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Bogotá, 16 de Octubre de 2006

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DIVISION DE NUEVAS CREACIONES

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SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO



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Respondiendo a la solicitud del requerimiento anterior me permito realizar las siguientes observaciones:

1. En el numeral 3 del requerimiento enviado se hace referencia al artículo "30 D 486" y se menciona la necesidad de solicitar y tramitar una copia del contrato de acceso genético ante la autoridad ambiental competente, al ser la *Guadua Angustifolia Kunth* un "endemismo" de América y nativo de Colombia, Ecuador y Venezuela, también se han establecido plantaciones con fines comerciales en países tan distantes como México, Costa Rica, La India y Tailandia, demostrando así su explotación en otros países y su aprovechamiento sujeto a la aplicación de varias legislaciones.

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Puntualmente en Colombia, el aprovechamiento de recursos biológicos se rige por el Decreto 1791 del 4 de octubre de 1996, el cual expresa lo siguiente: "El gobierno nacional estableció el régimen de aprovechamiento forestal, en virtud del cual, se regulan las actividades de la administración pública y de los particulares, respecto del uso, manejo, aprovechamiento y conservación de los bosques y la flores silvestre, con el fin de lograr su desarrollo sostenible. Que el artículo 62 del Decreto citado, faculta a cada corporación autónoma regional para reglamentar lo relacionado con los aprovechamientos de especies tales como la *Guadua*, el bambú y la cañabrava".

En la actualidad no se está realizando ningún aprovechamiento industrial de la *Guadua* para la producción de carbón activado, solamente se ha realizado como se plantea en la solicitud de patente a nivel investigativo y piloto, y en consecuencia a las cantidades extraídas y a la reglamentación de la CARDER, corporación

competente según la región de la investigación, no se requería permiso de aprovechamiento.

Teniendo en cuenta la reunión sostenida con su despacho, se procederá a profundizar en el llamado Permiso de investigación Científica con Biodiversidad y su posterior obtención para un proyecto de investigación que se desarrolla actualmente con el MADR.

2. En cuanto al cuestionamiento realizado en el caso de la patente D1 en la cual se plantea la utilización de residuos entre los cuales caben los residuos de bambú, consideramos que en este caso no se afecta esta patente, ya que el procedimiento descrito en nuestra solicitud está enfocado específicamente en la obtención de carbón activado usando solamente como precursor la *Guadua Angustifolia* Kunth lo cual no afecta ninguna otra especie de bambú. Aún cuando la *Guadua* pertenece a la familia de los bambúes, sus características fisicoquímicas la hacen única, y el proceso descrito es ajustado únicamente para el manejo de las particulares características fisicoquímicas que posee la *Guadua Angustifolia* Kunth y que la diferencian de las demás especies de bambú. Tal es el caso de su alto contenido de sílice y la acumulación de este en partes específicas de la planta.

Se puede obtener carbón activado de cualquier material que posea carbono, pero de acuerdo a las características de cada material el proceso presenta variaciones importantes en cuanto a temperatura, tiempo de residencia, presión, flujo y tipo de activante, por lo tanto consideramos que D1 y D2 son extremadamente generales en el tipo de precursor y el área que manejan. Es importante considerar que D2 aún cuando plantea un área mayor lo hace con un proceso en donde los tiempos van desde 17 hasta 450 horas, haciéndolo insostenible a nivel industrial. Situación verificable con las empresas del sector.

Consideramos, en consecuencia, que el proceso descrito en nuestra solicitud si es un avance en la técnica ya que se describió el proceso específicamente para aplicarlo a la *Guadua*. Para llegar a esto se debieron identificar puntos específicos de concentración de elementos químicos, como el sílice, y determinar la temperatura exacta de pérdida de masa para diseñar el proceso.

Adicionalmente D2 plantea un proceso en el que se usa cloruro de zinc el cual es un agente químico sumamente contaminante y de difícil manejo por los daños a nivel ambiental que puede causar, contrario al agente activante utilizado por nosotros (H_3PO_4), utilizado incluso por la industria de alimentos el cual no representa peligro para la salud humana o ambiental.

Consideramos que los tiempos de impregnación y las concentraciones de la sustancia deshidratante empleada (H_3PO_4) son muy diferentes a los planteados en las patentes D1 y D2. Finalmente en ninguna de las patentes se habla de la relación de impregnación que en el caso nuestro es de 3-1, factor clave en la obtención del área específica descrita.

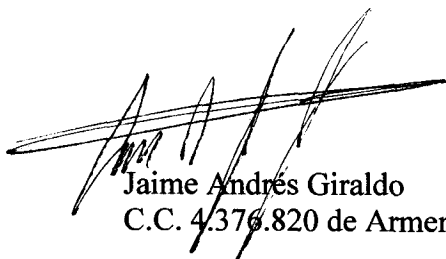
También se plantea que D1 obtiene un carbón activado que aunque posee menor área lo hace con un menor número de pasos; la patente presentada por nosotros obtiene un área mayor con un mayor número de pasos. Los primeros 3 corresponden básicamente a la fase de preparación, o pre-tratamiento como lo llama D1, de la materia prima utilizada. D1 desconoce la particularidad de cada una de las posibles materias primas, siendo diferente un alistamiento de cascarrilla de café, de arroz, madera, semillas de frutas, etc. Para el caso de la Guadua se debe enfrentar el problema de la presencia de sílice en su estructura, situación que se enfrenta con el proceso descrito en la solicitud hecha.

Por otro lado, hasta el momento de la presentación y radicación de la solicitud de patente, no existía ninguna solicitud específica para un carbón activado obtenido a partir de la Guadua Angustifolia Kunth.

Consideramos entonces que el proceso descrito en nuestra solicitud de patente, si representa un aporte a la técnica y se diferencia vía novedad del precursor y especialización del proceso según su composición fisicoquímica.

Agradecemos de antemano la colaboración prestada.

Atentamente,



Jaime Andrés Giraldo
C.C. 4.376.820 de Armenia

Production of activated carbon from bamboo scaffolding waste—process design, evaluation and sensitivity analysis

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Abstract

A feasibility study has been carried out on the preliminary process design of the production of activated carbon from the bamboo scaffolding waste based on 30 tonnes of bamboo waste per day throughput. A comparison of the process economics of the stand-alone bamboo carbonization plant with a plant that is integrated into another major processing facility has been studied. The preliminary process design was based on various literature sources and an economic evaluation, in which the total capital investment (TCI), the production cost, the return on investment (ROI), the cash flow and the internal rate of return (IRR) of the stand-alone plant and integrated plant were estimated. The TCI of the stand-alone plant and integrated plant are HK\$ 7,430,000 and HK\$ 6,430,000, respectively. Net present values of two plants at various discount factors have been determined and the IRR have been estimated as 13.0 and 20.1% for the stand-alone plant and integrated plant, respectively. Sensitivity analysis reveals that the cash flow of the project would be increased or decreased up to 40, 65 and 120% by varying production factors of cost of chemical activation agent, production capacity and selling price of activated carbon, respectively, in the extent of $\pm 25\%$.

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Keywords: Bamboo scaffolding waste; Activated carbon; Process design; Economic evaluation

1. Introduction

Bamboo is a tropical plant and is common in Southern Asia such as China [1], Thailand and Vietnam [2]. It can grow very fast, 120 cm in 24 h [3], and consume energy of 0.5 MJ/kg only during the growth comparing to 0.8 and 30 MJ/kg for timber and steel [4]. Proximate and elemental analyses of one kind of Indian bamboo are shown in Table 1 (Technology Information, Forecasting and Assessment Council, India).

Bamboo cane, indigenous to Hong Kong and China is available as scaffolding waste from Hong Kong construction projects. Over 50,000 tonnes of bamboo scaffolding waste each year is dumped as construction waste. Bamboo scaffolding is economical (US\$ 1.29 per 6 m bamboo pole), flexible (to cut a desired length) and efficient (erecting is easy) [2] in construction. Three types of bamboo imported mainly from Southern China are using for construction in Hong Kong,

namely, *Bambusa Pervariabius*, *Phyllostachys* and *Pubescens* sand Fir [5]. People also use it for signage, slope and demolition works. However, bamboo pole has a finite life span due to its weakening and degradation. As Hong Kong has a high frequency of construction and repair works, consequently, a lot of bamboo wastes were disposal into landfilling site each year. In 1992, the percentage of bamboo waste out of total construction waste was 0.4% [6].

Bamboo waste can be used as a raw material for the production of a range carbon chars and activated carbons due to its high carbon content shown in Table 1. The bamboo cane can be carbonized/charred in a furnace at high temperature in the absence of oxygen to produce carbon chars. The chars can be treated using various chemicals and over a range of temperatures to produce a selection of activated carbons for various uses [7–9]. Bamboo-based activated carbons can be expected to find uses as: (1) a potential commercially available activated carbon for the treatment of gaseous pollutants and (2) a potential commercially available activated carbon for the treatment of liquid pollutants in industrial effluents and in drinking water filtration applications.

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Programa: Foro internacional: "Normativa y realidad de los procesos de acceso a los recursos genéticos dentro del marco de la Política Nacional de Diversidad"

10 de septiembre de 2010. Auditorio 209 del Ed. 02 Fernando Barón S.J. de la Pontificia Universidad Javeriana.

8:00 a.m. Instalación. Palabras de Bienvenida.

Ingrid Schuler.

Decana, Facultad de Ciencias.

8:15 – 9:30am Conferencia. Política Nacional de Diversidad Biológica.

Doctora Xiomara L. Sanclemente M.

Ministerio de Ambiente, Vivienda y Desarrollo Territorial (MAVDT).

9:30 – 10:30 Conferencia. La Prospección Biológica y el Acceso a los Recursos Genéticos en el Perú.

Doctor Santiago Pastor.

Coordinador del Grupo Técnico de Recursos Genético y Conocimientos Tradicionales de la Comisión Nacional de Diversidad Biológica.

10:30 - 11:00 RECESO

11:00- 11:45 Conferencia. Avances en legislación colombiana e implementación de la Decisión Andina 391 de 1996, sobre acceso a Recursos genéticos en Colombia.

Doctoras Aleyda Martínez y Maria Jose Calderón.

Ministerio de Ambiente, Vivienda y Desarrollo Territorial (MAVDT).

11:45 – 12:30. Conferencia. Régimen Internacional de Acceso a Recursos Genéticos.

Doctora Marcela Jiménez.

Ministerio de Ambiente, Vivienda y Desarrollo Territorial (MAVDT).

12:30 – 14:30pm. Almuerzo libre.

14:30 – 16:30pm. Foro – discusión.

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Table 1

Proximate and elemental analyses of one kind of Indian bamboo

	Proximate analysis (dry basis (%))			Elemental analysis (%)			
	Volatiles	Fixed	Ash	Carbon	Hydrogen	Nitrogen	Sulfur
Bamboo	80.6	15.6	3.9	43.8	6.6	0.4	Nil

The use of waste bamboo scaffolding from the construction industry will be a valuable outlet for one of Hong Kong's waste products. In addition, many industries in Hong Kong (textiles, clothing, microelectronics, electroplating, chemical, food, drink, petrochemical) have problems finding an economically feasible method of removing pollutants from effluents. The development of activated carbons in Hong Kong will be a tremendous incentive for local industries to utilize these materials. It will also give industry a chance to recover, recycle and re-use these pollutants, which in most cases are valuable raw materials/intermediates or products of their processing operations. This project is specifically targeted at potential future uses in Hong Kong. Currently the Hong Kong SAR Government is looking at a number of options to reduce wastes (MSW, sewage sludge, hazardous chemical wastes) by incineration projects. It is well established that such incineration processes produce dioxins which can be most effectively removed by adsorption onto activated carbons—a usage of 50–100 tonnes/day.

2. Bamboo characteristics

2.1. Bamboo as raw material for activated carbon

The choice of raw material has an important impact on the economy of producing activated carbon. Typical raw materials used for the preparation of activated carbon include coal [10], bone char, lignite and agricultural by-products such as coconut shells [11,12], bagasse [13], rice hulls [14], peach stones [15]. The criteria used when choosing a carbonaceous raw material includes potential for obtaining high quality activated carbon low inorganic content, volume and cost of the raw material, workability of the raw material, minimum environmental impact, and storage life of the raw material.

The basis of this project is to utilize Hong Kong bamboo construction scaffolding waste as a raw material to produce activated carbon since it is cheap, even no cost. In Hong Kong, approximately 50,000 tonnes of bamboo scaffolding waste per year is dumped as construction waste. It has most of the desired properties for a good raw material and does not have the environmental impacts of using petroleum coke and wood, as it is a waste material. A literature survey has recently been carried out to investigate which raw materials have been used for activated carbon production but no references mentioned bamboo as a raw material. Current commercial processes use coal, bagasses, coconut shell, peat, lignite and wood.

2.2. Chemical properties of bamboo cane

Information on the chemical composition of the components that constitute bamboo is important in evaluating alternative processing and recovery options. The feasibility of carbonization depends on the chemical composition of the bamboo. Determining the elemental composition of bamboo by elemental analysis is a key factor for the detailed design of the production of activated carbon from a bamboo carbonization plant and helps confirm the accuracy of material and energy balances of the bamboo carbonization process. The ultimate analysis of a bamboo component typically involves the determination of the percent of carbon (C), hydrogen (H), oxygen (O), nitrogen (N), sulfur (S) and ash. Because of the concerns over the emission of chlorinated compounds, e.g. dioxins, during combustion, the determination of halogens is often included in an ultimate analysis. The results of the elemental analysis are used to characterize the chemical composition of the organic matter in bamboo.

The average chemical composition of bamboo is measured by an elemental analysis and is shown in Fig. 1. The major elements are carbon (47.6%) and oxygen (43.9%) accounting for around 91% of bamboo. Other elements include hydrogen (6.5%), nitrogen (0.3%), sulfur (0.3%) and ash (1.4%). The ash content of the bamboo is determined by a thermogravimetric analysis (TGA), the TGA will be discussed later. The results are very close to the finding by Technology Information, Forecasting and Assessment Council, India (see Table 1). A more detailed chemical composition of bamboo must be determined on different types of Hong Kong bamboo in future if the feasibility study of the bamboo carbonization process is to proceed.

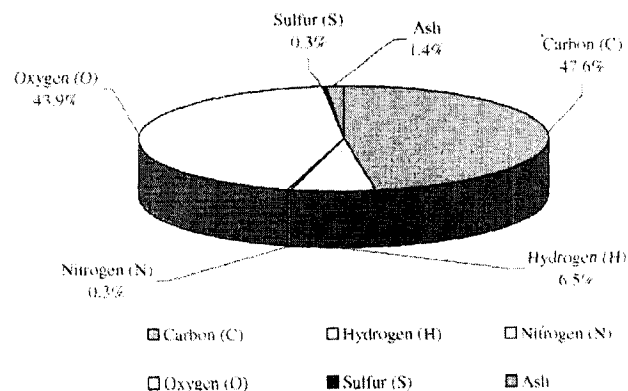


Fig. 1. Elemental composition of bamboo cane.



(12)

SOLICITUD de PATENTE

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(54) Título: **METODO Y SISTEMA PARA LA CARACTERIZACION DE YACIMIENTOS JUNTO CON OPERACIONES DE PERFORACION.**

(54) Title: **METHOD AND SYSTEM FOR RESERVOIR CHARACTERIZATION IN CONNECTION WITH DRILLING OPERATIONS.**

(57) Resumen

Se expone un metodo para analizar fluidos de yacimientos junto con una operacion de perforacion que incluye determinar la composicion o isotopos de los fluidos de inyeccion inyectados en una perforacion de pozos durante una operacion de perforacion y los fluidos de produccion recuperados de la perforacion de pozos durante la operacion de perforacion. Los fluidos de yacimientos provenientes de un deposito cruzado por la perforacion de pozos se caracterizan con base en la composicion e isotopos del fluido de inyeccion y del fluido de produccion.

(57) Abstract

A method for analyzing reservoir fluids in connection with a drilling operation includes determining composition and isotopes of injection fluids injected into a wellbore during a drilling operation and production fluids recovered from the wellbore during the drilling operation. Reservoir fluids from a reservoir intersected by the wellbore are characterized based on the composition and isotopes of the injection fluid and of the production fluid.

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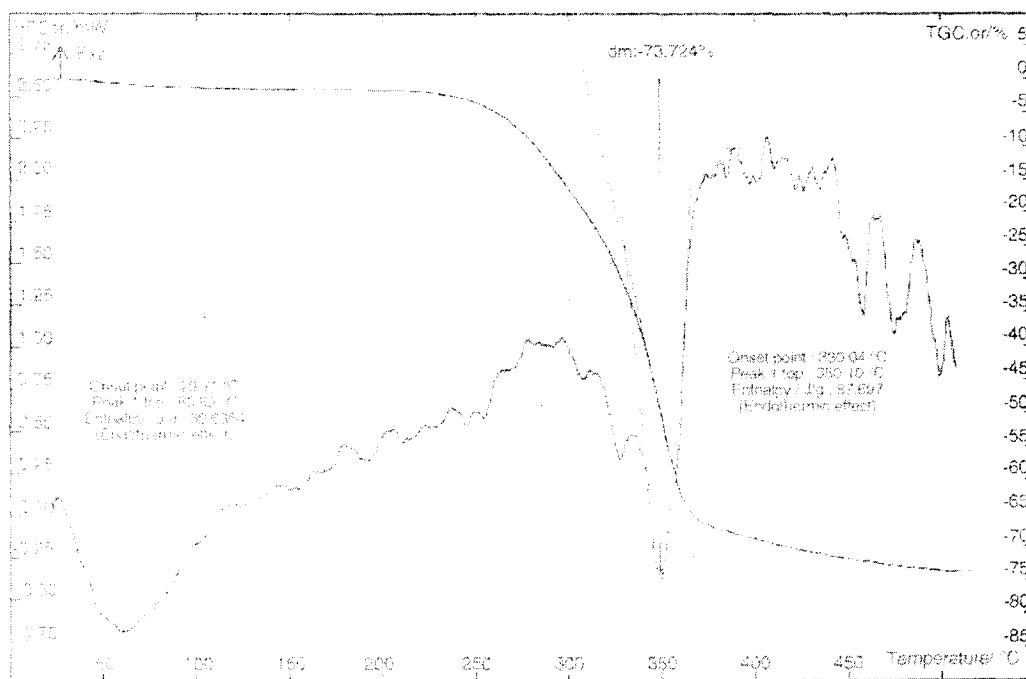


Fig. 2. Differential thermogram of bamboo in the absence of oxygen.

2.3. Heat of carbonization for bamboo

After estimating the elemental composition of the bamboo, the heat of carbonization of bamboo must be determined in order to perform a calculation of the material and energy balances for the bamboo carbonization process. The heat of carbonization can be found by using a differential thermal analysis (DTA). In DTA, the heat absorbed or emitted by a

chemical system is observed by measuring the temperature difference between the system and an inert reference compound as the temperatures of both are increased at a constant rate.

Fig. 2 is a differential thermogram obtained by heating the bamboo in a flowing stream of nitrogen (absence of oxygen), similar to the bamboo carbonization process, it was found that the bamboo carbonization process starts at around 250 °C and

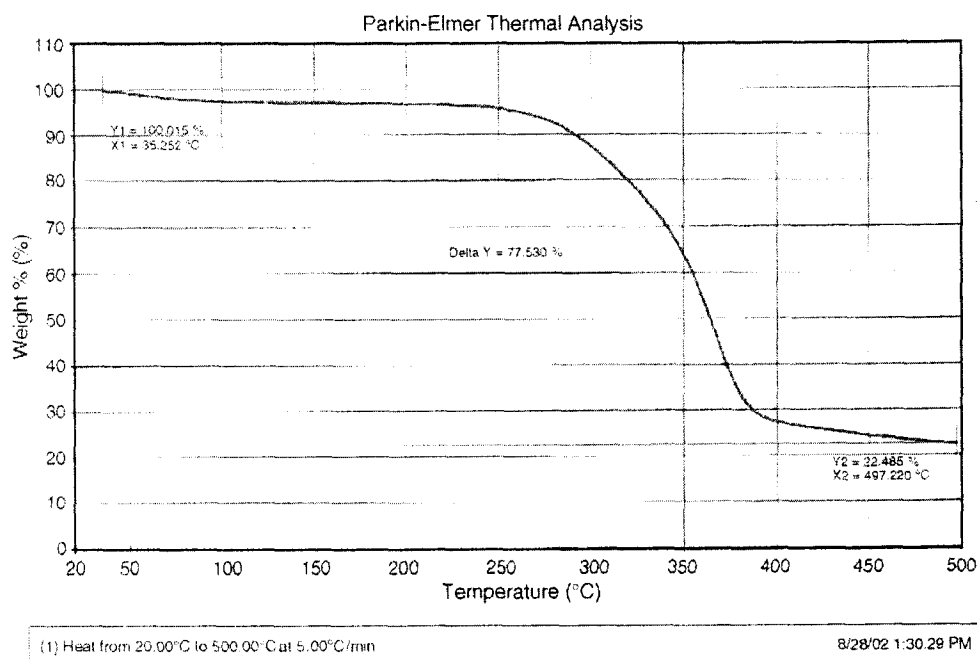


Fig. 3. Thermogram for carbonization of bamboo.

perforación 64 para formar el fluido de perforación 68 que se inyecta en la herramienta de perforación 34 o el tubo de circulación u otra línea acoplada a la herramienta de perforación 34.

5 Aunque no se muestra, se puede agregar un material trazador al fluido de perforación 68 para ayudar en la medición del tiempo transcurrido desde la inyección del fluido de perforación 68 hasta que regresa a la superficie en el sistema de producción 24. El tiempo transcurrido desde la inyección del material trazador hasta la reaparición del trazador indica el tiempo de circulación. El material trazador puede ser un carburo, una sustancia inerte tal como por ejemplo, gas neón, un gas o líquido no encontrado usualmente en 10 la naturaleza en yacimientos que portan hidrocarburos perforados comercialmente, o un material radioactivo de vida media corta u otro material adecuado.

El sistema de inyección 22 incluye instrumentos para medición, registro y/o reporte de 20 datos para los fluidos de perforación en corriente ascendente. En una modalidad particular, se puede acoplar un instrumento analizador de líquidos 70 al tubo de circulación u otra línea de inyección hidráulica para perforación para analizar la composición el fluido de 25 perforación inyectado 68. En esta modalidad, el

instrumento analizador de líquidos 70 puede proporcionar el análisis completo de la composición de los líquidos en el fluido de perforación inyectado 68. El análisis composicional total identifica todos, prácticamente 5 todos o los hidrocarburos significativos y otros líquidos presentes en cantidades traza u otras cantidades adecuadas, incluyendo agua, cloruros y otros químicos. El líquido, gas u otros fluidos es significativo cuando su detección contribuye 10 materialmente a la caracterización de fluidos de yacimiento y/o el yacimiento 14. En una modalidad particular, se puede utilizar una cromatografía para proporcionar el análisis composicional total en el sitio en tiempo real o tiempo casi real. En el sentido en el que se utiliza en la presente, tiempo casi real 15 significa durante la operación de perforación. En otra modalidad, el análisis composicional del fluido de perforación inyectado 68 se puede realizar fuera del sitio y/o después del término de la operación de 20 perforación.

Un instrumento analizador de gases 72 también se puede acoplar al tubo de circulación u otra línea de inyección para analizar el fluido de perforación inyectado 68. En una modalidad particular, el 25 instrumento analizador de gases 72 incluye un analizador

obtains a minima termed peak (350 °C) in which accounts for more than 70% weight loss of bamboo during the process. The minima indicate that the bamboo carbonization process is an endothermic reaction and the heat of carbonization of bamboo is 87.70 J/g. The specific heat of carbonization of bamboo at different conditions (under chemical activation or different temperatures) will be determined if this study is to proceed in more detail in the future.

2.4. Yield of the bamboo carbonization process

The yield of activated carbon from the bamboo carbonization process can be determined by using a thermogravimetric analysis (TGA). In a thermogravimetric analysis, the mass of sample is recorded continuously as its temperature is increased linearly from ambient to as high as 1200 °C. A plot of mass as a function of temperature (a thermogram) provides both qualitative and quantitative information. Fig. 3 is a recorded thermogram obtained by increasing the temperature of bamboo in a flowing stream of nitrogen (absence of oxygen) at 5 °C/min. The significant weight change of bamboo starts at 240 °C (same as DTA results) and stops at 500 °C, hence, the yield of bamboo carbonization is approximately equal to 22.5%. The thermogravimetric analysis (TGA) can also be used to determine the ash content of the bamboo in which the bamboo is heated up in a flowing stream of air.

3. Process design for bamboo carbonization plant

3.1. Process description for stand-alone plant

The current bamboo carbonization plant is designed to carbonize 30 tonnes of bamboo per day to produce activated carbon. The process flow diagram is shown in Fig. 4. The raw material, bamboo, will be crushed and blended into a smaller particle size in order to facilitate the carbonization thereafter. Then, the granular bamboo will be impregnated with the potassium hydroxide (KOH) solution for chemical activation which is then evaporated at 110 °C in an oven for 8 h to remove water and the potassium hydroxide addition is 70 wt.%. The alkaline treated bamboo is then transferred to a carbonization furnace through a conveyor. The carbonization furnace is operating at 850 °C in the absence of air. Nitrogen is used to purge the carbonization furnace to provide an oxygen-free environment for the carbonization reaction to take place.

Volatile gases, usually consisting of carbon dioxide, carbon monoxide, hydrogen, methane and some light hydrocarbons, will leave the carbonization furnace together with the nitrogen gas in the gas stream. These volatile gases are a high-energy content fuel gas and part of the energy fuel gas is used as fuel for combustion to provide heat in the carbonization furnace and oven. According to the experimental results in a laboratory, the overall yield of the activated carbon from the

bamboo carbonization process is around 20–24% and the production rate of the activated carbon is around 6.6 tonnes/day in this process. The resultant product, activated carbon, after cooling in an inert atmosphere will be washed with water to remove and recover the impregnant (KOH) and is then dried in a furnace. The recovered KOH is used to impregnate the new batch of bamboo in the chemical activation process again. The activated carbon formed will be delivered through a conveyor in an activated carbon storage tank for packaging and delivery.

The rest of the volatile gases generated from the carbonization furnace are then fed to the combustion chamber mixing with an air for final combustion. The temperature of combustion chamber is maintained at a high combustion temperature (around 1000 °C) with a residence time of not less than 2.5 s to reduce the formation of NO_x. The outlet temperature of the combustion chamber is high so that harmful materials such as dioxin are destroyed. Following the combustion chamber the flue gas is led into a cyclone for complete combustion. The particles are separated out, collected and discharged at the bottom of the cyclone.

The hot flue gas coming out from the cyclone at around 1000 °C flows to a steam boiler for energy recovery; and electricity is generated by a steam turbine. Then, a heat exchanger is used to produce hot water from the remaining heat. The steam turbine and heat exchanger system are designed to cool down the flue gas to around 170–200 °C. The driving force of the gas flow through the combustion chamber and the energy recovery system is a slight suction-pressure created by the flue gas fan. Flue gas coming out from the heat exchanger will then enter a lime scrubber unit for HCl and SO_x removal. The tail gas is then sent to the stack after removing fly ash and fine particles using a bag-house filter system. A continuous-emission-monitoring (CEM) unit is installed at the end of the pipe to ensure the quality of the gas emission does not exceed the government set limits by the Hong Kong Environmental Protection Department, HK-EPD (see Table 2). The equipment list of the stand-alone bamboo carbonization process is shown in Table 3.

3.2. Process description for integrated plant

In this case the overall process works in exactly the same way as the process in the stand-alone plant except that the environmental emission treatment equipment is not required. If the bamboo carbonization process plant is integrated into another major (or much larger) processing facility, such as

Table 2
Stack emission limit of Hong Kong

Species	HK-EPD half-hourly emission limit (mg/m ³)	Stack emission (mg/m ³)
SO ₂	200	113.7
NO	400	122.6
Particulates	30	1.4

de composiciones y un analizador de isótopos que juntos miden la composición y los isótopos de los hidrocarburos, los no hidrocarburos y gases traza. La medición de isótopos "tomar huellas" de los gases en el fluido de perforación 68. En una modalidad particular, el instrumento analizador de gases 72 puede comprender un cromatógrafo de gases que mide C1-C5 y posiblemente los hidrocarburos de peso molecular mayor así como también, nitrógeno, oxígeno, argón y los gases traza mensurables. En otra modalidad, el instrumento analizador de gases 72 puede comprender un espectrómetro másico, un espectrómetro láser otro instrumento operable para proporcionar un análisis composicional total de gases así como también identificar los isótopos presentes en hidrocarburo significativo, no hidrocarburo y gases traza. En otra modalidad, el instrumento analizador de gases 72 puede comprender un espectrómetro láser operable para detectar carbono-13 y deuterio. Los instrumentos analizadores de líquidos y/o gases 70 y 72 pueden medir cualquier trazador agregado al fluido de perforación 68.

El sistema de inyección 22 también puede incluir instrumentos paramétricos de inyección 74 acoplados al tubo de circulación 34 u otra línea de inyección. Los instrumentos paramétricos de inyección

74 en una modalidad pueden medir presión, temperatura y/o velocidad de flujo del fluido de perforación 68 inyectado en la herramienta de perforación 34. Los instrumentos paramétricos de inyección 74 en algunas modalidades también pueden medir la resistividad, volumen, densidad y/u otras características del fluido de perforación 68.

El sistema de producción 24 incluye un regulador para pozos petroleros 80, un separador 82, una antorcha de gas 84, un succionador 86 y un almacenamiento de líquidos 88. El regulador para pozos petroleros 80 regula la presión del fluido de producción 90 que regresa de la corona del pozo 12. El separador 82 puede ser un separador de etapa individual o múltiple que separa gases líquidos y sólidos. En una modalidad particular, el separador 82 puede separar el gas 92, los líquidos 94 y virutas de sólidos 96. El gas 92 se puede encender mediante una antorcha de gas 84. Los líquidos 94 se pueden procesar mediante el succionador 86 que separa el petróleo 98 del fluido de perforación y agua 100. El petróleo 98 se puede almacenar en un almacenamiento de líquidos 88. El fluido de perforación y agua 100 se puede depositar en el sistema de excavaciones 26 para el procesamiento y/o recirculación dentro del 12 junto con las operaciones de perforación.

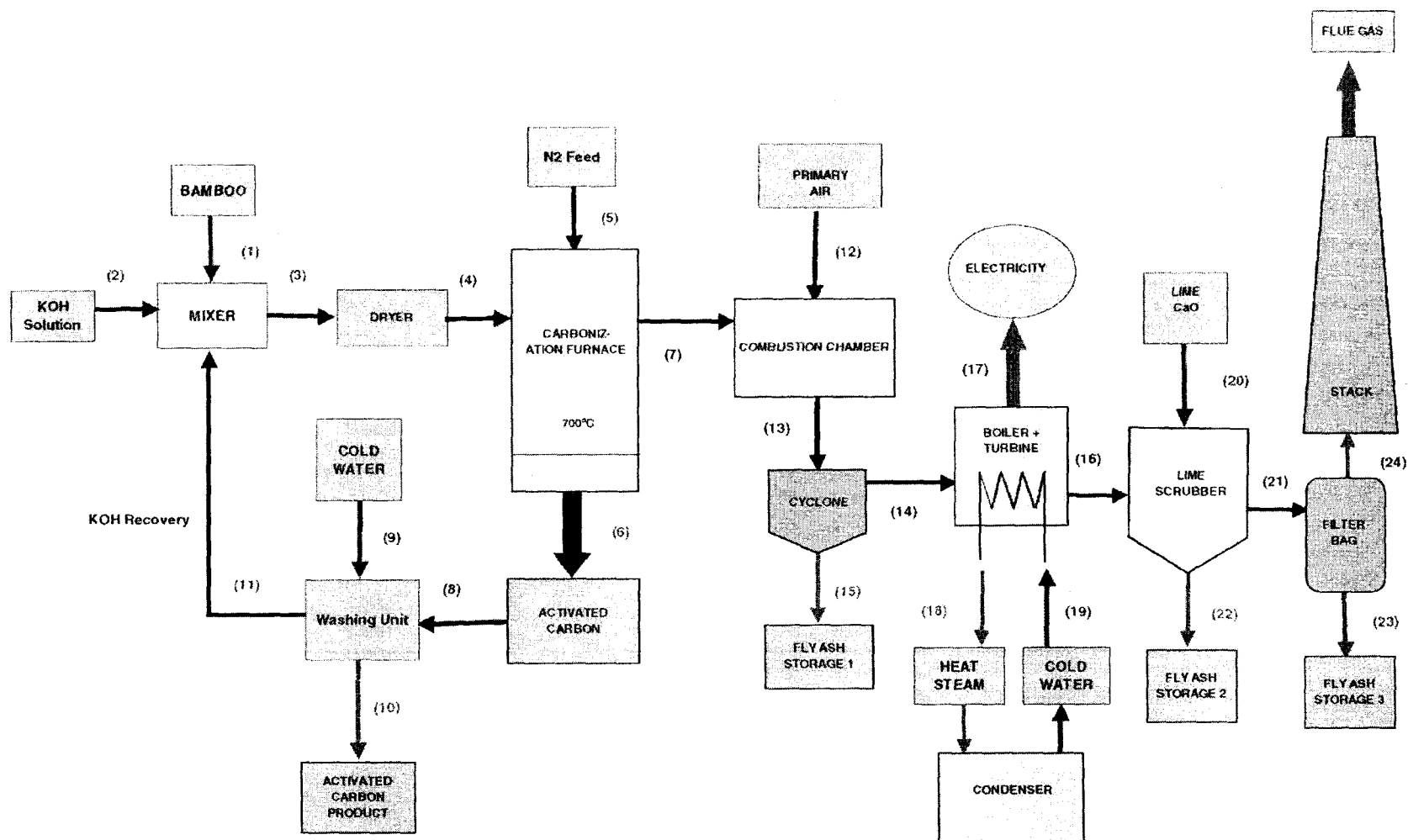


Fig. 4. Process flow diagram.

39 38

virutas 124 a la línea de desecho y se puede controlar ya sea manualmente o automáticamente para las virutas de muestra 96. El instrumento analizador de virutas 124 puede desprender rápidamente fluidos fuera de las virutas 96 en el sitio y/o el análisis de tiempo casi real. En una modalidad, el instrumento analizador de virutas 124 tritura mecánicamente, agita y/o calienta las virutas 96 para desprender los fluidos en minutos, una hora, una hora de acoplamiento la porción de un día o un día o más. En otra modalidad, se puede hacer que las virutas 96 de otra manera vibren mediante energía ultrasónica o de otra manera reduzcan la tensión superficial y se liberen del fluido contenido. El instrumento analizador de virutas 124 puede incluir un analizador de líquidos y un analizador de gases para determinar la composición del líquido y la composición de isótopos del gas desprendido de las virutas 96. El analizador de gases puede incluir un sistema de flujo constante de tal forma que el nitrógeno u otro gas siga fluyendo en ausencia del gas proveniente de las virutas. En otra modalidad, las virutas 96 se pueden muestrear mecánicamente. Las virutas también se pueden analizar parcial o totalmente fuera del sitio.

Durante las operaciones de perforación, la perforación se lleva cabo mediante la aplicación de peso

a la roca 40 y al hacer girar la herramienta de perforación 34, que a su vez hace girar la broca 40. La herramienta de perforación 34 se hace girar dentro de la perforación del pozo 15 mediante la acción de una mesa de rotación 30. Alternativamente o además, el motor situado en el fondo de la perforación 42 puede hacer girar la broca 40 independientemente de la herramienta de perforación 34 y la mesa de rotación 30 para una perforación direccional. Las virutas 96 se producen a medida que la broca 40 perfora en la tierra y se llevan fuera de la perforación del pozo 15 al hacer circular el fluido de perforación inyectado 68 suministrado por las bombas hidráulicas 60 y/o adicionalmente portadas por los fluidos del yacimiento producidos.

Los datos recolectados por los instrumentos del sistema de pozos 20, el sistema de inyección 22, el sistema de producción 24 y el sistema de excavaciones 26 se pueden proporcionar a una sistema de caracterización de yacimientos 200 (mostrado en la Figura 3) para procesamiento y análisis. Los instrumentos se pueden conectar al sistema de caracterización de yacimientos 200 mediante un cable de acero eléctrico o enlaces inalámbricos. Por ejemplo, los instrumentos se pueden conectar mediante cables directamente al sistema de caracterización de yacimientos 200 o se pueden conectar

Table 3

Major equipment items in the production of activated carbon from bamboo carbonization process

Item no.	Item description	Sizing parameter	Temperature (K)
E-101	Carbonization furnace	1.88 Mbtu/h	973
E-102	Bamboo dryer × 3	10 tonnes/day	383
E-103	Activated carbon dryer	7 tonnes/day	383
E-104	Crusher	2 tonnes/h	293
E-105	Nitrogen storage tank	1.92 m ³	196
E-105	Mixing tank	10 m ³	293
E-201	Combustion chamber	42297 m ³ /h	1499
F-202	Primary air blower	7591 m ³ /h	298
E-203	Carbon washing tank	10 m ³	973
E-204	Activated carbon storage tank	137 m ³	973
E-301	Cyclone	42135 m ³ /h	1493
E-302	Fly ash container (1)	5 m ³	1493
E-401	Steam boiler packed	3781 kg/h	1487
E-402	Steam turbine	337 kW	673
E-403	Condenser	4 m ² area	473
E-404	Deionization columns	3781 kg/h	293
E-405	Regeneration system	3781 kg/h	293
E-501	Scrubber	12501 m ³ /h	473
E-502	Fly ash container (2)	1 m ³	473
E-503	Lime feeder	0.4–14 kg/h	293
F-504	Lime storage tank	1 m ³	293
E-601	Filter bag house	12455 m ³ /h	443
E-602	Fly ash container (3)	1 m ³	443
E-701	Ash quenching tank system	Packaged	873
F-702	Wastewater treatment system	22 m ³ /day	293
E-801	Packaging unit	Packaged	293
E-802	Conveyor × 5 (100 ft)	2 tonnes/h	773
E-901	Stack	0.33 m × 50 m	443

one of the following:

1. a thermal electricity generating facility;
2. a cement manufacturing facility;
3. a thermal hazardous waste processing plant;

then these companies will already have the required environmental treatment trains of process equipment required for SO_x, NO_x reduction. Therefore, these additional items (if already available on the large scale treatment plants) will not be necessary and will reduce the capital costs of the bamboo processing facility. The items not required in the integrated plant are shown in Table 4. These results in net plant equipment will save of US\$ 158,674, and a saving in total capital investment (see chapter 6) of US\$ 1,000,260.

Table 4

Equipment items not necessary for integrated bamboo carbonization plant

Item name	Item number
E-501	Scrubber
E-502	Fly ash container (2)
F-503	Lime feeder
E-504	Lime storage tank
E-601	Filter bag house
E-602	Fly ash container (3)
E-701	Ash quenching tank system
E-702	Wastewater treatment system
E-901	Stack

4. Results and discussion

4.1. Process simulation

In order to carry out the costing and economic evaluation of the production of activated carbon from bamboo, a material and energy balance calculation of the bamboo carbonization process must be done before. Microsoft Excel is chosen as the software to simulate the whole bamboo carbonization process in order to find out all the information required in the economic evaluation such as the production rate of activated carbon, the sizing parameter of each operating units, temperature of the process, heat energy (fuel) required in the furnace system, amount of the utilities (water, nitrogen), etc. The basic principle for both material and energy balance is simply based on the following equation:

$$\text{Input} + \text{Generation} = \text{Output} + \text{Consumption} + \text{Accumulation}$$

In all the mass balance calculations, no mass accumulation in the design process is assumed. Since the mass balance involved reaction, it is calculated by using the mole flow of each compound when reaction is involved in the process. Each reaction depends on the conversion of reaction since all the reactions are assumed in equilibrium and the number of moles consumed in the reaction is equal to the number of generated in the process. In mole basis, the relation becomes

$$\sum (F_i)_{\text{input}} + \sum (F_i)_{\text{generation}} = \sum (F_i)_{\text{output}} + \sum (F_i)_{\text{consumption}}$$

where F_i = molar flowrate of species i (kmol/h).

In an open system, mass is allowed to cross the system boundary as the process occurs, the energy is usually governed by the following balance equation:

$$Q + \left[\sum F_i \int_{T_R}^T C_{p_i} dT \right]_{\text{in}} - \left[\sum F_i \int_{T_R}^T C_{p_i} dT \right]_{\text{out}} - F_i \Delta H_{RX}(T) = 0$$

4.2. Laboratory scale production on activated carbon from bamboo

A series of laboratory works were conducted to determine the relationship between experimental conditions and the yield as well as properties of bamboo carbon. The bamboo cane for experiment was shredded to a nominal size of 5 mm. The granular bamboo will be impregnated with the KOH solution (70 wt.%) for chemical activation which is then evaporated at 110 °C in an oven for 24 h to remove water.

After impregnating the bamboo cane, pre-weighed sample was then placed in a muffle furnace. Nitrogen was then introduced into the furnace at a rate of 200 cm³/min. The sample was activated at 850 °C in the absence of oxygen for 2 h. The resulting activated carbon was cooled under nitrogen and

al sistema de caracterización de yacimientos 200 mediante una red de área local (LAN, por sus siglas en inglés) tal como por ejemplo, una Ethernet. En otra modalidad, algunos o todos los instrumentos se pueden

5 comunicar con el sistema de caracterización de yacimientos 200 mediante radiofrecuencia (RF) u otros enlaces adecuados.

La Figura 2 ilustra los detalles de una modalidad del yacimiento 14. Como se describió anteriormente, el yacimiento 14 puede incluir zonas

10 múltiples 16A, 16B y 16C. Cada zona 16, o capa, puede tener su propio espesor h y permeabilidad k , así como también, otras propiedades del yacimiento.

Haciendo referencia a la Figura 2, el yacimiento 14 tiene un límite externo a $r = r_e$. la perforación de pozos 15 tiene un radio r_w y se perfora en el centro del yacimiento 14. En el tiempo $t = 0$, la proporción del pozo total q y la longitud total del pozo l_w son 0. Durante la perforación en un momento posterior

15 t , el pozo tiene una proporción de $q(t)$ y una longitud $l_w(t)$. A medida que la perforación del pozo 15 atraviesa cada zona 16, el flujo a través del recubrimiento de arena se redistribuye instantáneamente. Un método para modelar el flujo en la perforación del pozo puede asumir

20 que el flujo dentro de la perforación del pozo 15 es

uniforme a través de cada zona 16. Sin embargo, puede haber un flujo diferente en cada zona 16.

La Figura 3 ilustra el sistema de caracterización de yacimientos 200 de acuerdo con una

5 modalidad. En esta modalidad, el sistema de caracterización de yacimientos 200 es un sistema distribuido que incluye procesamiento en el sitio en la ubicación de la perforación 201a y el procesamiento remoto en un centro del yacimiento 201b. Los elementos

10 del sistema de evaluación de yacimientos 200 de otra manera se pueden distribuir y/o combinar adecuadamente. Los componentes en el sitio y remotos se pueden comunicar vía alámbrica y/o enlaces inalámbricos. Por ejemplo, la comunicación se puede proporcionar a través

15 de un enlace satelital. La caracterización de yacimientos puede comprender la evaluación de yacimiento y/o evaluación y caracterización adicionales.

Haciendo referencia a la Figura 3, el sistema para evaluación de yacimientos 200 incluye en la

20 ubicación de la perforación 201a un sistema para recolección de datos que comprende los datos de inyección 202, los datos de producción 204, los datos en el fondo del pozo 206, los datos SDL 208 y los datos de virutas 210. Los datos de inyección 202 se recolectan a

25 partir de los instrumentos 70, 72 y 74 del sistema de

then was rinsed and stirred with deionized water to recover the KOH until the water rinsed out had an approximate pH value of 8. The rinsed activated carbon was dried in an oven at 110 °C for 24 h and kept for further characterization such as BET surface area. It was found that the yield of this bamboo carbonization process is around 22% and carbons generated under these conditions yield product with high surface area up to 800 m²/g.

4.3. Economic evaluation of the stone-alone and integrated bamboo carbonization plant

The aim of this section is to present information regarding the economic feasibility for the production of activated carbon from bamboo construction waste. The technical feasibility and the process routes have been established and outlined in the previous sections. For the purpose of this economic study, the mass balance information presented in the process simulation section has been used in this study. This economic evaluation is based on the carbonization of 30 tonnes bamboo per day, the rate of production of activated carbon is around 6.6 tonnes and 300 kW of electricity will be generated by the bamboo carbonization process. The costing for this study is based on a standard factored estimate procedure; such estimates are typically accurate to within $\pm 25\%$ of the final cost of the plant. The complete cost estimation of the plant is included into two main parts—total capital investment and production cost. A detailed breakdown of each part is given in the following sections.

4.3.1. Total capital investment

Before a plant can be put into operation, a large sum of money must be supplied to purchase and install the necessary machinery and equipment. Land costs and service facilities

must be obtained, and the plant must be erected complete with all piping, controls, and services. In addition, it is necessary to have money available for the payment of expenses involved in the plant operation. The capital needed to supply the necessary manufacturing and plant facilities is called the fixed capital investment and includes direct and indirect costs, while that necessary for the operation of the plant, in the initial phase, is termed the working capital. The sum of the fixed capital investment and the working capital is known as the total capital investment. The total capital investment is determined by factorial method in this report. The following simple tree diagram (Fig. 5) can represent the calculation.

4.3.1.1. Costing for the major plant items. This section lists the major plant items that are required for the process and explains the techniques involved in sizing and costing of these major equipment items. Table 5 shows the major equipment items and the cost of those items which are required for this plant. Most cost information was provided and obtained by Matches Company, A Guide to Chemical Engineering Process Design and Economics [16], Coulson and Richardson's Chemical Engineering Volume 6 [17] and Plant Design and Economics for Chemical Engineers [18]. The expected error into the factored costing estimation is $\pm 20\text{--}30\%$. The cost obtained from the references may not be the latest equipment cost. Thus, the equipment cost can be updated by using the Marshall and Swift Index [19]:

$$\begin{aligned} \text{Cost of plant item (2003)} &= \text{Cost of plant item (19XY)} \\ &\times \left[\frac{\text{cost index 2003}}{\text{cost index 19XY}} \right] \end{aligned}$$

From Table 5, the total cost of the major plant equipment items is US\$ 1,193,273. We have assumed an additional fac-

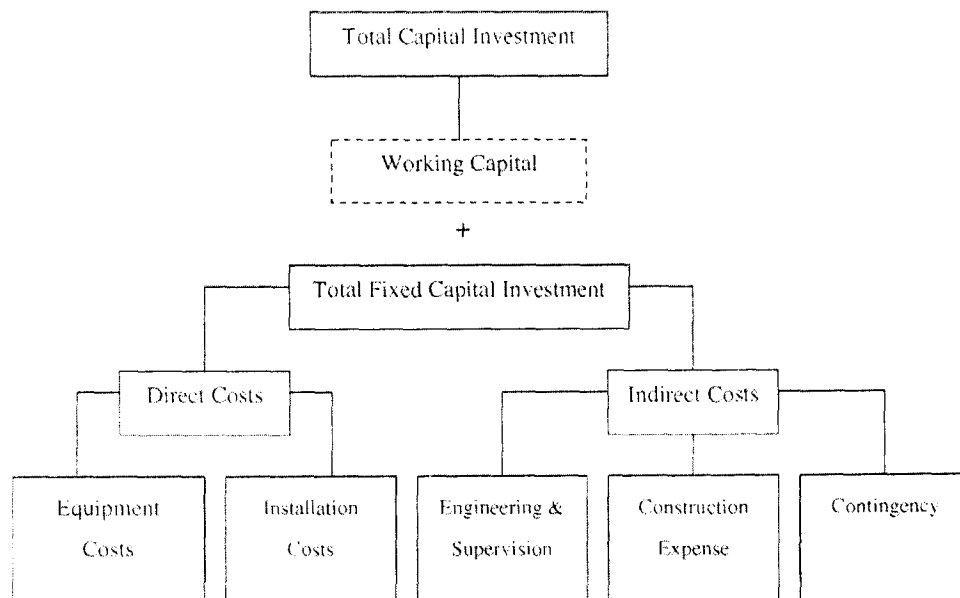


Fig. 5. Simple tree diagram for total capital investment determination.

NOVEDAD DE LA INVENCIÓN

Habiendo descrito el presente invento, se considera como una novedad y, por lo tanto, se reclama como propiedad lo contenido en las siguientes

REIVINDICACIONES:

1. Un método para análisis de fluidos de yacimientos junto con una operación de perforación, caracterizado porque comprende:

determinar la composición e isótopos de los fluidos de inyección, inyectados en una perforación de pozos durante una operación de perforación y los fluidos de producción recuperados de la perforación del pozo durante la operación de perforación; y

caracterizar los fluidos del yacimiento de un yacimiento cruzado por la perforación del pozo con base en la composición e isótopos del fluido de inyección y el fluido de producción.

2. El método según la reivindicación 1, caracterizado además porque comprende caracterizar los fluidos del yacimiento durante la operación de perforación.

3. El método según la reivindicación 1, caracterizado además porque comprende:

medir la presión y velocidad de flujo de los fluidos de inyección y producción durante la operación

de perforación; y

determinar la productividad del yacimiento con base en la presión de los fluidos de inyección y producción y con base en la caracterización de los fluidos del yacimiento.

4. El método según la reivindicación 3, caracterizado además porque comprende caracterizar el yacimiento con base en la productividad del yacimiento.

5. El método según la reivindicación 1, caracterizado además porque comprende:

determinar la composición e isótopos de los fluidos de virutas recuperados de las virutas del yacimiento; y

caracterizar los fluidos del yacimiento con base en la composición e isótopos de las virutas, fluidos de inyección y producción.

6. El método según la reivindicación 5, caracterizado además porque comprende caracterizar los fluidos del yacimiento durante la operación de perforación.

7. El método según la reivindicación 6, caracterizado además porque comprende recuperar el fluido de virutas proveniente de las virutas de formación mediante al menos uno de molido, agitación y calentamiento de las virutas.

Table 5

The major items of equipment and their costs involved in the production of activated carbon from bamboo carbonization process

Item no.	Item description	Sizing parameter	Design temperature (K)	Design pressure (atm)	Material of construction	Basic unit cost (US\$)	Year	Unit cost US\$ (2002)
E-101	Carbonization furnace	1.880 Mbtu/h	973	1.2	Carbon steel	130115	2002	130115
E-102	Bamboo dryer × 3	10 tonnes/day	383	1.2	Carbon steel	16400	2000	51266
E-103	Activated carbon dryer	7 tonnes/day	383	1.2	Carbon steel	12752	2000	39862
E-104	Crusher	2 tonnes/h	293	1.2	Carbon steel	35000	1990	44940
E-105	Nitrogen storage tank	1.92 m ³	196	1.2	Carbon steel	15000	1990	19260
E-105	Mixing tank	10 m ³	293	1.2	Carbon steel	11000	1990	14124
E-201	Combustion chamber	42297 m ³ /h	1499	1.2	Carbon steel	69199	2002	71064
E-202	Primary air blower	7591 m ³ /h	298	1.2	Carbon steel	6828	2002	6828
E-203	Carbon washing tank	10 m ³	973	1.2	Carbon steel	11000	1990	14124
E-204	Activated carbon storage tank	137 m ³	973	1.2	Carbon steel	50000	1990	64200
E-301	Cyclone	42135 m ³ /h	1493	1.2	Carbon steel	29129	2002	29129
E-302	Fly ash container (1)	5 m ³	1493	1.2	Carbon steel	7000	1990	8988
E-401	Steam boiler packed	3781 kg/h	1487	45	Carbon steel	100626	1999	103338
E-402	Steam turbine	337 kW	673	45	Carbon steel	201252	1999	206677
E-403	Condenser	4 m ² area	473	1.2	Carbon steel	9500	2002	9500
E-404	Deionization columns	3781 kg/h	293	1.2	Plastic	27118	2002	27118
E-405	Regeneration system	3781 kg/h	293	1.2	Plastic	27118	2002	27118
E-501	Scrubber	12501 m ³ /h	473	1.2	Carbon steel	6948	2002	6948
E-502	Fly ash container (2)	1 m ³	473	1.2	Carbon steel	3000	1990	3852
E-503	Lime feeder	0.4–14 kg/h	293	1.2	Carbon steel	7000	2002	7000
F-605	Lime storage tank	1 m ³	293	1.2	Carbon steel	3000	1990	3852
E-601	Filter bag house	12455 m ³ /h	443	1.2	Carbon steel	23790	2002	23790
E-602	Fly ash container (3)	1 m ³	443	1.2	Carbon steel	3000	1990	3852
E-701	Ash quenching tank system	Packaged	873	1.2	Carbon steel	5000	1990	5000
E-702	Wastewater treatment system	22.00 m ³ /day	293	1.2	—	73505	1990	94380
E-801	Packaging unit	Packaged	293	1.2	—	25707	1990	25707
E-802	Conveyor × 5 (100 ft)	2 tonnes/h	773	1.2	Carbon steel	22000	1990	141240
E-901	Stack	0.33 m × 50 m	443	1.2	Carbon steel	7722	1990	10000
Total equipment cost								1193273

tor of 15% for carrier delivery of those equipment items to the site; hence the total delivered equipment cost is US\$ 1,372,264. The equipment list in Table 5 is for a process with a processing rate of 30 tonnes bamboo per day and around 6.6 tonnes activated carbon is produced. The range of process options considered in this project will be discussed in Section 4.3.6 later.

A “Lang” factor method is used to calculate the rest of the capital investment based on the total purchase equipment cost. This technique, proposed originally by Lang [18], is used quite frequently to an accuracy of ±20–30%. This approach recognizes that the cost of a process plant is obtained by multiplying the basic equipment cost by some factor to approximate the total capital investment. The rest of the capital investment is divided into direct costs and indirect costs of the project fixed capital cost.

4.3.1.2. Direct costs. For stand-alone plant. Besides the equipment cost, many other factors should be considered in the estimation of the capital investment such as installation, piping and site development in order to complete the process plant. The direct-cost items that are incurred in the construction of a plant, in addition to the cost of the equipment items are:

1. purchased-equipment erection, installation;
2. piping, including insulation and painting;
3. electrical equipment and materials, power and lighting;
4. instrumentation and controls;
5. process buildings and structures;
6. yard improvements (site development);
7. service facilities (utilities), provision of plant for steam, water, air, firefighting services;
8. land.

The direct-cost factor used in the estimation of the capital cost is given in Table 6 and the direct costs of different items are also shown. From the table, the total direct plant cost of the bamboo carbonization process is US\$ 4,222,084. A continuous-emission-monitoring (CEM) unit is installed at “the end of the pipe” or stack to ensure the quality of the gas emission does not exceed the government set limits in the best practicable mean (BPM 12/1) guidelines for incinerator plant [20]. The cost of CEM including installation is US\$ 240,385; hence, the revised total direct plant cost of the activated carbon production from the bamboo carbonization process is US\$ 4,462,469.

For integrated plant. As these factors are changed by the removal of several equipment items, the modified form of

8. El método según la reivindicación 3, caracterizado además porque comprende:

al menos uno del marcado de tiempo y profundidad de las virutas con trazadores;

5 determinar un tiempo de demora de las virutas con base en al menos uno del marcado de tiempo profundidad de las virutas con trazadores; y

 determinar la productividad del yacimiento con base en el tiempo de retraso de las virutas.

10 9. Un método para el análisis de fluidos de yacimientos junto con las operaciones de perforación, caracterizado porque comprende:

 determinar una composición de fluidos de inyección, fluidos de producción y fluidos de virutas asociados con un yacimiento durante una operación de perforación; y

 caracterizar los fluidos del yacimiento con base en la composición de los fluidos de inyección, los fluidos de producción y los fluidos de virutas.

20 10. El método según la reivindicación 9, caracterizado además porque comprende:

 determinar los isótopos de los fluidos de inyección, los fluidos de producción y los fluidos de virutas; y

25 caracterizar los fluidos del yacimiento con

Table 6

Total direct plant cost for the bamboo carbonization stand-alone plant

Item	Typical factors for estimation of project direct fixed capital cost for different process types			Value of bamboo carbonization plant items for different process types (US\$)		
	Fluids – solid	Solids	Fluids	Fluids – solid	Solids	Fluids
Equipment-delivered cost	100	100	100	426994	365418	579852
Equipment erection	39	45	47	166528	164438	272531
Instrumentation and controls	13	9	18	55509	32888	104373
Piping	31	16	66	132368	58467	382702
Electrical	10	10	11	42699	36542	63784
Building, process	29	25	18	123828	91355	104373
Yard improvements	10	13	10	42699	47504	57985
Service facilities	55	40	70	234847	146167	405897
Land	6	6	6	25620	21925	34791
Total	293	264	346	1251092	964704	2006289
Total direct plant cost				4222084		

Table 7

Total direct plant cost for the bamboo carbonization integrated plant

Item	Typical factors for estimation of project direct fixed capital cost for different process types			Value of bamboo carbonization plant items for different process types (US\$)		
	Fluids – solid	Solids	Fluids	Fluids – solid	Solids	Fluids
Equipment-delivered cost	100	100	100	385896	344079	459815
Equipment erection	39	45	47	150499	154835	216113
Instrumentation and controls	13	9	18	50166	30967	82767
Piping	31	16	66	119628	55053	303478
Electrical	10	10	11	38590	34408	50580
Building, process	29	25	18	111910	86020	82767
Yard improvements	10	13	10	38590	44730	45981
Service facilities	55	40	70	212243	137632	321870
Land	6	6	6	23154	20645	27589
Total	293	264	346	1130674	908368	1590958
Total direct plant cost				3630000		

Table 6 is shown in Table 7. The total direct plant cost (including CEM installation) of the proposed activated carbon manufacturing integrated plant is US\$ 3,870,385.

4.3.1.3. Indirect costs. For stand-alone plant. In addition to the direct cost of the purchase and installation of equipment, the capital cost of a project will include the indirect cost the process plant. The indirect-cost items [17] that are incurred in the construction of a plant are:

1. engineering and supervision;
2. construction expense;
3. contractor's fee;
4. contingency.

The 'Lang' factor for engineering and supervision, construction expense, contractor's fee and contingencies used in the estimation of the capital cost and the indirect cost of those items are shown in Table 8. From the table, the total direct

Table 8

Total indirect plant cost for the bamboo carbonization stand-alone plant

Item	Typical factors for estimation of projection direct fixed capital cost for different process type			Value of bamboo carbonization plant items for different process types (US\$)		
	Fluids – solid	Solids	Fluids	Fluids – solid	Solids	Fluids
Engineering and supervision	32	33	33	136638	120588	191351
Construction expense	34	39	41	145178	142513	237739
Contractor's fee	18	17	21	76859	62121	121769
Contingency	36	34	42	153718	124242	243538
Total	120	123	137	512393	449464	794397
Total indirect plant cost				1756254		

TABLE 1-continued

Solution Concentration Calculations	
0.003403 mol SO ₂ × (1 osmole/mol) = 0.003403 osmoles	0.0034 osmole/0.100003 L = 0.034 osmoles/L saturated SO ₂ solution Necessary concentration of NH ₄ NO ₃
0.05 (osmole/L) × (1 mol/1.8 osmoles) = 0.028 moles/L	[0.028 moles = 504.2 ppm solute concentration (approximately)]

Referring now to FIG. 3, seawater flows into a heat exchanger (2), for example a steam condenser, at inlet (4) and is raised in temperature to approximately 100° C. The seawater then flows into seawater tank (6) through inlet (8), where it is opposed against a saturated solution of KNO_{3(aq)} in vessel (10), which is also at 100° C., by semi-permeable membrane (12). A net osmotic flow of H₂O takes place across membrane (12) (towards the KNO_{3(aq)} solution), which raises the level of the solution in the KNO_{3(aq)} tank (10) until the excess solution flows out conduit (14), for example an overflow pipe, into a water tower (16) and thereafter through a hydroelectric turbine (18), generating electricity. A crystalline NaCl(s) precipitate and a KNO_{3(s)} precipitate are kept suspended in their respective solutions to allow ordered deposit of solid and to maintain saturation.

Saturated KNO_{3(aq)} then flows into heat exchanger (20) and is allowed to cool to approximately 30° C. The saturated KNO_{3(aq)} solution then flows into KNO_{3(aq)} tank (22), where it is opposed against a saturated solution of SO_{2(aq)} in tank (24), (15 atm partial pressure, approximately 220.5 psi), which is also at 30° C., by a semi-permeable membrane (26). All pressures of SO₂ refer to partial pressures above the solution, such that the total ambient pressure may be considerably higher, yet never below 1 atmosphere. A net osmotic flow of H₂O takes place across membrane (26), (towards the SO_{2(aq)} solution) and raises the level of the SO_{2(aq)} solution in tank (24) until the excess solution flows out pipe (28) into water tower (30) and thereafter through a hydroelectric turbine (32), generating electricity. The energy generated from generators (18), (32) and those noted below, may be stored for later use in energy storage device (34). Crystalline KNO_{3(s)} is kept suspended as before, to allow ordered deposit of solid and to maintain saturation. A compressor (36), powered by electricity generated by the several generators, thereby maintaining the pressure of SO₂ (38).

Saturated SO_{2(aq)} then flows into the heat exchanger (38) and is raised in temperature to approximately 100° C. It then flows into the SO_{2(aq)} tank (40), (at 1 atm, approximately 0.2 atm partial pressure), where it is opposed against a solution of NH₄NO_{3(aq)} in tank (42), also at 100° C., by semi-permeable membrane (44). A net osmotic flow of H₂O takes place across membrane (44) towards the NH₄NO_{3(aq)} solution, raising the level of the solution in the NH₄NO_{3(aq)} tank (42). Any excess may be allowed to flow out of tank (42) through overflow pipe (46) into receptacle (48) and thereafter through a energy generator (50), generating electricity. SO_{2(g)} is removed via a conduit to the compressor (36), and NH₄NO_{3(s)} is added to the NH₄NO₃ tank (42), as needed, from solution holder (54). The aqueous product of the above process is allowed to be exited through a solution outlet (56).

Osmotic pressure, or the pressure generated by the net flow of solvent (H₂O) across a semi-permeable membrane, between two solutions of different concentrations, is a

colligative property. This means that it depends not on the type of dissolved species, but only on their number. It is important to note that some substances dissolve in solution into more than one solute particle. This dissolved species concentration is denoted by the term "osmolar concentration." And the degree to which species dissolve is represented by a "Van Hoff Factor," established for a specified solvent, solute, temperature, and concentration. The factors used in the calculations below, and as applied to the process above, are based on those for dilute solutions at close to room temperatures, and therefore imprecise, but all attempts have been made to approximate in a way the works against the efficiency of the disclosed system. Therefore, the actual osmolar concentrations are expected to be greater than those calculated here.

Additionally, the concentration of a gas in solution is directly proportional to its partial pressure above the solution. In these calculations, 15 atmospheres was considered to have increased the concentration of a SO_{2(aq)} by 15, according to Henry's Law. Calculations of this nature are very imprecise, both because of variances in the solubility of the gas and the tendency of reactive gases like SO₂ to dissociate into other species. These calculations are considered adequate as a general guide since the pressure of the gas can easily be adjusted. In addition, the osmolar concentration is independent of the type of solute, whether it is SO_{2(aq)} or some reactant product thereof. Densities were also important in these calculations, and in all but those of the SO₂ solutions, the data used is highly reliable. In the calculations involving SO₂ it was assumed that the density was approximately 1.3 g/mL, a conservative estimate for the number of grams dissolved. Under one atmosphere, the density was assumed to be the same as water. While these assumptions may not be entirely accurate, there are appropriate in that they decrease the efficiency of the system disclosed herein, in that higher densities lead to higher concentrations.

When discussing the generation of osmotic pressure the difference in osmolar concentrations in "stage 1" (portion of method immediately before, during and immediately after movement of solvent across membrane (12)) is:

$$13.216 (\text{KNO}_3) - 9.017 (\text{NaCl}) = 4.20 \text{ osmole/L}$$

Using the equation ($\pi = MRT$), where π is osmotic pressure, the following can be determined. In stage 1, (4.20 osmole/L) (0.0821 L atm/k mol) (373 K) = 128.618 atm. In "stage 2" (portion of method immediately before, during and immediately after movement of solvent across membrane (26)), [10.943 osmole/L (SO₂) - 6.72 osmole/L (KNO₃)] (0.0821 L atm/k mol) (313 K) = 108.52 atm (-15 atm pressure of SO₂ (gas) on the solution) = 93.52 atm. In "stage 3" (portion of method immediately before, during and immediately after movement of solvent across membrane (44)), [0.05 osmole/L (NH₄NO₃) - 0.034 osmole/L (SO₂)] (0.0821 L atm/k mol) (373 K) = 0.5 atm. Throughout the entire process, 128.618 atm + 93.52 atm + 0.5 atm = 222.638 atm of pressure which

may potentially be generated. Additionally the dissolution of NH₄NO_{3(s)} in stage 3 has a significant cooling effect on its resulting solution. If the semi-permeable membrane used is able to discriminate between water molecules of differing thermal energies, additional pressure may be generated through the thermostatic effect.

By setting equal two versions of the ideal gas constant (0.0821 L atm/K mol = 3.14 J/K mol), it is possible to establish a relationship between atm pressure and the energy that this pressure theoretically represents: 38.246 J/L atm. Using this ratio, 222.638 atm (38.246 J/L atm) = 8515.01 J/L or 8.515 KJ/L (H₂O). For each liter of water desalinated, 8.5 KJ of energy may theoretically be obtained. Alternatively for each mole, 153.4 J may be obtained (1 L = 1000 mL = 1000 g/18.016 g/mol) = 55.51 moles water; and 8515.01/55.51 moles = 153.4 J/mol).

The electricity generated in this process represents a partial reclamation of the energy contained in the low-pressure waste steam used to heat the solutions in stages 1 and 3 (153.4 J/mol water 4.5 moles water/mol. steam = 690.3 J reclaimed/mole. waste steam used). This electricity, generated by the hydroelectric turbines involved in the process, should be sufficient to power the SO_{2(g)} compressor between stages 2 and 3.

It is possible that there may be enough electricity produced to power a reverse osmotic step, should such an additional step be needed or desirable. This additional reverse osmotic purification step would require a small amount of piston pressure, approximately 12.2329 atm. This application of this pressure would of course need to be supplied from an energy source.

It is important to note that all quantitative data here is theoretical, and that the actual process will have somewhat different actual results, particularly in regards to the quantity of energy produced.

The energy required to raise the temperature of water is computed by use of its heat capacity, which is 75.4 Joules/(mol ° C.). The actual heat capacities of saturated or nearly saturated aqueous solutions are, of course, different but the figures here give a good approximation. However, the above figures still provides an adequate approximation for the necessary calculations of the current invention, see Table 1, above.

In order to raise the temperature of water from 50° C. to 100° C. (stage 1), the following amount of energy must be used: 50° C. × [75.4 J/(mol ° C.)] = 3770 J/mol or 3.770 KJ/mol. The same calculations apply for exchanger (38) (stage 3), with a change in temperature from 30° C. to 100° C. arc: 70° C. × [75.4 J/(mol ° C.)] = 5278 J/mol or 5.278 KJ/mol. The total energy requirement for the heating of one mole of solution through the desalination process is then: 3.770 KJ/mol + 5.278 KJ/mol = 9.048 KJ/mol.

The energy provided by the condensation of steam is represented by the negative of the enthalpy of vaporization: -40.6 KJ/mol. Therefore, each mole of steam which condenses on pipes conducting solutions has the potential of heating to the required temperatures: 40.6 KJ/9.048 KJ = 4.487 moles solution. For each unit of steam passed through a power plant's generating turbines, there exists the energy needed for the desalination of nearly four and one-half units of seawater.

In an alternate embodiment of the invention disclosed herein, if the rate of the process is slowed sufficiently in stage 2, the temperature of stage 1 may be reduced to approximately 60° C., in which case the process becomes much more energy efficient.

FIG. 4 illustrates an alternate embodiment of the invention illustrating another means of heating the first solution to

the desired temperature by using heat exchanger (20). Heat exchanger (20) can be used instead of heat exchanger (2), but it is preferred to use exchanger (20) to supplement the heat provided by exchanger (2) rather than be the sole heat source. In this manner, the first solution, prior to flowing into heating means (2), can be heated to the desired temperature, such as 50° C., by first passing through the second heat exchanger (20), removing heat from the second solution. Since the second solution flowing into exchanger (20) is at an elevated temperature and is being cooled, some of the first solution can be directed to exchanger (20) through inlet (4) and be used to draw heat from the second solution, resulting in an increase in the temperature of the first solution. This warmed first solution is then directed to heat exchanger (2) by conduit (70) for further increasing of its temperature, or directly to vessel (6) if it is already at the desired temperature.

As noted above, the final product, with slight modification, can be used as produced from vessel (40), i.e., the additives presented in vessel (42) are optional. In the embodiment shown in FIG. 5, the solution exiting vessel (40) would be subjected to residual gas solute removal means (58). Typically the amount of gas solute still present in the solution exiting vessel (40) is small. However, it is still preferable to have it removed by means (58). For example, when the solute is SO₂, removal means (58) would be a lime bed or other acid removal system.

The invention also encompasses apparatus for conducting the methods described herein. One embodiment of the invention pertains to an apparatus for the extraction of a solvent from a first solution, having a first solute difficult to separate from the solvent from a first solution comprising a means for feeding the first solution to a first heating means to heat said first solution to about 60 to 100° C.; a first conduit connecting the first heating means to a first chamber; a second chamber separated from the first chamber by a first semi-permeable membrane; a cooling means to cool a second solution to about 20 to 40° C., connected to the second chamber by a second conduit and connected to a third chamber by a third conduit; a fourth chamber separated from said third chamber by a second semi-permeable membrane; a second heating means to heat a third solution to about 60 to 100° C., connected to the fourth chamber by a fourth conduit and connected to a fifth chamber by a fifth conduit; a sixth conduit connected to the fifth chamber, by which a final product exists the apparatus.

FIGS. 3 and 5 illustrate one embodiment of this apparatus: a means (4) for feeding the first solution to a first heating means (2); a first conduit (60) connecting the first heating means (2) to a first chamber (6); a second chamber (10) separated from the first chamber (6) by a first semi-permeable membrane (12); a cooling means (20) to cool a second solution, connected to the second chamber (10) by a second conduit (14) and connected to a third chamber (22) by a third conduit (62); a fourth chamber (24) separated from the third chamber (22) by a second semi-permeable membrane (26); a second heating means (38) connected to the fourth chamber (24) by a fourth conduit (28). Referring now to FIG. 5, the embodiment is shown where the fourth chamber (24) is connected to a fifth chamber (40) by a fifth conduit (64). A sixth conduit (68) is connected to fifth chamber (40), with an optional residual gas solute removal means (58) in between, to allow the final product to exist the apparatus.

Referring back to FIG. 3, another embodiment of the apparatus of the invention is shown, which further comprises a sixth chamber (42) separated from the foremen-

Table 9

Total indirect plant cost for the bamboo carbonization integrated plant

Item	Typical factors for estimation of projection direct fixed capital cost for different process type			Value of bamboo carbonization plant items for different process types (US\$)		
	Fluids – solid	Solids	Fluids	Fluids – solid	Solids	Fluids
Engineering and supervision	32	33	33	123487	113546	151739
Construction expense	34	39	41	131204	134191	188524
Contractor's fee	18	17	21	69461	58493	96561
Contingency	36	34	42	138922	116987	193122
Total	120	123	137	463075	423217	629946
Total indirect plant cost				1516238		

plant cost of the production of activated carbon process is US\$ 1,756,254. Hence, the fixed capital investment of the production of activated carbon from the bamboo carbonization plant is US\$ 6,218,723 which is equal to the sum of the direct plant cost and indirect plant cost.

For integrated plant. These factors are influenced by the equipment item capital costs and therefore Table 8 needs to be modified as shown in Table 9. Hence, the fixed capital investment of the activated carbon manufacturing integrated plant, which is equal to the sum of the direct and indirect plant cost, is US\$ 5,386,622.

4.3.1.4. Working capital. The working capital for an industrial plant consists of the total amount of money invested in raw materials and supplies carried in stock, finished products in stock and semi-finished products in the process of being manufactured, accounts receivable, cash kept on hand for monthly payment of operating expenses, such as salaries, wages, and raw-material purchases, accounts payable and taxes payable. The ratio of working capital to total capital investment varies with different companies, but most chemical plants use an initial working capital amounting to 5–20% of the total capital investment. This percentage may increase to as much as 30% or more for companies producing products of seasonal demand because of the large inventories. The 'Lang' factor of working capital used in the estimation is shown in Table 10. In this project, the working capital is around 15% of the total capital investment in both stand-alone and integrated plants since the production of activated carbon is a simple process and the working capital of this bamboo carbonization stand-alone and integrated plants are US\$ 1,063,133 and US\$ 914,977, respectively (see Table 10).

Table 10

Working capital for the bamboo carbonization process

Working Capital (about 15% of total capital investment)	Typical factors for estimation of projection working capital cost for different process type			Value of bamboo carbonization plant items for different process types (US\$)		
	Fluids – solid	Solids	Fluids	Fluids – solid	Solids	Fluids
Stand-alone plant	74	68	86	315975	248484	498673
Work capital cost				1063133		
Integrated plant	74	68	86	285563	233974	395441
Work capital cost				914977		

Table 11

Summary of the total capital investment of the stand-alone plant activated carbon manufacturing

	Percent	US\$
Delivered-equipment cost	20.6	1532521
Direct cost (including equipment cost)	60.1	4462469
Indirect cost	23.6	1756254
Working capital	14.3	1063133
EIA (1%) + HAZOP (1%)	2.0	148609
Total capital investment	100.0	7430465

4.3.1.5. Costs summary of total capital investment. For stand-alone plant. By adding the direct plant cost, indirect plant cost and working capital, the total investment required can be estimated. However, an Environmental Impact Assessment (EIA) and HAZOP safety study may be required in the production of activated carbon plant and the cost of the EIA and HAZOP study is assumed to be 2% of the total capital investment. The total capital investment for this project is US\$ 7,430,465. The cost summary of the total capital investment of the activated carbon production process is shown in Table 11.

For integrated plant. These factors are influenced by the equipment item capital costs and therefore Table 11 needs to be modified as shown in Table 12. The total capital investment for the integrated bamboo carbonization plant will be US\$ 6,430,203. About US\$ 1 million can be saved on the total capacity investment by integrated the bamboo carbonization plant into other major processing facility.

4.3.2. Production costs

The determination of the necessary capital investment is only one part of a complete cost and evaluation estimate. An-

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tioned fifth chamber (40) by a third semi-permeable membrane (44). In this embodiment, the sixth conduit (68) would be connected to the sixth chamber (42) instead of to the fifth chamber (40).

Alternately, one or more sets of chambers (adjacent chambers) can be combined to form single vessels. For example, instead of chambers (6) and (10), shown as separate vessels in FIG. 3, can be housed in a single vessel (72), as illustrated in FIG. 6. Vessel (72) is partitioned into two chambers (6) and (10) which are separated by solvent transfer means (12). Chambers (22) and (24), as well as chambers (40) and (42) could similarly be housed in single vessels.

The apparatus may further include one or more means for stirring or otherwise agitating solutions contained within the chambers so as to enhance osmotic flow. In addition, the apparatus may include a means for applying mechanical pressure to a solution contained within the sixth chamber, and thereby effect assisted forward osmosis of the solvent.

Accordingly, it is to be understood that the embodiments of the invention herein described are merely illustrative of the application of the principles of the invention. Reference herein to details of the illustrated embodiments are not intended to limit the scope of the claims, which themselves recite those features. It should be understood by those skilled in the art that various changes may be made and equivalents may be substituted without departing from the true spirit and scope of the invention. In addition, many modifications may be made to adapt a particular situation, material, composition of matter, process, process step or steps, to the objective, spirit and scope of the present invention. All such modifications are intended to be within the scope of the claims appended hereto.

What is claimed is:

1. An osmotic method for the extraction of a solvent from a first solution, having a first solute difficult to separate from the solvent by passing said solvent through a series of intermediate solutions comprising the steps: (a) drawing said first solution into a first heat exchanger where said first solution is heated; (b) drawing said first solution into a first chamber, said chamber being divided by a first semi-permeable membrane from a saturated second solution having a second solute in a second chamber, wherein the solubility of said second solute is directly dependent upon the temperature of said second solution; (c) subjecting said first solution to forward osmosis, via said first semi-permeable membrane, in opposition to said second solution such that a net osmotic flow of said solvent takes place across said first semi-permeable membrane and into said second solution increasing its volume; (d) drawing said second solution from the second chamber into a second heat exchanger where it is cooled; (e) drawing said second solution into a third chamber, said chamber being divided by a second semi-permeable membrane from a third solution having a third solute in a fourth chamber, wherein the solubility of said third solute is inversely dependent upon the temperature of said third solution; (f) subjecting said second solution to forward osmosis, via said second semi-

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permeable membrane, in opposition to said third solution such that a net osmotic flow of said solvent takes place across said second semi-permeable membrane and into said third solution, increasing its volume; (g) drawing said third solution into a third heat exchanger where said third solution is heated; (h) drawing said third solution into a fifth chamber to provide for removal of any remaining third solute; and (i) collecting the third solution, now diluted, for use.

2. The method of claim 1 wherein said first solution is selected from the group consisting of seawater, brine, brackish water, mineralized water and industrial waste water.

3. The method of claim 2 wherein said first solute is a chemically precipitable soluble salt.

4. The method of claim 3 wherein said first solute is NaCl.

5. The method of claim 1 wherein said solvent is H₂O.

6. The method of claim 1 wherein said second solute is selected from the group consisting of KNO₃, Na₂PO₄ and sucrose.

7. The method of claim 6 wherein said second solute is KNO₃ and said second solution is a saturated KNO_{3(aq)} solution.

8. The method of claim 1 wherein said third solute is selected from the group consisting of SO₂, Ce(SO₄)₃, and CO₂.

9. A method of claim 1 wherein the fifth chamber is divided by a third semi-permeable membrane from a fourth solution having a fourth solute in a sixth chamber, and said method further comprises, prior to collecting the third solution, the steps of: (i) subjecting the third solution to forward osmosis by means of the third semi-permeable membrane, in opposition to the fourth solution such that a net osmotic flow of the solvent takes place across the third semi-permeable membrane and into the fourth solution, increasing its volume and diluting it; and (ii) collecting the fourth solution, now diluted, for use.

10. The method of claim 9 wherein said fourth solute is selected from the group consisting of fertilizers, vitamins, minerals, NaF, chlorine and water treatment additives.

11. The method of claim 1 further comprising the generation of energy wherein when at least one solution increases in volume due to net osmotic flow, said solution is allowed to overflow its chamber and the osmotic head is used to drive a hydroelectric turbine and potential energy is captured for use.

12. The method of claim 1 wherein said first solution is heated to about 60 to 100° C.

13. The method of claim 12 wherein said first solution is heated to about 100° C.

14. The method of claim 1 wherein said second solution is cooled to about 20 to 40° C.

15. The method of claim 14 wherein said second solution is cooled to about 30° C.

16. The method of claim 1 wherein said third solution is heated to about 60 to 100° C.

17. The method of claim 16 wherein said third solution is heated to about 100° C.

* * * * *

Table 12

Summary of the total capital investment of the activated carbon manufacturing integrated plant

	Percent	US\$
Delivered-equipment cost	21.0	1350045
Direct cost (including equipment cost)	60.2	3870385
Indirect cost	23.6	1516238
Working capital	14.2	914977
EIA (1%) + HAZOP (1%)	2.0	128604
Total capital investment	100.0	6430203

other equally important part is the estimation of the cost of operating the plant. The total production cost is generally divided into the categories of manufacturing costs and general expenses. All expenses directly connected with the manufacturing operation or the physical equipment of a process plant itself are included in the manufacturing costs. The manufacturing costs are divided into two main groups as follows: (1) fixed operating costs and (2) variable operating costs. The general expenses are involved in any company's operations. The total production costs are calculated on an annual basis in this project.

4.3.2.1. Fixed operating costs. For stand-alone plant. Fixed operating cost are expenses which are practically constant from year to year and do not vary widely with changes in production rate. These are the bills that have to be paid whatever the quantity of "product" produced. The items of the fixed operating costs are:

1. maintenance;
2. operating labor;
3. supervision and clerical;
4. plant overheads;
5. plant spares;
6. insurance.

The capital charges represent interest on a capital loan which is often recovered using a depreciation technique. We have not considered this but when considering the return on investment this fact should be considered. The fixed operating cost items and its factors using in this project are presented in Table 13. the total fixed operating cost is US\$ 1,116,851.

For integrated plant. The fixed operating costs are based on seven components shown in Table 14. As item 1, maintenance, is a percentage of the fixed capital investment, therefore, the maintenance cost will be been changed. Operating labor will decrease slightly as the existing plants will have an operating team. Therefore, the number of workers per shift will reduce to 4 from 5. Due to the change in operating labor, supervision/clerical, laboratory and plant overheads will all decrease by 20%. Plant spares, insurance will also be changed due to the change of maintenance and fixed capital investment while royalties/patents will stay the same. The details of fixed operating cost items for integrated tyre plant are presented in Table 14. the total fixed operating cost is around US\$ 0.86 million. About US\$ 250,000 can be saved on the total fixed

Table 13

Summary of the fixed operating cost items and its factors for stand-alone plant

Fixed operating costs items	Values used in the carbonization project	US\$
Maintenance	5% of fixed capital	373123
Operating labor	5 shift workers, 3 shifts per day, IIK\$50/h	254499
Supervision and clerical	15% of operating labor	38175
Plant overheads	50% of total labor and maintenance	332898
Plant spares	15% of maintenance	55969
Insurance	1% of fixed capital investment	62187
Total fixed operating cost		1116851

Table 14

Summary of the fixed operating cost items and its factors for integrated plant

Fixed operating costs items	Values used in the carbonization project	US\$
Maintenance	5% of fixed capital	323197
Operating labor	4 shift workers, 3 shifts per day, HK\$50/h	203599
Supervision and clerical	15% of operating labor	24432
Plant overheads	50% of total labor and maintenance	220491
Plant spares	15% of maintenance	38784
Insurance	1% of fixed capital investment	53866
Total fixed operating cost		864369

operating cost by integrated the bamboo carbonization plant into other major processing facility.

4.3.2.2. Variable operating costs. For stand-alone plant. Variable operating costs include expenses directly associated with the manufacturing operation and they are dependent on the amount of product produced. The variable operating cost items are shown below:

1. raw materials;
2. utilities;
3. miscellaneous operating materials.

It is assumed that the raw material of bamboo is obtained from the construction and demolition (C&D) waste material, so the cost of this bamboo is zero in the evaluation. The plant will be operated for 330 days of the year with the rest of time for maintenance and 30 tonnes per day of bamboo will be carbonized in this activated carbon production plant. Table 15 shows the raw material required and the corresponding es-

Table 15

Estimated prices of raw materials for stand-alone and integrated plants

Raw material	Quantity (per annum)	Price US\$/unit	US\$
Bamboo	9900000	0.000	0
Lime	57756	0.11	6353
KOH	407647	1.16	943142
Total			949495

face by a liquid-permeable topsheet (11) and on the outer face by a liquid-impermeable outer layer (18). The liquid-permeable topsheet (11) can cover the absorbent core (2) and extend continuously into the side panel portions (10), as shown in FIG. 2, or be attached to the side panel portions (10) by a seam (not shown). Similarly, the liquid-impermeable outer layer (18) can extend beyond the absorbent core (2) portion into the side panel portions (10), as shown in FIG. 2, or be attached by a seam (6) to a discrete side panel portion (10).

In a preferred arrangement, as shown in FIG. 2, the liquid-impermeable outer layer (18) is a laminate comprising a liquid-impermeable inner layer (17) laminated to an outer layer (19) of a fibrous web. Inner layer (17) would preferably be a liquid-impermeable plastic film such as a polyethylene or polypropylene film or a consolidated woven or nonwoven web. The outer layer (19) is preferably a soft woven (including knitted or stitchbonded webs) or nonwoven web, such as a melt blown, spun bond, carded, or otherwise formed nonwoven web, formed of synthetic and/or natural fibers. Preferably, fibrous web (19) is sufficiently coherent and lofty, such that fibers of the web (19) are spaced sufficiently far apart from each other and the backing such that the fibers are engagable with the mechanical fastening tab free end male mechanical fastening elements.

The liquid-permeable topsheet (11) is of conventional design as used in disposable diapers and generally would be a spun bond web of hydrophobic thermoplastic fibers (i.e., polypropylene fibers). The backsheet and topsheet layers (11 and 18) are joined to each other and the absorbent pad by conventional lamination techniques including the use of hot melt adhesives, thermal bonding, sonic bonding and the like.

The side panel portions (10) can be integral with the front panel (31) of the absorbent core (2) portion and/or the rear panel (32) portion of the absorbent core (2) portion or are joined to each other by a side seam (5), such as shown in FIG. 2.

Alternatively, the side panels (10) can be integral with either just the front panel (31) or just the rear panel (32) and extend to the opposing rear or front panel and joined to the opposing panel by adhesion, welding, or the like, such as disclosed in PCT 94/00292, published Jan. 6, 1994.

In a further alternative shown in FIG. 1, side panels (10) are attached at seams (6) to both the front panel (31) and the back panel (32) with an intermediate seam (5). Intermediate seam (5) in this arrangement could be eliminated, by using a single side panel element, however preferably, intermediate seam (5) is used to facilitate manufacture of the training pant, such as disclosed in U.S. Pat. Nos. 4,938,757 or 5,246,433 and incorporation of the mechanical fastening tab (20) into the seam (5).

Side panels (10) can be elastic or inelastic, however, preferably are elastic, such as by incorporation of an elastomeric layer (15) to facilitate fit. The elastomeric layer (15) can be any conventional elastomeric woven or nonwoven web comprising elastomeric fibers such as melt blown fibers, spun bond fibers, extruded fibers, or the like, or an elastomeric film or coextruded elastomeric film. At least the inner or outer face of the side panels are (10) provided with a fibrous woven or nonwoven web, (12) or (14), engagable with the male mechanical fastening elements (25) on the mechanical fastening tab (20).

The mechanical fastening tab (20) has an array of upstanding male mechanical fastening elements (25), which can be in the form of upstanding stems having fiber engaging structures at the distal end, which fiber engaging structures

have a shape suitable for engaging fibers. Preferably, the male mechanical fastening elements would be in the form of upstanding hook or mushroom type structures. The elements (25) generally are 75 to 500 microns high from the stem base to the outer tip of the fiber engaging structures. The stems, other than the distal end fiber engaging structure, would generally be free of fiber engaging structures or protrusions and be straight or taper inward from the stem base to the distal end fiber engaging structure. The distal end fiber engaging structures would generally extend outwardly, preferably outwardly and downwardly, from the stem by a distance at least 1 times the average engaged fiber width.

At a manufacturers end (22), the mechanical fastening tab (20) is permanently bonded to the inner topsheet (11) extension, the inner fibrous web (12) or the outer fibrous web (14). The male mechanical fastening elements (25) on the opposing free end (21) remain free to releasably engage an outer fibrous web (14), outer fibrous web layer (19) or a discrete mating mechanical fastener element attached to a side panel (10) or the front panel (31). This mating mechanical fastener element will also be a fibrous web, such as a woven (including stitchbonded and knitted webs) or nonwoven web where the fibers are sufficiently coherent and lofty (e.g., fibrous loops or an open fibrous structure) to engage the male mechanical fastening elements. The mating mechanical fastener element can extend across the entire side panel and/or front panel or rear panel or only a portion of the side panel or front panel or rear panel rear panel, or or a combination thereof.

The permanent bond at the manufacturers bond end (22) is preferably formed by male mechanical fastening elements (25) securely engaging the fibers of the topsheet or a fibrous web (12, 14, 19 or mating mechanical fastening element). This secure engagement is preferably created by locking the mechanical fastening elements around and between the fibers of the topsheet or fibrous web, using heat welding, pressure welding, ultrasonic welding, mechanical welding, or the like, however an adhesive could also be employed. In this manner, certain of the mechanical fastening elements (25) permanently anchor the fastening tab (20) to at least one panel while other mechanical fastening elements (25) on the fastening tab (20) free end (21) remain undeformed for releasably engaging the fibers of an outer fibrous web (14 or 19) or a suitably placed mating mechanical fastening element.

Mechanical fastening tab (20) allows wide adjustments to the fit or size of the training pant (1) by gathering excess side panel material between the permanently attached manufacturers end (22) and the user placed free end (21). The fit can also be adjusted after wear to gather excess material created due to elastic hysteresis or cold stretching of the side panels (10) or absorbent core structure (2) of the training pant chassis (1). Either one or more mechanical fastening tabs (20) can be placed on or adjacent each side panel (10), with the mechanical fastening tabs (20) placeable on one or both sides of the training pant (1). When the training pant (1) is ready for disposal, the mechanical fastening tab (20) can be used to maintain the training pant in a rolled or folded form, as shown in FIG. 6, by suitable placement of the free end (21) of the mechanical fastening tab (20) where the manufacturers end (22) remains permanently attached to one panel (10).

FIG. 3 shows a preferred embodiment for placement of the fastening tab (20) between adjacent side panels (10) connected by a seam (5), such as shown in FIG. 1. Although in FIG. 1 this seam (5) is shown provided equidistantly between the front and rear panels (31) and (32) of the

Table 16

Estimated costs of utilities in the activated carbon production process for stand-alone and integrated plants

Utility	Quantity (per annum)	Price US\$/unit	US\$
Electricity	200 kW	0	0
Water	12217 m ³	0.589/m ³	7346
Nitrogen	79200 kg	2.31	182952
Total			190298

estimated prices for the activated carbon production process. The prices given are delivered prices.

The quantities of different utilities required per annum and the current costs of utilities for the activated carbon production process are shown in Table 16. We have assumed 5% of water (~1500 m³ per year) in the close-loop boiler system will be lost during the electricity generation process (from blowdown and purging). The quantity of water usage for washing the activated carbon after the carbonization process is around 8700 m³ per year and around 2100 m³ water per year is required in the bamboo chemical activation process by the KOH solution. For chemical activation process, it is assumed 10% of KOH (~2470 kg/day) will be lost during the bamboo carbonization process.

The cost of liquid nitrogen is around US\$ 2.06 per liter and the expansion ratio of liquid nitrogen to gaseous nitrogen is around 700, therefore, the cost of nitrogen gas is around US\$ 2.31 per kg. The nitrogen gas acts as a purging gas to provide an oxygen-free environment in the carbonization furnace and will not be consumed within the carbonization reaction. Thus, once the carbonization furnace is filled with nitrogen, only a small amount of nitrogen is required to maintain an inert atmosphere. It is estimated that the usage rate of nitrogen is 8 m/h (or 10 kg/h) and this is used to purge the carbonization furnace during the process.

Another utility required in the activated carbon production is electricity in which the electricity is mainly used to drive all the motors, conveyors and pumps in the plant and the consumption is estimated at 200 kW. Therefore, no electricity cost is required to pay in this process since about 300 kW electricity is generated during the production of activated carbon from the bamboo carbonization process. The cost of miscellaneous materials (including packaging) is taken as 10% of the maintenance cost and the cost is US\$ 37,312. The total variable operating costs are summarized in Table 17. The total manufacturing cost, the sum of fixed and variable operating cost, is US\$ 2,293,957.

Table 17

Summary of the variable operating cost items for stand-alone and integrated plants

Variable operating costs items	US\$
Raw materials	949495
Utilities	190298
Miscellaneous materials	37312
Total	1177106

Table 18

Summary of the general expense for stand-alone plant

General expense items	Factor	US\$
Administrative expenses	15% of total labor and maintenance	99870
Sales expenses	11% of total manufacturing cost	252335
Research and development expense	8% of total manufacturing cost	183517
Total		535721

Table 19

Summary of the general expense for integrated plant

General expense items	Factor	US\$
Administrative expenses	15% of total labor and maintenance	82684
Sales expenses	11% of total manufacturing cost	224013
Research and development expense	8% of total manufacturing cost	162919
Total		469616

For integrated plant. Based on the raw materials and utilities in Table 17, more will be need in the existing units of the existing plants. Therefore, no reduction in these variable production costs in proposed. Hence, the total manufacturing cost of the integrated plant is US\$ 2,036,483.

4.3.2.3. General expenses. For stand-alone plant. Besides, the fixed and variable manufacturing costs, other general expenses are involved in any company's operations. These general expenses are administrative expenses, distribution and marketing expenses and research and development expenses. The general expenses of the Bamboo Carbonization Plant are US\$ 535,721 as shown in Table 18.

For integrated plant. The general expenses items will change to a small extent as there are based on a percentage of labor costs and the manufacturing costs. These are shown in Table 19. The general expenses for integrated plant are US\$ 469,616.

4.3.2.4. Costs summary of total production cost. For stand-alone plant. By adding the fixed operating cost, variable operating cost and general expenses, the total production cost required can be estimated. The cost summary of the total production cost of the stand-alone plant is shown in Table 20. The total annual production cost for this stand-alone activation carbon manufacturing process is US\$ 2,829,678. A 39.5% of total production cost is due to the fixed operating

Table 20

Summary of the total production cost of the bamboo carbonization stand-alone plant

	Percent	Cost (US\$)
Fixed operating cost	39.47	1116851
Variable operating cost	41.60	1177106
General expenses	18.93	535721
Total production cost	100.00	2829678

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absorbent pad (2) structure, the seam (5) can be placed at any location, and one or more seams can be provided depending on the number and type of side panels (10). For example, in European Patent Application No. 320 989, an intermediary break-away inelastic side panel is provided between two elastic side panels providing at least two seams and three side panels intermediary the front and rear panels (31) and (32) of the absorbent core (2) structure. The side panels (10) are joined along seam (5) by use of heat, pressure, ultrasonics, or the like, which preferably simultaneously permanently engages the male mechanical fastening elements (25) on manufacturers end (22) with the fibers of the inner fibrous web (12) or a topsheet extension. If the side seam (5) is subsequently torn, in order to remove the training pant, the mechanical fastening tab (20) will remain permanently attached to one panel element (10) by the fastening elements (25) on manufacturers end (22), suitably releasing from the opposing panel element (10) on the opposite face of the tab along side seam (5).

In the alternative embodiment of FIG. 4, the mechanical fastening tab (20) is permanently bonded to the outer fibrous web (14) on a side panel (10). Alternatively, the outer fibrous web could be web 19 or a mating mechanical fastening element. Preferably, the permanent bond is formed simultaneously with the formation of the side seam (5), however, this permanent bond can be created before or after formation of the side seam (5). Mechanical inter-locking of the fastening elements (25) at manufacturer's end (22) with the fibers of web (14) keep the fastening tab (20) temporarily in place prior to formation of the permanent bond through the application of heat, pressure, ultrasonics, or the like, to permanently lock at least some of the fastening elements (25) with the fibers of web (14).

In the embodiment shown in FIG. 5, the mechanical fastening tab (20) is bonded at manufacturers end (22) to a face of a side panel (10) having an outer fibrous web (14). FIG. 5 shows the presence of a welded side seam (29), which can be formed in the manner described in U.S. Pat. No. 5,246,433.

As is clear from the above description, the invention training pant design allows wide adjustments in fit and size, by a suitable gathering of side panel material between a permanently attached manufacturers end (22) and a free end (21) of a mechanical fastening tab (20). The permanent bond at end (22) can be created without the necessity of adhesive, although such certainly could be employed, and is easily integrated into known manufacturing schemes which employ heat, ultrasonics, or pressure to form side seams for disposable training pants.

Various modifications and alterations of this invention will be apparent to those skilled in the art without departing from the scope and spirit of the invention, and this invention should not be restricted to that set forth for illustrative purposes only.

I claim:

1. A disposable training pant comprising an absorbent core structure formed by an absorbent pad with a liquid-permeable topsheet covering one face and a liquid-impermeable outer layer covering the opposing face of the absorbent pad, at least two side panel portions joining a front panel and a rear panel of the absorbent core structure so as to form a waist opening and two leg openings, at least one mechanical fastening tab, having male mechanical fastening elements on at least one face, said mechanical fastening tab male mechanical fastening elements permanently bonded to at least one panel portion at a manufacturers bond end, mechanical fastening elements on a free end of the mechanical fastening tab being releasably engagable with a first

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fibrous web on the outer face of the disposable training pant, wherein by placement of the free end of the mechanical fastening tab on the outer face fibrous web, said side panel portion can be gathered between the manufacturers bond end and the free end of the mechanical fastening tab.

2. The disposable training pant of claim 1 wherein the male mechanical fastening element comprises a stem with an enlarged fiber engaging structure at the stem distal end.

3. The disposable training pant of claim 2 wherein the male mechanical fastening element enlarged fiber engaging structure is a hook-like structure.

4. The disposable training pant of claim 1 wherein the male mechanical fastening element enlarged fiber engaging structure is a mushroom-like structure.

5. The disposable training pant of claim 1 wherein said manufacturers bond end male mechanical fastening elements are welded to the fibers of said first fibrous web.

6. The disposable training pant of claim 1 wherein said manufacturers bond end male mechanical fastening elements are attached to said first fibrous web at a first seam between at least one side panel portion and an adjacent panel.

7. The disposable training pant of claim 6 wherein said first seam is between said at least one side panel portion and an adjacent side panel.

8. The disposable training pant of claim 6 wherein said first seam is between said at least one side panel portion and a front or rear panel of the diaper absorbent core structure.

9. The disposable training pant of claim 6 wherein said manufacturers bond end mechanical fastening elements are attached to a second fibrous web on an inner face of said at least one side panel portion.

10. The disposable training pant of claim 9 wherein said second fibrous web on the outer face of said at least one side panel portion is a nonwoven fibrous web.

11. The disposable training pant of claim 6 wherein said manufacturers bond end mechanical fastening elements are attached to a second fibrous web on an outer face of said at least one side panel portion.

12. The disposable training pant of claim 11 wherein said second fibrous web on the outer face of said at least one side panel portion is a nonwoven fibrous web.

13. The disposable training pant of claim 1 wherein the manufacturers bond end is attached to a second fibrous web on the outer face of at least one side panel portion.

14. The disposable training pant of claim 13 wherein said second fibrous web on the outer face of said at least one side panel portion is a nonwoven fibrous web.

15. The disposable training pant of claim 1 having at least one elastic side panel.

16. The disposable training pant of claim 1 wherein the manufacturers bond end is bonded to the at least one panel portion at least by engagement of the male mechanical fastening elements on said manufacturers bond end with fibers of a second fibrous web on the inner or outer face of said at least one panel portion.

17. The disposable training pant of claim 1 wherein the first fibrous web is on an outer face of an adjacent panel.

18. The disposable training pant of claim 17 wherein the first fibrous web is a nonwoven fibrous web.

19. The disposable training pant of claim 17 wherein the first fibrous web is a knitted or woven fibrous web having fibrous loops.

20. The disposable training pant of claim 19 wherein the knitted or woven fibrous web is laminated to at least a portion of said liquid impermeable outer backsheet layer which backsheet layer comprises a liquid impermeable thermoplastic film.

Table 21

Summary of the total production cost of the bamboo carbonization integrated plant

	Percent	Cost (US\$)
Fixed operating cost	34.49	864369
Variable operating cost	46.77	1172113
General expenses	18.74	469616
Total production cost	100.00	2506099

costs and the variable operating cost is 41.6% of total production cost in which more than 80% variable operating cost is spent on the raw material of potassium hydroxide (KOH).

For integrated plant. Similarly, the cost summary of the total production cost for the integrated plant is listed in Table 21. The total annual production cost for this integrated activation carbon manufacturing process is 2.5 million dollars.

4.3.3. Revenues for the bamboo carbonization process

The revenues of the bamboo carbonization process options mainly come from the direct sales of activated carbons. Based on the usage of 30 tonnes of bamboo per day, the activated carbon production capacity is around 6.6 tonnes per day, and the product yield is 22.5%. The selling price of activated carbon largely depends on its quality, and the price could range from US\$ 0.82 (from China) to 3.11 (from Japan) per kg. It is expected that this plant is able to produce moderate to high quality activated carbons. Based on the fact that the pricing pressure would be intense due to continuing competition from other suppliers particularly in China, the initial selling price of the activated carbon will be set at US\$ 1.93 per kg. A sensitivity analysis has been performed to test the effect of the selling price on the overall economic evaluation, which will be discussed later in this paper. A breakdown of revenues from different sources is shown in Table 22. The annual sales revenues from the activated carbon manufacturing plant based on the capacity of 30 tonnes of bamboo per day will be US\$ 4,183,172. The annual sales revenues for both stand-alone and integrated process plants are the same.

4.3.4. Simple estimate on return on investment (ROI)

Before performing the detailed economic evaluation, a simple return on investment ROI is calculated as a measure of annual rate of return on capital employed by the proposed activated carbon manufacturing project. In engineering economic evaluation, it is usually defined as the percent ratio of average yearly profit (net cash inflow) over the productive life of the project, divided by total initial investment. A positive ROI means the annual revenue is larger than the production

cost; in other word, the plant is profitable.

• For stand-alone plant.

$$\begin{aligned} \text{ROI} &= \frac{\text{annual profit}}{\text{total capital investment}} \times 100\% \\ &= \frac{\text{annual sales revenue} - \text{annual production cost}}{\text{total capital investment}} \\ &\quad \times 100\% = \frac{\text{US\$ } 4,183,172 - \text{US\$ } 2,829,678}{\text{US\$ } 7,430,465} \\ &\quad \times 100\% = 18.2\% \end{aligned}$$

• For integrated plant.

$$\begin{aligned} \text{ROI} &= \frac{\text{US\$ } 4,183,172 - \text{US\$ } 2,506,099}{\text{US\$ } 6,430,203} \times 100\% \\ &= 26.1\% \end{aligned}$$

4.3.5. Economic evaluation of projects

The prime purpose of the project evaluation is to permit a decision to be taken on whether or not to proceed with a new plant or plant modification. If the result shows that a better rate of return on the investment than could be achieved by leaving it in the bank with an additional factor for risk, then it is probable that the project will proceed. On the contrast, if a lower return is obtained, the project is unlikely to be implemented. In this study the project period of the bamboo carbonization plant is set to be 16 years and the carbon production will be started after the first 2-year construction period. The cumulative cash flow diagrams of the stand-alone and integrated plants are presented in Fig. 6 (0% discount rate), Figs. 7 and 8 (at different discount rates). It is noted that the payback period of the stand-alone plant is 8 years after the plant starts operation at the discount rate of 0% from the start of the project. Alternatively it is 6 years after the start of production. The project net profit value (NPV) of the stand-alone plant project at the discount rate of 0% is around

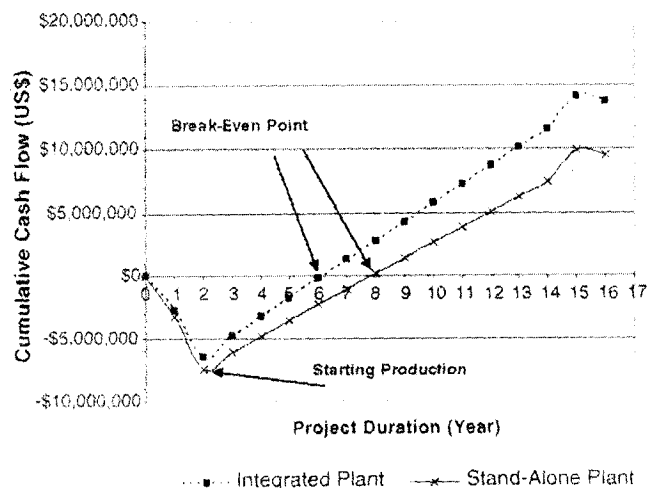


Fig. 6. Cumulative Cash flow for stand-alone and integrated activated carbon plants at 0% discount factors.

Table 22

Summary of revenues generated from the stand-alone and integrated plants

	Quantity (per annum)	Unit price	Revenues (US\$)
Activated carbon	2169672 kg	US\$ 1.93 per kg	4183172
Total sales revenues			4183172



US006551316B1

(12) **United States Patent**
Rinner et al.

(10) **Patent No.:** **US 6,551,316 B1**
(45) **Date of Patent:** **Apr. 22, 2003**

(54) **SELECTIVE COMPRESSION AND
DISTRACTION INSTRUMENT**

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(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 0 days.

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(21) Appl. No.: **09/796,410**

(22) Filed: **Mar. 2, 2001**

(51) Int. Cl.⁷ **A61B 17/66**

(52) U.S. Cl. **606/57; 606/205; 81/427.5;**
81/423; 81/352

(58) Field of Search **606/205-208;**
606/53, 57, 90, 99, 105, 55, 58; 600/216,
218, 219, 222; 81/427.5, 423, 352-354,
362

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Primary Examiner—Kevin Shaver

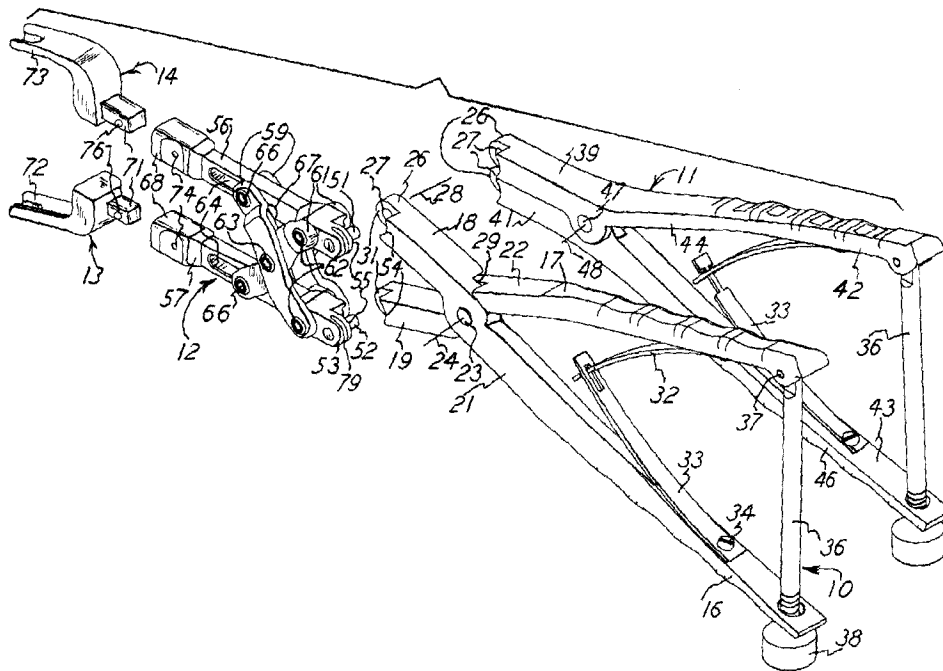
Assistant Examiner—Michael B. Priddy

(74) *Attorney, Agent, or Firm*—Arthur J. Hansmann

(57) **ABSTRACT**

A selective compression and distraction instrument useful in manipulating bone, such as a person's spine during surgery. There are two handle sections and one jaw section. One handle section produces a compression action and the other produces a distraction action. The user determines which action to apply, and then selects the appropriate handle section which is releasably attached to the one jaw section. The jaw section is arranged to have two tips, and the jaw section moves the tips in a parallel relationship toward and away relative to each other. The tips are releasably and interchangeably attachable to the jaw section, and they provide selective spacing of tip blades from each other.

27 Claims, 3 Drawing Sheets



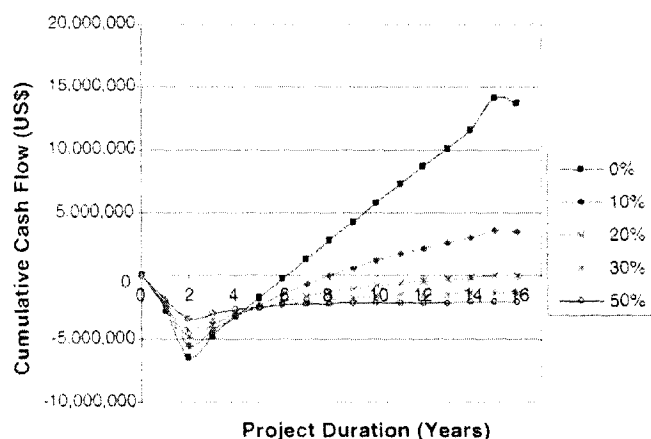


Fig. 7. Cumulative cash flow for stand-alone plant at different discount factors.

US\$ 9,470,000. For the integrated process plant, the payback time at the discount rate of 0% is 6 years and it is 4 years after the start of production. The NPV of the integrated plant is 44.5% more than the NPV of stand-alone plant and it is around US\$ 13,700,000.

Fig. 9 shows the relationship between the NPV for this project and the applied discount rate, internal rate of return (IRR) diagram. It provides a measure of the rate of return expected on a project investment over the whole project life, and so the larger the value of the IRR the more economically attractive is the project. From the graph, the IRR is where the curve cuts the discount rate axis at NPV is equal to zero and it is found to be 13.0 and 20.1% for the stand-alone plant and integrated plant, respectively.

Table 23 is a summary of the major indicators of the performance on the economic matter of the stand-alone and integrated process projects and it was found that integrated process shows more profitable than stand-alone process. The positive values of both ROI and IRR together of both stand-alone and integrated processes with a 6 and 8 years long, respectively, payback period reveal a profitable prospect of the proposed production process. In the following sections a

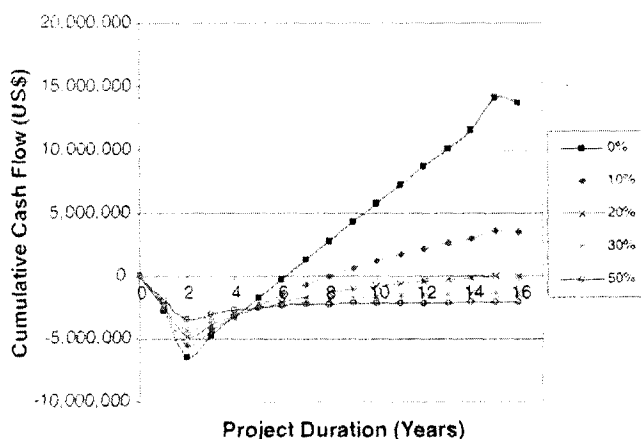


Fig. 8. Cumulative cash flow for integrated plant at different discount factors.

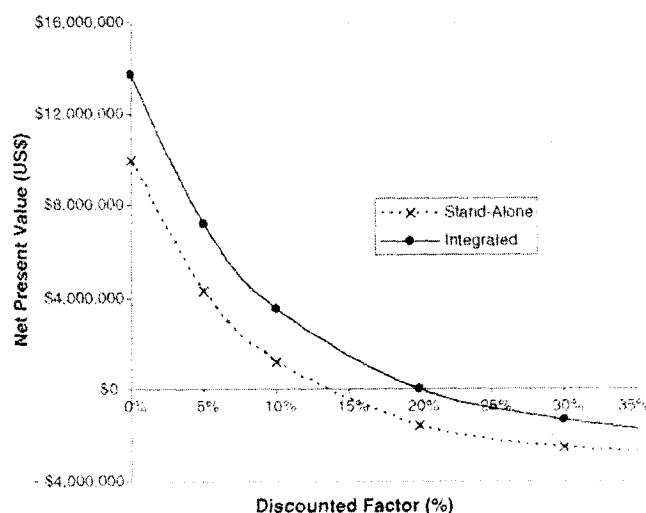


Fig. 9. Internal rate of return (IRR) of the stand-alone and integrated activated carbon plants.

sensitivity analysis has been carried out on the stand-alone process only.

4.3.6. Sensitivity analysis

In order to investigate the effect on the economic viability of a project of possible changes in the forecast data which contribute to the project cash flows, a sensitivity analysis for the manufacture of activated carbon from bamboo carbonization process is undertaken. This involves selecting the five main factors affecting the economic attractiveness of the project which are taken into consideration. These factors are listed below:

- total capital investment;
- cost of KOH;
- operating labor wage;
- selling price of activated carbon;
- production capacity.

Table 24 shows the effect of variations of these five forecast factors over the range -25 to $+25\%$, with 5% increment each time, to see the effects on the project net present value. The rows for zero variation are the base NPV values corresponding to the original forecasts and economic evaluation. The data in Table 24 is shown graphically in Fig. 10. The steeper the slope of the line for a factor, the more sensi-

Table 23
Major indicators on stand-alone and integrated processes project economic performance

	Stand-alone process	Integrated process
Return on investment (ROI) (%)	18.2	26.1
Internal rate of return (IRR) (%)	13.0	20.1
Payback period (at 0% discount rate) (years)	8	6
Net profit value (NPV) (US\$)	9470000	13700000

CURSO INTRODUCTÓRIO

Curso 1: INTRODUCCIÓN

DÍA	HORA	ACTIVIDAD	RESPONSABLE CONTENIDO	INSTRUCTOR
1º DÍA	09:00 hasta 10:30	Apertura	ONAPI y INPI	ONAPI y INPI
	10:30 hasta 12:30	El Sistema de Propiedad Intelectual: Contexto de Creación y Premisas Básicas	INPI	Alex Todorov
	12:30 hasta 14:00	ALMUERZO		
	14:00 hasta 17:30	Organizaciones y Tratados Internacionales sobre Propiedad Intelectual	INPI	Alex Todorov
DÍA	HORA	ACTIVIDAD	RESPONSABLE CONTENIDO	INSTRUCTOR
2º DÍA	09:00 hasta 12:30	(A CONFIRMAR) Clasificación Internacional de Patentes + Búsqueda de Patentes en Bases de	INPI	Jeziel
	12:30 hasta 14:00	ALMUERZO		
	14:00 hasta 17:30	Clasificación Internacional de Patentes + Búsqueda de Patentes en Bases de Datos	INPI	Jeziel
DÍA	HORA	ACTIVIDAD	RESPONSABLE CONTENIDO	INSTRUCTOR
3º DÍA	09:00 hasta 12:30	Clasificación Internacional de Patentes + Búsqueda de Patentes en Bases de Datos	INPI	Jeziel / Átila Alex / Márcia / Nathaly
	12:30 hasta 14:00	ALMUERZO		
	14:00 hasta 17:30	Clasificación Internacional de Patentes + Búsqueda de Patentes en Bases de Datos	INPI	Jeziel / Átila Alex / Márcia / Nathaly
DÍA	HORA	ACTIVIDAD	RESPONSABLE CONTENIDO	INSTRUCTOR
4º DÍA	09:00 hasta 12:30	Clasificación Internacional de Patentes + Búsqueda de Patentes en Bases de Datos	INPI	Jeziel / Átila Alex / Márcia / Nathaly
	12:30 hasta 14:00	ALMUERZO		
	14:00 hasta 17:30	Clasificación Internacional de Patentes + Búsqueda de Patentes en Bases de Datos	INPI	Jeziel / Átila Alex / Márcia / Nathaly
DÍA	HORA	ACTIVIDAD	RESPONSABLE CONTENIDO	INSTRUCTOR
5º DÍA	09:00 hasta 12:30	Conceptos Generales para el Examen de Solicitudes de Patentes	INPI	Átila
	12:30 hasta 14:00	ALMUERZO		
	14:00 hasta 16:30	Evaluación de Conocimientos	INPI	Alex / Átila / Jeziel / Márcia / Nathaly
DÍA	HORA	ACTIVIDAD	RESPONSABLE CONTENIDO	INSTRUCTOR
6º DÍA	09:00 hasta 12:30	Novedad / Altura o Nivel Inventivo	INPI	Átila
	12:30 hasta 14:00	ALMUERZO		
	14:00 hasta 16:30	Altura o Nivel Inventivo / Aplicación Industrial	INPI	Átila
DÍA	HORA	ACTIVIDAD	RESPONSABLE CONTENIDO	INSTRUCTOR
7º DÍA	09:00 hasta 12:30	Divulgación suficiente y adecuada Unidad de invención	INPI	Átila
	12:30 hasta 14:00	ALMUERZO		
	14:00 hasta 17:30	Los aspectos particulares de la Biotecnología	INPI	Átila / Márcia / Nathaly
DÍA	HORA	ACTIVIDAD	RESPONSABLE CONTENIDO	INSTRUCTOR
8º DÍA	09:00 hasta 12:30	El Tratado de Cooperación de Patentes (PCT)	OMPI	Rolando Hernández Vígand
	12:30 hasta 14:00	ALMUERZO		
	14:00 hasta 17:30	Método de Examen de una Solicitud de Patente	INPI	Átila / Márcia / Nathaly
DÍA	HORA	ACTIVIDAD	RESPONSABLE CONTENIDO	INSTRUCTOR
9º DÍA	09:00 hasta 12:30	Ejemplos prácticos de Examen	INPI	Átila / Márcia / Nathaly
	12:30 hasta 14:00	ALMUERZO		
	14:00 hasta 17:30	Ejemplos prácticos de Examen	INPI	Átila / Márcia / Nathaly
DÍA	HORA	ACTIVIDAD	RESPONSABLE CONTENIDO	INSTRUCTOR
10º DÍA	09:00 hasta 12:30	Ejemplos prácticos de Examen	INPI	Átila / Márcia / Nathaly
	12:30 hasta 14:00	ALMUERZO		
	14:00 hasta 17:30	Mesa redonda para Evaluación	ONAPI y INPI	Todos los participantes

Table 24

Sensitivity of NPV (million US\$-based value NPV = 9.47) to various factors

% Variation	Cost of KOH	Operating labor wage	Total capital investment	Activated carbon selling price	Production capacity
-25	12.51	11.00	13.09	-1.89	3.25
-20	11.90	10.70	12.37	0.38	4.55
-15	11.29	10.39	11.64	2.65	5.77
-10	10.68	10.08	10.92	4.93	6.99
-5	10.08	9.77	10.19	7.20	8.23
0	9.47	9.47	9.47	9.47	9.47
5	8.86	9.16	8.74	11.74	10.68
10	8.25	8.85	8.02	14.01	11.94
15	7.64	8.54	7.29	16.28	13.19
20	7.03	8.24	6.57	18.55	14.43
25	6.42	7.93	5.84	20.82	15.68

tive is the NPV to that factor. From the diagram, comparing the slopes of five lines obtained by difference factors, 25% changes in operating labor wage shows little effect on NPV while the NPV is more sensitive to the change of the cost of KOH and the total capital investment and is much more sensitive to the production capacity of the plant and the selling price of activated carbon. When the production capacity and the selling price of the activated carbon increase, the corresponding NPV will increase significantly. The opposite trend can however be observed for the total capital investment, the operating labor wage, the cost of KOH.

4.3.6.1. Selling price of activated carbon. For instance, a 10% increase of activated carbon selling price from HK\$ 15 per kg to HK\$ 16.5 per kg would induce a 48% increase in the NPV. Thus the selling price of the activated carbon is the most important of the key issues which dictates the viability of the project; however the selling price is associated with many other parameters such as the quality of the activated carbon produced, the demand of the activated carbon and the competition of the other activated carbon sources, which may make the selling prices fluctuate with the external factors. Fig. 11 shows the NPV and ROI of this project at different price of the activated carbon. Detailed experimental studies must be

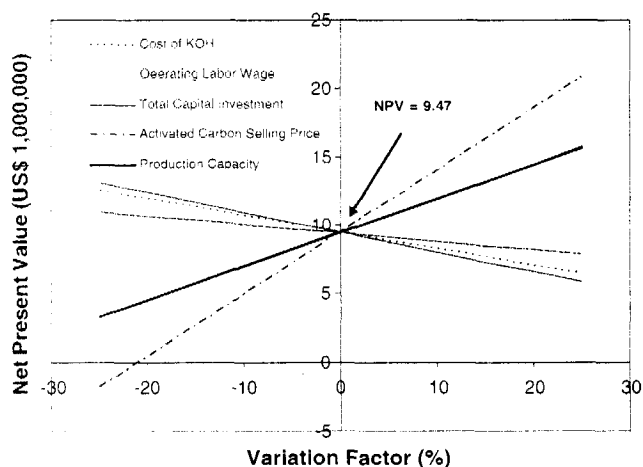


Fig. 10. NPV sensitivity analysis of the bamboo carbonization process.

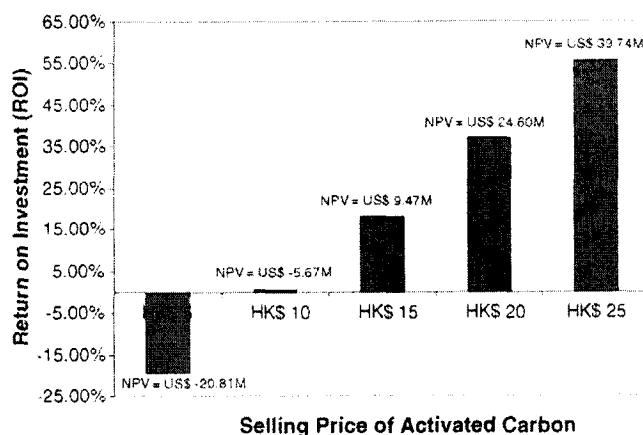


Fig. 11. Comparison of ROI and NPV for different selling price of activated carbon.

performed in the future, in order to find out the optimum conditions, such as temperature, activation methods and agents, etc., for the bamboo carbonization process to produce a high BET surface area and high adsorption ability (high quality) activated carbon from bamboo cane. A high quality activated carbon is required which can be most effectively removed dioxin and heavy metals from the effluent of the MSW incineration process.

4.3.6.2. Production capacity. From Fig. 10, it is found that the production capacity of the bamboo carbonization process is the second most significant factor affecting the NPV of this project. The change in the production capacity will also make a change in the total capital investment because the size and cost of the equipment items change accordingly. A "six-tenths-factor rule" [18] has been used to calculate the cost of the equipment items at different production capacities:

new equipment cost = old equipment cost

$$\times \left(\frac{\text{new production capacity}}{\text{production capacity}} \right)^{0.6}$$

The NPV and ROI at different bamboo carbonization capacities at different selling prices of activated carbon are shown in Table 25 and some data in the table are presented

PRELIMINARY AMENDMENT

- means (16) for wiping the coated metal strip (1) on leaving the metal bath (12), characterised in that it comprises, on the one hand, in the region (17) where the strip (1) leaves the liquid metal bath (12), an enclosure (20) for isolating the liquid metal in this region (17) with respect to the surface of the said bath (12) and for recovering the metal oxide particles and intermetallic compound particles by the liquid metal flowing from this region (17) into the said enclosure (20), the drop in height of the liquid metal (12) in the enclosure (20) is greater than 50 mm in order to prevent the metal oxide particles and intermetallic compound particles from rising as a countercurrent to the flow of liquid metal and, on the other hand, means (30) for extracting the said particles from this enclosure (20).

3. (Original) Plant according to Claim 2, characterised in that the drop in height of the liquid metal in the enclosure (20) is greater than 100 mm.

4. (Currently Amended) Plant according to Claim 2-~~or~~ 3, characterised in that the enclosure (20) surrounds the metal strip (1) and has a bottom (21) and two concentric walls (22, 23) making between them a compartment (24) and defining, in the upper part of the said enclosure (20), an opening (25), the upper edge (22a) of the external wall (22) being positioned above the surface of the liquid metal bath (12) and the upper edge (23a) of the internal wall (23) being positioned below the said surface.

5. (Original) Plant according to Claim 4, characterised in that the internal wall (23) of the enclosure (20) has a lower part flared out towards the bottom of the tank (11) and an upper part parallel to the metal strip (1).

Table 25

Return on investment (ROI) and net present value (NPV) for bamboo carbonization plant at various conditions

Selling price of activated carbon	Daily bamboo processing capacity (tonnes)			
	15	30	45	60
Return on investment (ROI) for bamboo carbonization plant (%)				
HKS 10	−12.5	−0.55	5.76	10.1
HKS 15	0.95	18.2	27.9	34.7
HKS 20	14.4	37.0	50.1	59.3
Net present value (NPV million US\$) for bamboo carbonization plant				
HKS 10	−10.7	−5.67	−0.73	4.46
HKS 15	−3.13	9.47	21.9	34.7
HKS 20	4.44	24.6	44.7	65.0

graphically in Fig. 12. The result of the ROI for the bamboo plant at different plant capacities is a function of selling prices of activated carbon. When the selling price of the activated carbon is HKS 15, the ROI of this project with 15–60 tonnes/day bamboo carbonization capacity increases from 14.36 to 34.70% and the NPV of this project with 15, 30, 45, 60 tonnes/day bamboo capacity is US\$ 4.44, 9.47, 22.0 and 65.0 million, respectively. It is a fact that the larger the production capacity of the activated carbon, the higher the rate of return of the project. With a larger bamboo carbonization capacity, 60 tonnes/day, we can reduce the selling price of activated carbon from \$15.0 to \$11.7 with the same value of the ROI to increase the competitiveness of the product.

The bamboo carbonization capacity of plant depends on the potential market demand of the activated carbon and the amount of dumped bamboo scaffolding waste discarded in a country each year. For example, in Hong Kong, the annual amount of activated carbon imported into Hong Kong in the past 10 years is around 2000–3000 tonnes (6.0–8.8 tonnes/day, 330 operating days). If the yield of bamboo carbonization is approximately equal to 22.5% according to the experimental results, then the amount of waste bamboo required is 27–40 tonnes/day. Therefore, it is suggest that the proposed maximum capacity of the bamboo carbonization plant will be 40 tonnes/day. From the waste

statistics report, over 50,000 tonnes (~136 tonnes/day) of bamboo scaffolding waste each year is dumped as construction waste in Hong Kong, around 30% of daily waste bamboo will be treated in the 40 tonnes bamboo carbonization plant to produce 8.8 tonnes high-quality activated carbon per day selling at around HKS 15 per kg. The ROI, payback time and, NPV of the bamboo plant will be 25.1%, 4.3 years and US\$ 17.8 million, respectively.

4.3.6.3. Equipment from China-based company. Another significant factor affecting the viability of the project is the total capital investment. A “Lang” factor method is used to calculate the rest of the total capital investment based on the total purchase equipment cost. The total capital investment is calculated by multiplying the total purchased equipment by an appropriate factor which accounts for all direct and indirect capital cost. Therefore, the cost of the equipment items is a main factor to control the NPV in the sensitivity analysis of the total capital investment. The equipment cost data presented in Table 5 are US-based equipment costs, but the equipment cost from China could be half or even one-third of the US prices. The price of the equipment items bought and constructed from “Chinese” contract companies are much cheaper than the American companies and the potential cost savings of the equipment items can save more than 50%. If the equipment cost of the plant could be purchased from China at a half price as compared with those bought from US, the equipment cost would be decreased from US\$ 1.37 to 0.69 million, and the resulting ROI will soar from 18.2 to 46.6%, with the assumption that the activated carbon would be of the same quality and sold at the same price. The production of activated carbon from bamboo carbonization process will become a very attractive investment since the payback period of the plant is less than 3 years. If the equipment cost from China Company is only one-third compared to that of a US Company, the rate of investment (ROI) of the bamboo carbonization plant will increase from 18.2 to 73.3%. The cumulative cash flow profiles for these three cases are presented in Fig. 13. Moreover, for the case of half price equipment cost from China Company, the activated carbon selling price can also be reduced from US\$ 1.93 per kg to US\$ 1.54 per kg to increase the competitiveness of the product, the ROI will

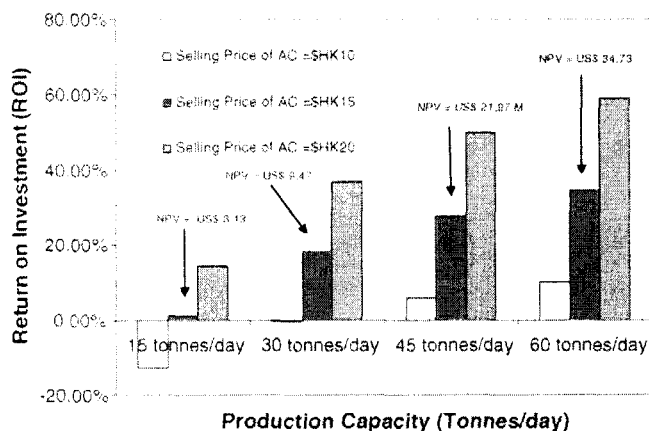


Fig. 12. Comparison of ROI for different production capacity as a function of activated carbon selling price.

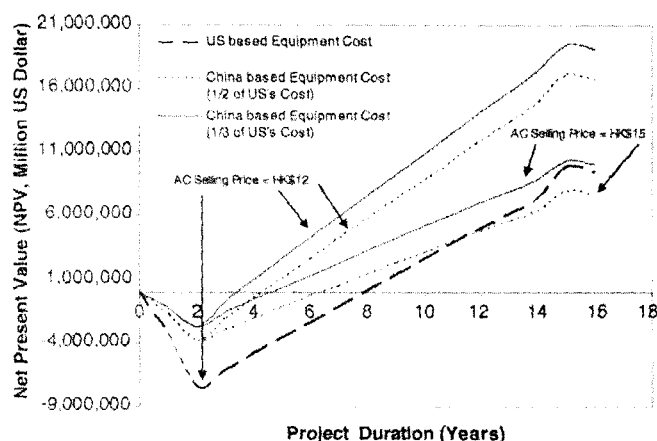


Fig. 13. Comparison between US- and China-based equipment costs on the effect of cumulative cash flow for the bamboo carbonization plant.

become 24.8% and payback period will reduce to around 4.2 from 6 years. The cumulative cash flow profiles for difference prices of activated carbon with two China-based equipment costs (half of the US prices and one-third of the US prices) are also presented in Fig. 13. A summary of NPV, ROI, IRR and payback period of the bamboo carbonization plant based on US-contract and China-contract equipments at different selling price of activated carbon are shown in Table 26.

4.3.6.4. Chemical activation agent. The activation process is to enhance the volume and to enlarge the diameters of the pores which were created during the carbonization process and to create some new porosity. The two common activation processes are chemical activation and physical activation process. Since chemical activation usually is carried out when the raw material is of wood origin, therefore, it is designed to use chemical activation method in the bamboo carbonization process. From Fig. 10, it is found that the change for the cost of potassium hydroxide (KOH) has a significant effect as well as the total capital investment on the NPV of this project. Potassium hydroxide is one of the common chemical agents using in the production of high quality activated carbon and the other widely used activating agents are potassium carbonate, phosphoric acid and sulfuric acid. Using different

Table 27

Sensitivity analysis on chemical activation agent

Chemical activation agent	Price	ROI (%)	NPV (million US\$)
Potassium hydroxide (KOH)	HK\$ 9	18.2	9.47
Potassium carbonate (K_2CO_3)	HK\$ 8	19.9	10.8
Phosphoric acid (H_3PO_4)	HK\$ 6	23.2	13.5
Sulfuric acid (H_2SO_4)	HK\$ 4	26.6	16.2

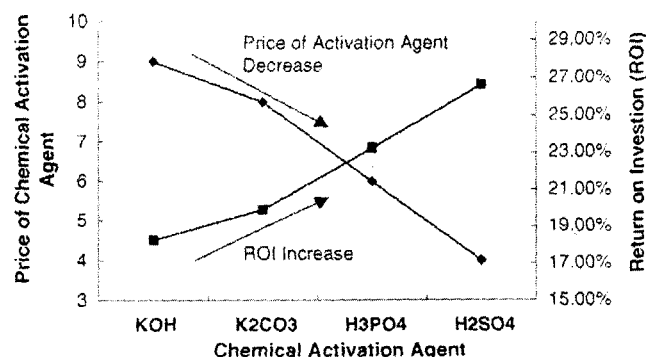


Fig. 14. Relationship between chemical activation agents and ROI of this project.

chemical activation agents in the bamboo carbonization process should provide different quality activated carbon and the yields of the production are also different. In order to compare the sensitivity of different chemical activation agents on the NPV of this project, if the consumption of the chemical activated agents in the process are the same, then it is assumed that the quality and production rate of the activated carbon from the bamboo carbonization process is almost the same (activated carbon sold at the same price). The quotation prices of four different chemical activation agents are shown in Table 27. The resulting ROI and NPV of this project using these four chemical activation agents are also tabulated in Table 27. Using sulfuric acid, the lowest price chemical agent, instead of potassium hydroxide in the carbonization process will increase NPV from US\$ 9.47 to 16.2 million and increase ROI from 18.2 to 26.6%, increasing 71% profit of this project. Fig. 14 shows the relationship between the chemical activation agents and the ROI of this project. Using a cheap chemical activation agent with high activation

Table 26

Return on investment (ROI) and net present value (NPV) of bamboo carbonization plant at various equipment contractors

	US-based equipment cost	China-based equipment cost (1/2 of US's cost)	China-based equipment cost (1/3 of US's cost)
Selling price of activated carbon = US\$ 1.93 (HK\$ 15)			
NPV (million US\$)	9.47	16.7	19.1
ROI (%)	18.2	46.6	73.3
IRR (%)	13.0	35.9	53.8
Payback period (years)	8	4.2	3.4
Selling price of activated carbon = US\$ 1.54 (HK\$ 12)			
NPV (million US\$)	0.38	7.63	10.5
ROI (%)	7.0	24.8	41.6
IRR (%)	0.6	19.0	32.3
Payback period (years)	14.5	6.3	4.7

power on the bamboo carbonization process is important and significant to provide a high return on investment. However, to perform a more detailed and accurate economic evaluation on the effect of chemical activation agents, laboratory studies on the production quality of activated carbon with different chemical activation agents including yield of the bamboo carbonization, adsorption ability of activated carbon and amount of chemical activation agent consumption must be carried out in future.

4.3.6.5. Electricity generation system. Other consideration for the plant design of the sensitivity analysis is electricity generation system. In the bamboo carbonization plant, a steam turbine is designed to recover the heat energy from the hot flue gas to generate electricity (~300 kW) for the production plant and the neighboring cement production plant, thus saving on the electricity cost. The cost of the steam turbine is around US\$ 200,000 and contributes to 17% of the total equipment cost. In order to investigate the economic effectiveness of installing the electricity generation system, a process simulation for the bamboo carbonization process without generating electricity, no steam turbine, is carried out. The rate of investment (ROI) of the bamboo carbonization plant will increase from 18.2% (NPV=US\$ 9.47 million) to 22.2% (NPV=US\$ 10.1 million) since the bamboo carbonization plant can generate around 300 kW but the electricity demand of the plant is assumed to be 200 kW. If we can utilize all the rest of electricity to the neighboring cement production plant, the ROI of the bamboo carbonization plant with electricity generation system will become 19.4% (NPV=US\$ 10.4 million). For the above results, the installation of the electricity generation system in the bamboo carbonization plant does not provide a good economical return and reduce the ROI of the production plant. Moreover, a cheaper gas cooler system can be used to replace the boiler package system if electricity generation is not considered; it can further reduce the total capacity investment and increase the ROI of the bamboo carbonization plant.

5. Conclusion

A feasibility study for the carbonization of bamboo scaffolding waste to make activated carbon has been performed in this paper based on 30 tonnes of bamboo waste per day throughput. This paper consists of a preliminary process design based on various literature sources and an economic evaluation, in which the estimation of the capital investment, the production cost, the return on investment (ROI), the cash flow and the internal rate of return (IRR), has been carried out. For the stand-alone activated carbon plant, it is found that ROI is up to 18.2% when the total capital investment is HK\$ 7,430,000. The internal rate of return is 13.0%, showing a profitable prospect of the production plant. The payback period is estimated to be 6 years after the commencement of

production. For the integrated activated carbon plant, the total capital investment of the bamboo treatment process can be reduced to HK\$ 6,430,000 plant, therefore the ROI increases to 26.1% and the internal rate of return becomes 20.1%. The payback period is estimated to 4 years after the commencement of production.

Sensitivity analysis reveals that the cash flow of the project would be increased or decreased up to 40, 65 and 120% by varying production factors of cost of KOH, production capacity and selling price of activated carbon, respectively, in the extent of $\pm 25\%$. There are some limiting assumptions in the costing calculation:

1. Accuracy may vary in the range of $\pm 25\text{--}30\%$, as equipment costs and detailed equipment designs at this stage have not been finalized.
2. The costs of major equipments are based on the price in United States. It could be lower if suppliers from other countries (for instance, mainland China) could offer cheaper equipment items.
3. Energy integration analysis of the entire process has not yet been conducted. The costs relating to energy consumption have not been fully analyzed at this stage of design.
4. Other weaknesses relate to the actual values of the Lang factorial method, e.g. cost of land. Absolute values of Lang factors have been used in the financial calculations, whereas these parameters are a range of numbers. Each component needs to be assessed carefully for greater accuracy.
5. The quality of the activated carbon has a major effect on its market value. More laboratory tests are required to assess the range and quality of tyre-based activated carbon.

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**SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO
DIRECCION DE NUEVAS CREACIONES**

2020
Bogotá, D.C.,

Señor
JUAN CARLOS GOMEZ VALLEJO
Inventor

ASUNTO	Radicación	06-17793
	Trámite	002
	Evento	001
	Actuación	430
	Oficio	<u>1</u> 2496
	Folios	07

Patente de Invención

☒

Patente de Modelo de Utilidad

☐

Como resultado del examen de fondo, realizado con fundamento en el artículo 45 de la Decisión 486 de la Comisión de la Comunidad Andina, se le comunica:

1. Documentos estudiados

Descripción:	Folios: 3 a 7	como se radicó inicialmente
Reivindicaciones:	Folios: 8 a 9	como se radicó inicialmente
Respuesta del solicitante:	Folios: 31 a 33	

2. Objeto de la invención

Título de la presente invención:

Proceso para la obtención de carbón activado utilizando como precursor guadua *Angustifolia Kunth* (folio 1).

El problema planteado en esta solicitud como producir carbón activado con procesos eficientes y con reducción de impactos ambientales, usando recursos renovables que cumplan con los estándares del mercado.

Para solucionar este problema técnico se desarrolla un proceso fisicoquímico para producir carbón activado a partir de guadua *Angustifolia Kunth*.

Clasificación internacional de Patentes (IPC) en C01B31/00.

3. De la solicitud de Patente (según el caso)

Reivindicaciones (artículo 30 D 486)

- Como esta solicitud se basa en un proceso y producto, que utiliza la *Guadua angustifolia Kunth* para producir carbón activado, es necesario hacer llegar la copia del Permiso de Estudio con fines de Investigación Científica en Diversidad Biológica (PEFIC), tramitada ante la autoridad ambiental nacional competente, debido a que la presente solicitud involucra manipulación del recurso biológico, siendo esta una de las actividades que requieren permiso para usar recursos biológicos.
- El término "hasta" en la reivindicación 3, para denotar el valor de área superficial, no proporciona precisión ni concisión a esta característica del producto "Carbón activado".

- Las reivindicaciones 6 y 7 describen el efecto del proceso de inmersión en ácido fosfórico, lo cual no es permitido. No se aceptan reivindicaciones que caractericen resultados, usos, ventajas o efectos. Por lo anterior, las reivindicaciones 6 y 7 deben eliminarse del capítulo en cuestión.

4. Determinación del Estado de la Técnica

La fecha para determinar el estado de la técnica es el 22 de febrero de 2006, de acuerdo a la fecha de prioridad invocada.

Tendiendo en cuenta la anterior fecha indicada, se realiza la búsqueda de las anterioridades de la presente solicitud, encontrándose los siguientes documentos relevantes:

Nº	Documento	Título	Fecha de publicación
D1	US2003196954	METHOD FOR MANUFACTURING ACTIVATED CARBON FROM COFFEE WASTE	2003-10-23
D3	ART 1*	PRODUCTION OF ACTIVATED CARBON FROM BAMBOO SCAFFOLDING WASTE—PROCESS DESIGN, EVALUATION AND SENSITIVITY ANALYSIS	2005-05

ART*: Keith K.H. Choy, John P. Barford and Gordon McKay. "PRODUCTION OF ACTIVATED CARBON FROM BAMBOO SCAFFOLDING WASTE—PROCESS DESIGN, EVALUATION AND SENSITIVITY ANALYSIS". Chemical Engineering Journal. Volume 109, Issues 1-3, 1 May 2005, Pages 147-165.

5. Análisis de patentabilidad (según requisito) (artículo 14 D486)

Nivel Inventivo (artículo 18 D486)

Respecto a la reivindicación 1 y 22:

La reivindicación 1 dice "Carbón activado para procesos de adsorción en fase líquida y gaseosa, caracterizado porque su precursor es la Guadua Angustifolia Kunth".

La reivindicación 22 dice "Proceso para obtener carbón activado usando como precursor Angustifolia Kunth proveniente de culmos cosechados, de material de descarte en los procesos de industrialización y material de reciclaje, mediante una activación fisicoquímica caracterizado porque comprende las siguientes etapas:

- SELECCIÓN DE LA MATERIA PRIMA: selección de culmos y selección de residuos de Guadua.
- SECADO DE MATERIA PRIMA: en un horno solar.
- LIMPIEZA DEL MATERIAL: remoción de la corteza de la materia prima, corte en 4 secciones y remoción de la capa interior.
- CARBONIZACIÓN: en un horno acerado.
- INMERSIÓN: en H₃PO₄ al 85% durante 12 horas.
- LAVADO Y SECADO: lavado del material y posterior secado a una temperatura de 200°C durante tres horas.
- PULVERIZACIÓN: reducción del material a partículas por debajo de 0.01 cm.
- IMPREGNACIÓN: del carbón pulverizado con H₃PO₄ al 40%.
- ACTIVACIÓN: el material es llevado al reactor en un ambiente ausente de oxígeno y saturado de CO₂ o vapor de agua y temperatura entre 800 y 950°C.

Respecto al estado de la técnica:

D1 describe un método de manufactura de un carbón activado a partir de residuos de café. El método incluye los pasos: a) Inmersión los residuos de café en una solución con un activador a fin de que el activador se adsorbe en la superficie del residuo de café, b) transferir el residuo de café inmerso en un reactor rotatorio a

alta temperatura para proceder a las reacciones de carbonización y activación dando como resultado un carbón activado con una alta área de superficie específica (Resumen).

- Pre-tratamiento del residuo de café. Se pueden usar los siguientes materiales en esta invención: madera, lignito, carbón bituminoso, residuos de varas de bambú, bagazo entre otros (Pág. 1 párrafo 0009).
- Inmersión en el activador: El compuesto activador es carbonato (Pág. 1 párrafo 0016). La inmersión es por 1 a 2 horas (Pág. 1 párrafo 0019).
- Carbonización y Activación en el reactor rotatorio: Las temperaturas de reacción se encuentra en el rango de 700 a 900°C (Pág. 1 párrafo 0020), con un tiempo de reacción de 1 a 3 horas (Pág. 1 párrafo 0022). Esta se realiza en un atmosfera inerte por medio de nitrógeno (Pág. 1 párrafos 0025 y 0026).
- Tratamiento al carbón activado bruto: un lado acido y lavados con agua, sumergir este carbón activado bruto en acetona y agitar por ultrasonido por una hora. Lavar con agua destilada y cocer dicho carbón activado por 12 a 24 horas a 200°C (Pág. 3 Reiv. 14)

D3 describe un estudio preliminar de un diseño de producción de carbón activado a partir de residuos de bambú de construcción. En este estudio se usa el hidróxido de potasio (KOH) como agente de activación pero también se nombran otros agentes activadores comúnmente usado como el carbonato de potasio, ácido fosfórico y ácido sulfúrico (pág. 163). El proceso de la figura 4, muestra que el bambú es

- El material residual, bambú es aplastado y reducido de tamaño.
- El bambú granular es impregnado con una solución de KOH para su activación química.
- Luego se seca a 110°C por 8 horas.
- El bambú con tratamiento alcalino es transferido a un horno de carbonización. El proceso de carbonización se lleva a cabo a 850°C en ausencia de aire (Pág. 150, Descripción del proceso).

Respecto a la solicitud en estudio:

De acuerdo con las reivindicaciones independientes 1 y 22 de la solicitud en estudio, el principio técnico de esta es un carbón activado que usa como precursor la guadua *Angustifolia Kunth* y su proceso de obtención. No obstante D1 divulga un carbono activado que utiliza como precursor residuos entre los que pueden estar los residuos de bambú (Pág. 1 párrafo 0009).

D1 plantea un proceso para obtener carbón activado a partir de residuos de café, afirmando que el carbón activado también comúnmente puede ser obtenido a partir de palillos de residuos de bambú (párrafo 0009). Donde el proceso se inicia con un pre-tratamiento a los residuos que consiste en lavar, secar y moler. Luego el residuo es inmerso en un activador químico como carbonato. La concentración de la solución activadora preferiblemente se encuentra en una rango de 10% al 40%. Después de una a dos horas de inmersión es filtrado y secado. Posteriormente, el residuo es tratado por pirólisis térmica en atmósfera de nitrógeno con incrementos de 10°C/min hasta 700°C-900°C, donde la temperatura es mantenida de una a tres horas hasta la completa carbonización y activación obteniéndose una muestra rugosa de carbón activado (párrafos 0048, 0050, 0054).

La solicitud colombiana se diferencia con D1 en el paso de inmersión del los residuos de bambú en ácido fosfórico al 85% y luego utilizar una solución al 40% como agente activador.

El problema técnico a resolver es como obtener carbón activado a partir de

guadua Angustifolia Kunth con un área específica alta.

Para solucionar el anterior problema técnico D3 muestra que el proceso de activación es el que aumenta el volumen y el diámetro de los poros creados durante el proceso de carbonización por lo tanto aumentando la porosidad. A pesar que este documento utiliza hidróxido de potasio como agente de activación, también afirma que existe otros agentes de activación ampliamente usados como son el ácido fosfórico entre otros (Pág. 163, 4.3.6.4. Chemical activation agent).

Así las cosas, un técnico de nivel medio versado en la materia que tuviera acceso a D1 y D3, y enfrentado al problema técnico, podría verse motivado a realizar pruebas de rutina para seleccionar el mejor agente de activación, partiendo de la información divulgada en D3, dentro del proceso divulgado en D1.

Es así como un técnico medio en la materia que tuviera acceso a los documentos D1 y D3, podría verse motivado a desarrollar un carbón activado a partir de residuos o material vegetal como los de *guadua Angustifolia Kunth* (*bambusa guadua*) que pertenece a la misma familia del bambú y utilizar como agente de activación el ácido fosfórico tal como lo propone la solicitud en estudio.

Lo anterior también se concluye del hecho que el solicitante nunca mostro una ventaja al utilizar *guadua Angustifolia Kunth* comparado con otros materiales vegetales residuales muy ampliamente utilizados en los procesos de obtención de carbón activado, ya que como lo muestra D1 la única característica comparable de la solicitud con el estado de la técnica es el área superficial, siendo esta de la misma magnitud que el de la solicitud, es decir de 450 m²/g a 1500 m²/g (solicitud) y de 726 m²/g a 1317 m²/g (D1). Además, el técnico medio en el arte puede utilizar los criterios descritos en D3 para seleccionar material vegetal residual como son bajo contenido de inorgánicos, volumen y costo del material, mínimo impacto ambiental, entre otros, dejando en claro que la *guadua* cumpliría con estos criterios y por lo tanto seria obvio para un técnico medio en la materia también utilizar esta materia como precursor y por lo tanto no implicaría actividad inventiva.

En conclusión, estas reivindicaciones se encuentran afectadas en su nivel inventivo ya que se derivan de manera evidente del estado de la técnica y pueden ser obvias para un experto en la materia.

6. Conclusión

Los requisitos de patentabilidad de la presente solicitud se encuentran afectados así:

Nº	Documento	Reivindicaciones afectadas	Requisito que afecta
D1	US2003196954	1-8	Nivel Inventivo
D3	ART 1*	1-8	Nivel Inventivo

7. Respuesta a los argumentos del solicitante

- Respecto a la objeción del numeral 3 del requerimiento del 11 de junio de 2009, en el cual se le pide al interesado solicitar y tramitar una copia del contrato de acceso genético ante la autoridad ambiental competente, éste argumenta:

"Puntualmente en Colombia el aprovechamiento de recursos biológicos se rige por el Decreto 1791 del 4 de octubre de 1996, el cual expresa lo siguiente: 'El gobierno nacional estableció el régimen de aprovechamiento

forestal en virtud del cual, se regula las actividades de administración pública y de los particulares, respecto del uso, manejo, aprovechamiento y conservación de los bosques y la flores silvestres con el fin de lograr su desarrollo sostenible. Que el artículo 62 del Decreto citado, faculta a cada corporación autónoma regional para reglamentar lo relacionado con los aprovechamientos de especies tales como la Guadua, el bambú y la cañabrava.

En la actualidad no se está realizando ningún aprovechamiento industrial de la Guadua para la producción de carbón activado, solamente se ha realizado como se plantea en la solicitud de patente a nivel investigativo y piloto, y en consecuencia a las cantidades extraídas y a la reglamentación de la CARDER, corporación competente según la región de la investigación, no se requería permiso de aprovechamiento". (folios 31 y 32)

En relación con lo expuesto por el solicitante, esta Oficina se permite hacer las siguientes precisiones:

Si bien es cierto que en la solicitud no se está accediendo a la guadua como un recurso genético y en consecuencia no se necesita el contrato de acceso a recursos genéticos, también es cierto que sí se está realizando investigación científica sobre diversidad biológica, la cual se encuentra expresamente regulada por el Decreto 309 de 2000 del Ministerio de Ambiente hoy Ministerio de Ambiente, Vivienda y Desarrollo Territorial (MAVDT).

En virtud de dicha norma, toda persona natural o jurídica (nacional o extranjera) que vaya a realizar alguna o todas las actividades de colecta, recolecta, captura, caza, pesca y/o manipulación de recursos biológicos y/o su movilización en el territorio nacional, debe solicitar y obtener ante la autoridad ambiental competente el "Permiso de Estudio con Fines de Investigación Científica en Diversidad Biológica" (PEFIC). Según la ubicación del recurso biológico, dicha autoridad puede ser: las Corporaciones Autónomas Regionales, los Grandes Centros Urbanos, la Unidad Administrativa Especial del Sistema de Parques Nacionales Naturales, el Instituto Colombiano Agropecuario (ICA), la Dirección Marítima y Portuaria (DIMAR), el Ministerio de Relaciones Exteriores o el Ministerio de Ambiente, Vivienda y Desarrollo Territorial.¹

De conformidad con lo anterior, es necesario que el solicitante tramite y obtenga el PEFIC ante la autoridad ambiental competente, pues este requisito debe cumplirse siempre que se realice investigación científica sobre la biodiversidad nacional, como ocurre en el presente caso. Es decir, el aprovechamiento industrial del recurso estudiado, no exime de la obligación de obtener el PEFIC, pues éste es diferente al permiso de aprovechamiento mencionado por el solicitante en su respuesta.

Al respecto, de manera expresa la normatividad nacional vigente establece que no se requiere PEFIC en los siguientes casos:

- *"Cuando las actividades no involucren colecta, recolecta, captura, caza, pesca y/o manipulación de especímenes o muestras de fauna y/o flora silvestres, como por ejemplo, audición y visualización.*
- *Cuando se trata de especies domésticas.*
- *En prácticas docentes en salud y/o agricultura, cuando no involucren colecta, recolecta, captura, caza, pesca y/o manipulación de recursos*

¹ VALLEJO TRUJILLO, Florelia, et.al. *Guía práctica para el acceso a los recursos biológicos, genéticos y/o sus productos derivados, y el componente intangible*. Universidad Nacional de Colombia, Bogotá, 2009. PP 14-23.

http://www.plebio.unal.edu.co/images/pdf/documentacion_publicaciones/guia_practica_acceso.pdf

biológicos y/o su movilización en el territorio nacional".²

En conclusión, se reitera que debido a que la legislación nacional no contempla como exclusión para la obtención del PEFIC no estar desarrollando actividades de aprovechamiento industrial, el solicitante se encuentra obligado a obtener dicho permiso, el cual debe ser allegado junto con la respuesta al presente requerimiento de fondo.

Lo anterior, en cumplimiento del deber de salvaguardia del patrimonio biológico en la concesión de patentes, contenido en el artículo 3 de la Decisión 486 de 2000, según el cual "Los países miembros asegurarán que la protección conferida a los elementos de la propiedad industrial se concederá salvaguardando y respetando su patrimonio biológico y genético, así como los conocimientos tradicionales de sus comunidades indígenas, afro americanas o locales. En tal virtud, la concesión de patentes que versen sobre invenciones desarrolladas a partir de material obtenido de dicho patrimonio o dichos conocimientos estará supeditada a que ese materia haya sido adquirido de conformidad con el ordenamiento jurídico internacional, comunitario y nacional". -Subraya fuera de texto-

- *El solicitante objeta el documento D1 en la cual se plantea la utilización de residuos entre los cuales caben los residuos de bambú, este caso no afecta esta patente, ya que el procedimiento descrito en nuestra solicitud esta enfocado específicamente en la obtención de carbón activado usando solamente como precursor guadua Angustifonia Kunth.*

Respecto a lo anterior, la Oficina le aclara al solicitante que en el último requerimiento nunca se afectó su solicitud por un análisis de novedad, siendo este análisis una comparación explícita de todas las técnicas esenciales de la invención con los documentos del estado de la técnica. En el citado requerimiento se afectó el nivel inventivo de la solicitud por medio de un análisis de nivel inventivo, siendo este totalmente diferente al análisis de novedad. Es así como, en el análisis de nivel inventivo, se evalúa si la invención se deduce del estado de la técnica en forma evidente para un técnico medio en la materia, es así como quedo demostrado, ya que D1 es el documento más cercano del estado de la técnica y D3 es el documento que soluciona el problema técnico objetivo.

Por otro lado el argumento del solicitante no es persuasivo, ya que la anterioridad D3 describe que cualquier material que contenga alto nivel de carbono en su estructura puede ser una opción para producir carbón activado. Además, como dentro de la solicitud no se encuentra un efecto sorprendente al utilizar material residual vegetal de origen Colombiano como lo es la *guadua Angustifonia Kunth* no se puede aceptar que este precursor conceda nivel inventivo, toda vez que en el estado de la técnica ya que utilizaba material vegetal residual de la misma familia de la guadua como es el bambú que produce un carbón activado con un área superficial similar que el de la solicitud.

- *Adicionalmente D2 plantea un proceso en el que usa cloruro de zinc el cual es un agente químico sumamente contaminante y de difícil manejo por los daños a nivel ambiental que puede causar, contrario al agente activante utilizado por nosotros (H3PO4).*

Respecto a lo anterior, a pesar que D2 utilice otro agente activante la ventaja nombrada por el solicitante al utilizar ácido fosfórico no es cierta, dado que en la actualidad se esta reevaluando también el uso de este ácido por los efectos adverso producidos al medio ambiente por este debido a la eutrofización. Es así que el técnico medio en la materia en su practica habitual de optimización de

² Ob. Cit. P. 14

condiciones evaluaría el efecto adverso, el costo, entre otras características de los agentes activantes para seleccionar, pero lo anterior no implica actividad inventiva por si sola.

- *Los tiempos de impregnación y las concentración de la sustancia deshidratante empleada son muy diferentes a los planteados de las patentes D1 y D2. Finalmente en ninguna de las patentes se habla de la relación de impregnación que en este caso nuestro es de 3-1, factor clave en la obtención del área específica descrita.*

Respecto a lo anterior es importante tener en claro que si la característica que menciona el solicitante es relevante para su invención debe ser incluida en el capítulo reivindicatorio, dado que las reivindicaciones deben contener todas las características técnicas esenciales de la invención las cuales definen a la invención y la hacen o pudieran hacerla distintiva del estado de la técnica. Estas características esenciales definen la solución al problema técnico que intenta resolver la invención. Dado lo anterior, en el anterior examen de patentabilidad no se pudo tener en cuenta esta característica ya que el solicitante no la incluyó en ninguna de las reivindicaciones presentadas.

Ahora bien, como ya se ha mencionado en respuesta a otros argumentos del solicitante, se observa que a pesar de que los tiempos y la concentración de la sustancia deshidratante empleada en las anterioridades no son las mismas, nunca se muestra una ventaja con las condiciones del proceso reivindicado, es decir el solicitante plantea un proceso alterno para obtener carbón activado con un área superficial como la obtenida en la anterioridad D1.

Finalmente, la relación de impregnación que el solicitante asegura que da como resultado el área específica descrita, sería una ampliación de materia dado que el capítulo descriptivo ni en el reivindicatorio, nunca se nombro esta característica ni se demostró una ventaja técnica sobre los procesos conocidos en el estado de la técnica.

Se le enfatiza al solicitante que la Oficina después de dos artículos 45 procederá a decidir sobre su invención, dado que no ha mostrado el nivel inventivo de su invención a pesar de haber tenido la oportunidad de cambiar el capítulo reivindicatorio dos veces.

En cumplimiento del artículo 45 de la Decisión 486 de la Comisión de la Comunidad Andina, se le indica que debe dar respuesta dentro del término de 60 días contados a partir de la fecha de notificación de la presente comunicación. En caso de no dar respuesta al presente requerimiento, o si a pesar de la respuesta subsistieran los impedimentos para la concesión, se denegará la patente.

Notifíquese el presente oficio conforme a lo dispuesto en el numeral 5.2, literal e), del capítulo quinto del título primero de la Circular Única N° 10 de 2001.

ALIX CARMENZA CÉSPEDES DE VERGEL
Directora de Nuevas Creaciones (C)

El anterior requerimiento fue notificado por fijación en lista, de fecha

23 SET. 2010

CONCEPTO TÉCNICO N° 3206	EXAMINADOR TÉCNICO Código N° 202090
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