists of an oxygen supply conduit communicating with the  
20 connecting conduit for introducing oxygen into the connecting conduit and an in-line mixer mounted within the connecting conduit downstream of the oxygen supply conduit for mixing the oxygen introduced into the connecting conduit with the  
25 fibrous materials flowing to the reaction zone. In one embodiment of the invention, alkaline chemicals and/or steam are introduced into the connecting conduit to maintain an optimum pH value of the pulp solution as well as to heat it to a desirable  
30 temperature.

Preferably, the in-line mixer that is utilized in the connecting conduit, is a motionless

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mixer so that the energy imparted to the pulp suspension by the thick stock pump itself is used to perform the mixing operation. A motionless mixer also does not create the high shear forces which are detrimental to pulp strength. Surprisingly, it has been found that adequate mixing of pulp with oxygen can be achieved using a motionless mixer rather than the high intensity mixers taught by the prior art.

In a preferred embodiment, oxygen is introduced into the pulp within the connecting conduit upstream of a single in-line mixer. In an alternate embodiment, downstream of the in-line mixer a conduit is positioned for introducing an alkaline solution to the mixture and downstream from that is a second in-line mixer for mixing the alkaline solution with the pulp and oxygen. Steam may be introduced through a conduit downstream of the alkaline mixer and a third in-line mixer may be utilized to mix the steam with the alkaline liquor, oxygen, and pulp mixture. In a third embodiment, a single supply conduit is joined to the connecting conduit through which a combination of oxygen, alkaline chemicals, and steam is introduced upstream of a single in-line mixer. In a modification of the second embodiment of the invention, some or all of the oxygen can be predispersed in the alkaline liquor prior to the introduction of the alkaline liquor into the pulp. In all of the embodiments of the invention, the oxygen may be predispersed in a liquid prior to the introduction of the oxygen into the pulp upstream of the mixing elements. The liquid may be water, oxygen bleaching filtrate, or an alkaline solution.

It is necessary with the horizontal reactor tube design that the thick stock pump be located below the level of the reactor tube and that the connecting conduit be inclined upwardly from the pump to the reactor tube. The connecting conduit can be joined to the tube either at the underside of the tube or through the top of the tube. This difference in elevation is necessary to prevent the reverse flow of oxygen gas through the connecting conduit to the thick stock pump where it could collect and present a hazard.

By placing an in-line mixer in the upwardly inclined connecting conduit and by introducing oxygen into the thick stock at a location adjacent the pump, the oxygen is mixed with the pulp at a location in which the pressure is substantially greater than the operating pressure within the horizontal reactor tube because of the hydrostatic head and the friction losses within the connecting conduit leading to the reactor tube. Since the pressure is greater, the solubility of the oxygen is higher and the oxygen delignification reaction which is initiated at the location adjacent the pump occurs at an increased rate.

There is an additional advantage of using the present invention when Kraft white liquor is used as the alkaline liquor and when oxygen is predispersed in the alkaline liquor. The sodium sulfide in the white liquor will be somewhat oxidized before it is added to the pulp. Thus, the white liquor will react with a portion of the oxygen so that it will not take up additional oxygen in the

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reaction zone or connecting conduit which would then be unavailable for the delignification reaction.

Also the preoxidized white liquor sometimes produces pulp with higher viscosity and strength.

5                   Accordingly, it is an object of the present invention to provide an improved apparatus for the oxygen delignification of fibrous material in which oxygen delignification is initiated prior to a first introduction of the pulp into the horizontal reaction  
10 zone so that efficient use is made of the time the pulp is in the conduit between the pump and the reaction zone; to provide an apparatus in which the size, and hence cost, of the reaction zone or zones is reduced; and to provide an apparatus for oxygen  
15 delignification which is relatively low-cost and relatively easy to fabricate.

Other objects and advantages of the invention will become apparent from the following description, the accompanying drawings, and the  
20 appended claims.

In order that the invention may be more readily understood, reference will now be made to the accompanying drawings in which:

25                   Fig. 1 is a schematic flow diagram illustrating the overall apparatus of the present invention utilizing a plurality of horizontal reactor tubes;

Fig. 2 is a schematic representation of a  
30 second embodiment of the invention which utilizes a plurality of in-line mixers; and

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Fig. 3 is a schematic representation of a connecting conduit forming a part of a third embodiment of the invention.

5           As shown in Fig. 1, pulp at from 8-20% consistency and preferably 10-15% is contained within a pulp source 10 which communicates with a thick stock pump 12. Pump 12 may be a Moyno progressing cavity pump available from Robbins & Myers, 10 Inc., Springfield, Ohio. Alternatively, pump 12 may be a Cloverotor thick stock pump manufactured by the Ingersoll Rand Company in Nashua, New Hampshire, a thick stock pump manufactured by Warren Pumps, Inc., Warren, Massachusetts, or any other type of thick 15 stock or high density pump known in the industry.

A connecting conduit 14 extends from the pump 12 to an inlet 16 of a first or primary reactor tube 18. The primary reactor tube 18 includes an outlet 20 communicating with a substantially vertical 20 conduit 22 which communicates with the inlet 24 of a second reactor tube 26. The second reactor tube 26 may be joined to subsequent reactor tubes 28,30, if desired, which ultimately are joined to a blow chamber 32.

25           The primary reactor tube 18 and the subsequent reactor tubes 26,28,30, if utilized in the system, each include a screw 34 with drive means 36, preferably an electric motor. The screw 34 preferably has a helical flight design. Each 30 reactor tube 18,26,28,30 also includes an alkaline liquor supply line 38, which is optional, and a steam supply line 40.

Generally, the total alkaline material charge will be from 1-20% by weight calculated as  $\text{Na}_2\text{O}$  of the oven dry weight of the raw fibrous material. Examples of alkaline materials suitable for use with this invention include sodium hydroxide, sodium carbonate, sodium borate compounds, ammonia, kraft white liquor, oxidized kraft white liquor and mixtures thereof, although other known alkaline pulping liquors may also be used. The steam introduced through the steam supply lines preferably is sufficient to maintain the temperature within the reactor tubes 18,26,28,30 within the preferred temperature range of 80°-160°C.

The oxygen delignification system described to this point is of known design and is disclosed and discussed in greater detail in European application Serial No. 80304340.5, filed December 2, 1980. The improvement in the system consists of adding an oxygen supply line 42 communicating with a source of oxygen under pressure and further communicating with the connecting conduit 14 at a location adjacent the thick stock pump 12. Downstream of the thick stock pump is located a means for mixing the oxygen with the stock which preferably is an in-line, motionless mixer 44. An example of such a motionless mixer is a Komax triple action motionless mixer manufactured by Komax Systems, Inc., Long Beach, California. The oxygen supplied through the line 42 may be in a gaseous form or predispersed in a liquid such as water, oxygen bleaching filtrate, or an alkaline solution, and is preferably supplied at a point adjacent the inlet of mixer 44.

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As shown in Fig. 1, the thick stock pump typically is of a type having a horizontal discharge. Since the pump 12 must be positioned at an elevation below that of the primary reactor tube 18, the

5 connecting conduit 14 must include an upwardly inclined portion 46 in addition to a substantially horizontal portion 48. The difference in elevation is necessary to prevent oxygen gas, which is present above the stock within the primary reactor tube 18,

10 from travelling backwardly from the reactor tube toward the thick stock pump 12. The in-line mixer 44, although shown mounted along the horizontal portion 48 of the connecting conduit 14, alternatively may be positioned along the inclined

15 portion 46 of the connecting conduit.

The operation of the oxygen delignification system shown in Fig. 1 is as follows. Pulp from the pulp source 10 is pumped by the thick stock pump 12 through the connecting conduit 14 to the primary

20 reactor tube 18. Oxygen is introduced into the connecting conduit 14 through the supply line 42 at a point downstream of thick stock pump 12 and immediately upstream of the inlet to mixer 44. The oxygen and the stock are mixed as the stock flows

25 through the in-line motionless mixer 44 at which time the oxygen delignification process is initiated. Consequently, the stock delivered to the primary reactor tube 18 through the inlet 16 contains dissolved oxygen and oxygen gas intimately dispersed

30 within the stock slurry and is not delivered in a somewhat compacted mass devoid of oxygen. Accordingly, the length of primary reactor tube 18

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can be shorter than that required for a system not having oxygen mixing occurring in the connecting conduit.

Once the partially delignified pulp enters  
5 the primary reactor tube 18, alkaline liquor is introduced to the pulp through supply line 38 and steam is introduced to the pulp through supply line 40. Optionally, some or all of the stream or alkaline chemicals may be added to the pulp prior to  
10 the thick stock pump. Optionally, additional oxygen may be introduced into the primary reactor tube 18 through a supply line 50.

As the pulp travels along the length of the primary reactor tube 18 driven by screw 34, it  
15 further reacts with the oxygen present in the tube and the alkaline solution. Temperature is maintained by the steam so that the delignification process continues at an adequate rate. The pulp exits the primary reactor tube 18 through the outlet  
20 20 and falls through the vertical conduit 22 to the second reactor tube through the inlet 24. The delignification process continues in the same manner until the delignified pulp is deposited into the blow region 32. In some instances, only a single  
25 reaction tube is required to achieve the desired degree of delignification.

A second embodiment of the invention is shown in Fig. 2 in which the primary reactor tube 18 receives stock from the pump (not shown) through a  
30 connecting conduit 14'. Connecting conduit 14' communicates with a source of oxygen through an oxygen supply line 42'. The conduit 14' communicates



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with a source of alkaline liquor through an alkaline supply line 52, and communicates with a source of steam through a steam supply line 54. Downstream of each of the supply lines 42', 52, 54, are positioned  
5 in-line, motionless mixer elements 44A, 44B, 44C.

These elements may be three separate mixers or may comprise elements in a single mixer. It should also be noted that an alternate inlet 16' may be provided for the reactor tube 18 which permits the stock to  
10 be pumped into the reactor tube from the underside.

The oxygen supply line 42' preferably is upstream of the alkaline liquor supply line 52 and the steam supply line 54. Should the alkaline liquor or the steam be added prior to the addition  
15 of the oxygen, loss in pulp yield or loss in pulp strength or viscosity may result. Furthermore, it is preferable to maintain the location at which the oxygen line 42' is positioned adjacent the thick stock pump (not shown) and immediately upstream of  
20 the inlet of mixer element 44A so that the oxygen enters the stock at a point where a relatively high pressure exists. It is desirable to add alkaline liquor and steam to the connecting conduit 14' to increase the pH and temperature to optimum levels  
25 which improves the rate of oxygen delignification within the connecting conduit.

In operation, the conduit 14' conveys pulp from the thick stock pump and the pulp receives oxygen from line 42', which is mixed with the pulp  
30 in mixer 44A to initiate the delignification reaction. The pH level and temperature of the mixture is maintained by injections of alkaline

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chemicals and steam into the stock from lines 52,54. After each injection, the mixture is mixed by mixers 44B,44C to maintain the homogeneity of the mixture. The pulp mass entering reactor 18 is more readily accessible to the oxygen gas in the reactor than it would be without the improvement of the present invention.

A modification of the second embodiment of the invention is also illustrated in Fig. 2 in which some or all of the oxygen may be supplied via line 60 to alkaline solution 52. Preferably, the oxygen is dispersed into the alkaline solution using a venturi-type system, injector, diffuser, or small motionless mixer, as well as other known methods.

A third embodiment of the invention is shown in Fig. 3 and is similar to the preceding embodiments except that a connecting conduit 14'' suppling the primary reactor tube (not shown) with stock from the pump (not shown) includes a single supply line 56 which communicates with sources of oxygen, alkaline liquor, and steam. The supply line 56 preferably terminates in a distribution ring 58, or other suitable gas dispersion apparatus, having nozzles arranged about its inner periphery to distribute the oxygen, alkaline liquor, and steam evenly about the stock. As in the previously discussed embodiments, the supply line 56 and distribution ring 58 preferably are located adjacent the thick stock pump and upstream of an in-line, motionless mixer 44.

In operation, stock flowing from the pump receives a mixed stream of oxygen, steam, and

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alkaline solution through line 56 and ring 58. The charge is immediately mixed with the stock by mixer 44 to initiate the delignification reaction throughout the pulp flowing downstream of the ring 58. The pulp entering the reactor tube is already partially delignified and is at the optimum pH level and temperature.

A system such as that disclosed in Fig. 3 would provide the lowest cost form of the invention and would provide a hot gas-liquid mixture to be injected into the connecting conduit 14''. If oxygen gas is used as the source of oxygen, the gas could be well dispersed in the alkaline liquid using a venturi-type system, injector, diffuser, or a small motionless mixer, as well as other known methods. An additional advantage of the invention is that, when white liquor is used as the alkaline chemical, the sodium sulfide in the white liquor reacts with the oxygen and is somewhat oxidized before it is added to the pulp. In some cases, this can result in an improved pulp viscosity and strength.

While the methods and apparatuses herein described constitute preferred embodiments of the invention, it is to be understood that the invention is not limited to these precise methods and apparatuses, and that changes may be made therein without departing from the scope of the invention as defined in the appended claims.

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CLAIMS

1. In an apparatus for the continuous oxygen delignification of fibrous materials of the type having at least a first substantially horizontal tubular reaction zone (18) including an inlet (16)  
5 and an outlet (20), means (34) for agitating and transporting fibrous materials through said first reaction zone to said outlet thereof, means (12) for pumping fibrous materials to said first reaction zone, and conduit means (14) for conveying fibrous  
10 materials from said pumping means to said inlet, the apparatus characterized by:  
means (42) for introducing oxygen into said conduit (14) means whereby an oxygen delignification reaction may be initiated in fibrous materials  
15 flowing through said conduit means; and  
motionless mixing means (44) positioned within said conduit means (14) for mixing oxygen from said introducing means with fibrous materials in said conduit means.
2. An apparatus as claimed in claim 1, wherein said pumping means (12) is positioned at an elevation below said horizontal tubular reaction zone (18) and said conduit means (14) is inclined  
5 upwardly to said tubular reaction zone (18).
3. An apparatus as claimed in claim 2, further comprising means (52) for introducing alkaline chemicals into said conduit means and means for introducing steam into said conduit means.

4. An apparatus as claimed in claim 3, wherein said motionless mixing means (44) comprises an in-line motionless mixer including a plurality of mixer elements (44A, 44B, 44C), each positioned  
5 downstream and adjacent a different one of said oxygen introducing means (42'), said alkaline chemical introducing means (52'), and said steam introducing means (54).

5. An apparatus as claimed in claim 3, further comprising a supply conduit (56) joined to said conduit means upstream of said mixing means and communicating with said means for introducing  
5 oxygen, alkaline chemicals and steam such that oxygen, alkaline chemicals and steam are mixed together prior to entering said conduit means.

6. An apparatus as claimed in claim 1, further comprising a supply conduit (56) joined to said conduit means upstream of said motionless mixing means and communicating with said means for  
5 introducing oxygen including means in said supply conduit for dispersing said oxygen in a liquid flowing through said supply conduit.

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7. In a process for the continuous oxygen delignification of fibrous materials of the type in which said materials are pumped by a thick stock pump (12) through a conduit (14) to a reaction zone (18) at a consistency of from 8-20%, the process  
5 characterized by:

introducing oxygen (42) into said materials while said materials are flowing through said conduit (14) to said reaction zone (18); and  
10 agitating said fibrous materials within said conduit (14) to mix said materials with said oxygen and initiate an oxygen delignification reaction without generating high shear forces on said fibrous materials.

8. A process as claimed in claim 7, further comprising the steps of introducing alkaline chemicals (52) to said mixture of fibrous materials and oxygen in said conduit (14) and agitating said  
5 fibrous materials within said conduit (14) to mix said alkaline chemicals with said fibrous materials and oxygen.

9. A process as claimed in claim 7 or 8, further comprising the steps of introducing steam (54) to said mixture of fibrous materials, oxygen, and alkaline chemicals in said conduit (14) and  
5 agitating said fibrous materials within said conduit to mix said steam with said fibrous materials and oxygen.

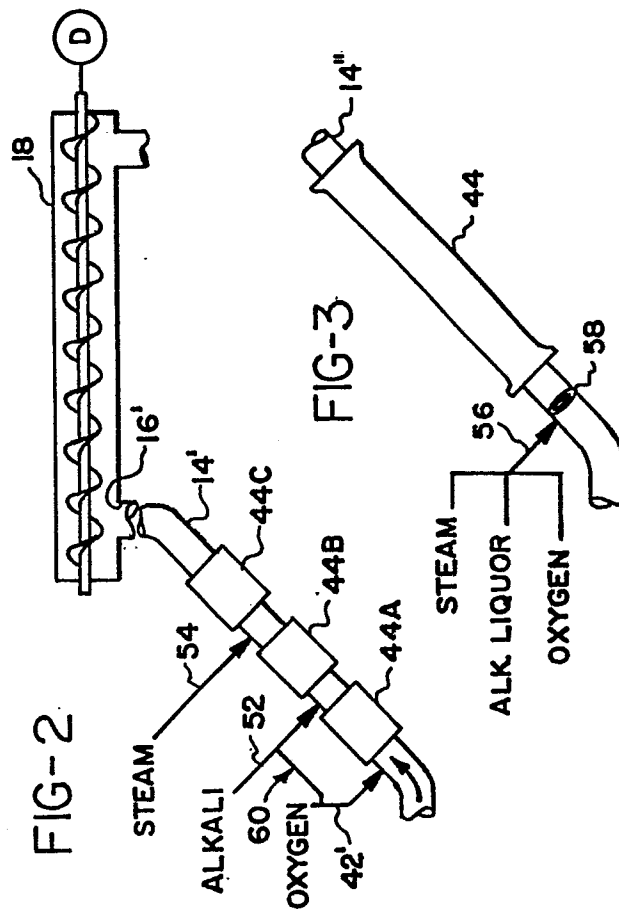
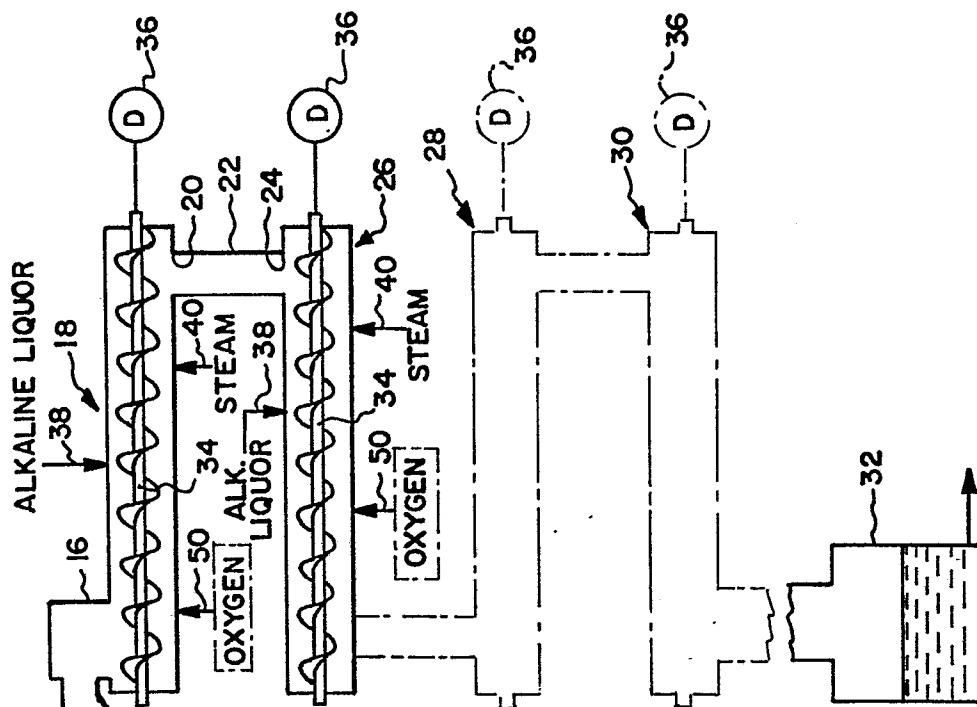
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10. In a process for the continuous oxygen delignification of fibrous materials of the type in which said materials are pumped by a thick stock pump (12) through a conduit (14) to a substantially  
5 horizontal reaction zone (18), introducing alkaline chemicals (52) into said fibrous materials, introducing oxygen (42) into said fibrous materials in said reaction zone, transporting said fibrous materials through said reaction zone while agitating  
10 said fibrous materials to mix said materials with said oxygen and alkaline chemicals and maintaining a consistency of from 8-20% throughout said reaction zone, the process characterized by:

locating said pump (12) below the level of  
15 said reaction zone (18) and pumping said fibrous materials to said reaction zone through an upwardly inclined conduit (14),

introducing the oxygen (42) into said materials as said materials are pumped through said  
20 upwardly inclined conduit (14); and

agitating said materials as said materials are pumped through said upwardly inclined conduit such that said oxygen is mixed with said materials to initiate an oxygen delignification reaction  
25 without generating high shear forces on said fibrous materials.







European Patent  
Office

## EUROPEAN SEARCH REPORT

0106460

Application number

EP 83 30 4894

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. <sup>3</sup> )
X	US-A-2 000 953 (P. HOOKER et al.) * The whole document *	1,7	D 21 C 9/10
D,A	US-A-4 161 421 (M.I. SHERMAN) * Figures 1,4; column 4, lines 32-51 * -----	1,3,5-9	
			TECHNICAL FIELDS SEARCHED (Int. Cl. <sup>3</sup> )
			D 21 C
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 20-12-1983	Examiner NESTBY K.
<b>CATEGORY OF CITED DOCUMENTS</b>			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	