

SOSTENIBILIDAD EN CADA FIBRA

Aprovechamiento energético de residuos en la industria del papel

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Septiembre 1 de 2022



120.000 años atrás



3100 AC



S III AC



S I DC



S VIII DC

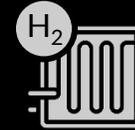


1700

1769



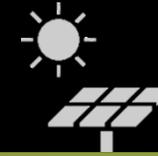
1876



1932



1951

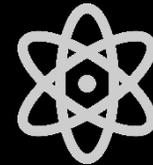
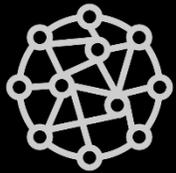


1954



1980

2000



2000

2022

2050

- Acerca de Smurfit Kappa
- Aprovechamiento de residuos
 - Etapa 1: Fase investigativa
 - Etapa 2: Pruebas industriales
 - Etapa 3: Implementación
- Proyecciones

Agenda

An aerial photograph of a dense evergreen forest, likely spruce or fir, with a rich green color palette. The trees are packed closely together, creating a textured, layered appearance. The lighting is soft, highlighting the individual branches and needles. In the center of the image, the text "ACERCA DE SK" is written in a clean, white, sans-serif font, with wide letter spacing. The text is centered horizontally and vertically, standing out against the darker green background of the forest.

ACERCA DE SK

Alcance geográfico



48.000

Colaboradores



3

Continentes



36

Países



355

Operaciones



65.000

Clientes

Nuestras operaciones en Colombia



Forestal

68.000

hectáreas de
plantaciones
forestales



Reciclaje

7,4 Millones

toneladas de papel
recuperado al año



Papel

8,3 Millones

toneladas de papel
y cartón al año



Empaques

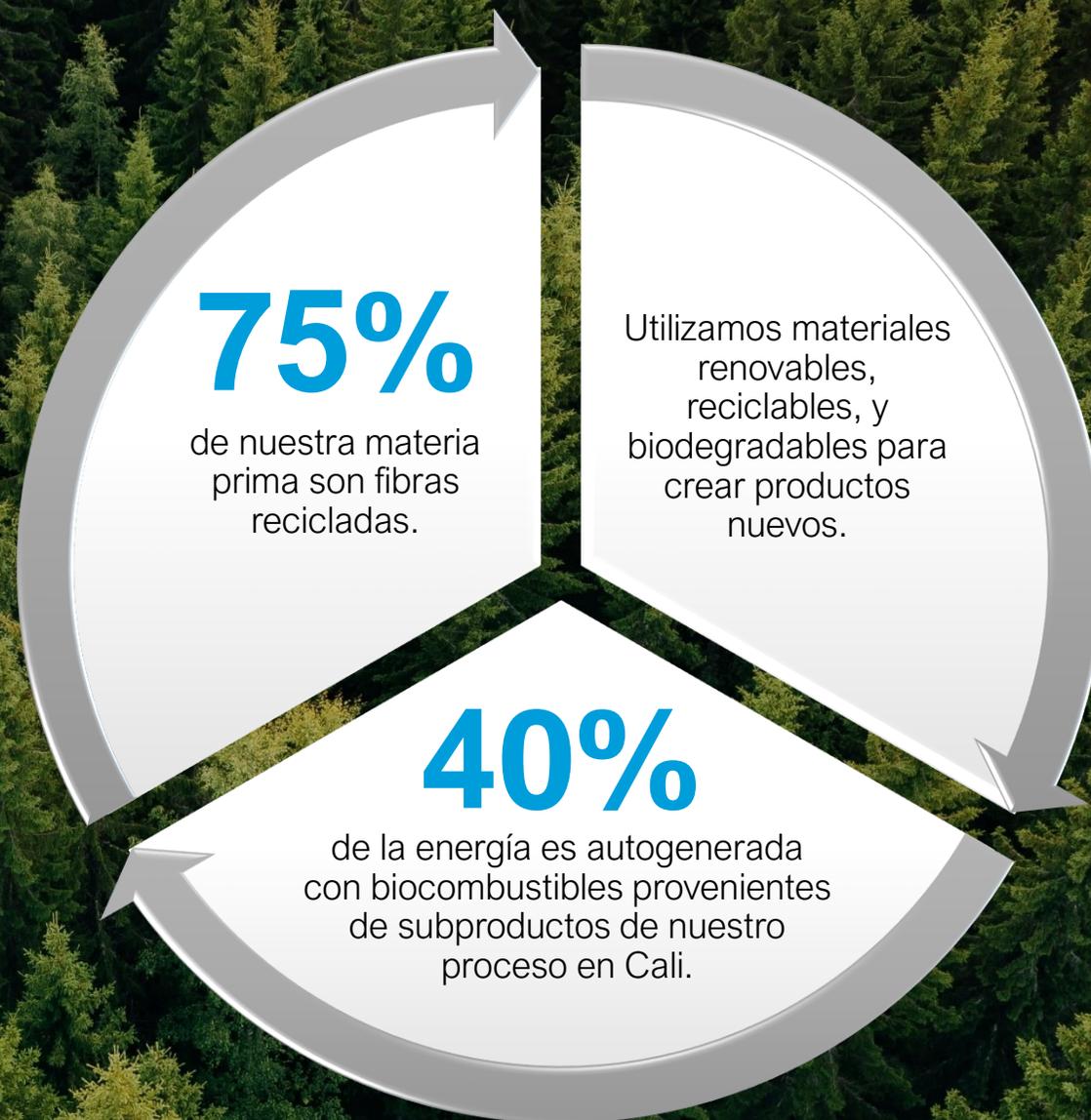
12,5 Mil Millones

m² producidos al
año

**La verdadera
sostenibilidad es de
extremo a extremo**



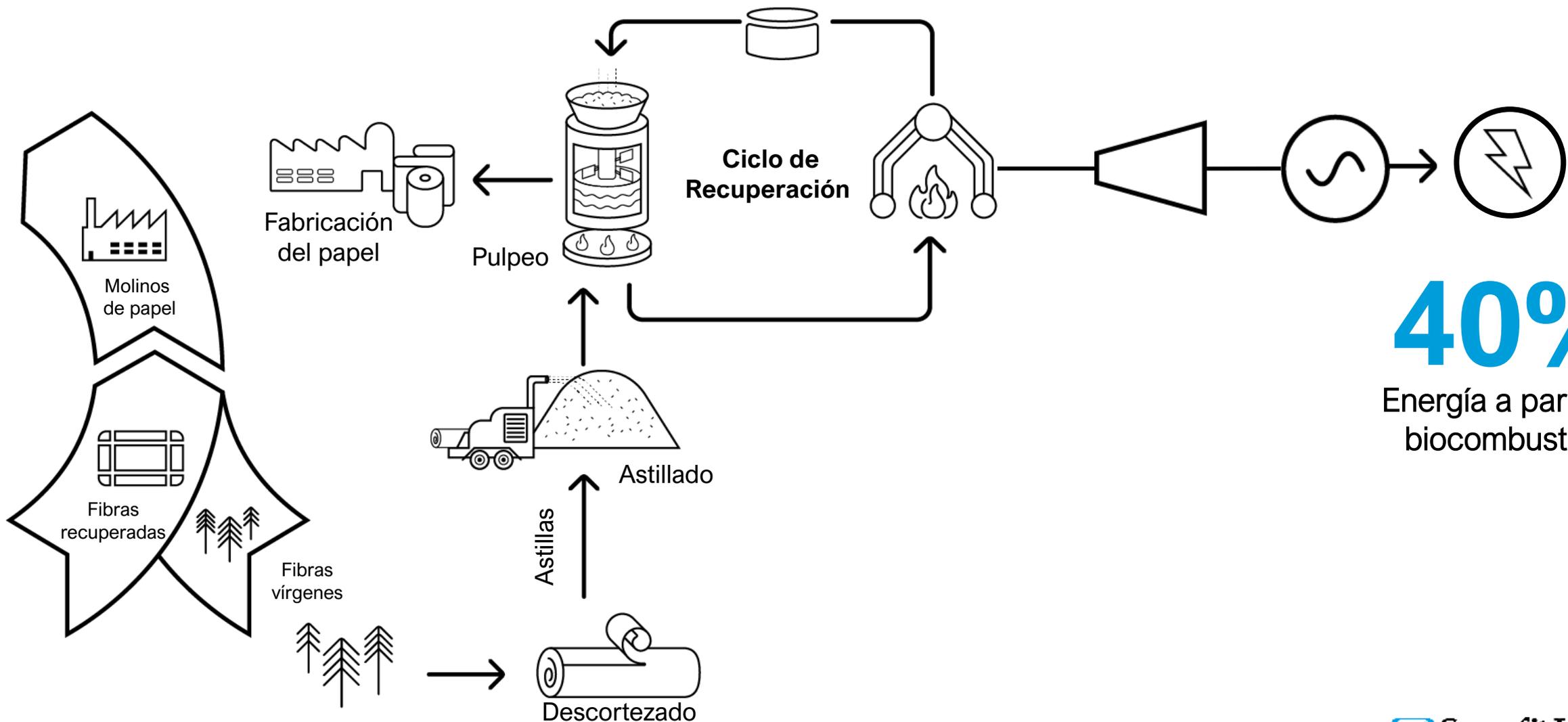
Nuestro modelo de negocio circular



A dense, textured background of light brown wood chips, likely mulch, covering the entire frame. The chips are irregular in shape and size, creating a natural, organic pattern.

APROVECHAMIENTO DE RESIDUOS

¿Cómo producimos bioenergía en SK?



40%
Energía a partir de
biocombustible

Otros subproductos aprovechables



Pin Chips



Aserrín



Lodos de PTAR

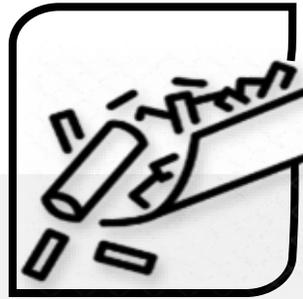


Cenizas con altos inquemados

Ruta de navegación



Etapa 1



Etapa 2



Etapa 3

2014

2019

2022

2024

Fase investigativa

Inicio de investigación, caracterización de fuentes, y ensayos.

Pruebas industriales

Peletización y alimentación a caldera de carbón.

Implementación

Co-combustión en caldera existente.

A large, bold, blue number '1' is positioned on the left side of the frame. The background is dark, featuring a dynamic trail of golden-brown particles or dust that originates from the right and moves towards the left, creating a sense of motion and depth.

1

FASE
INVESTIGATIVA

Sinergia entre residuos

Estudio con el Grupo de investigación TAYEA de la UNAL Medellín

Dos residuos sólidos muy diferentes, ambos con alto contenido de inorgánicos (bajo valor económico):



Lodos de PTAR



Quema fácilmente

33% material volátil



Quema por corto tiempo

0,4% carbón fijo



Cenizas de caldera de carbón con alto contenido de inquemados



Necesita temperatura muy alta para quemar

9% material volátil



Quema por más tiempo

58% carbón fijo



No pueden aprovecharse energéticamente de forma separada



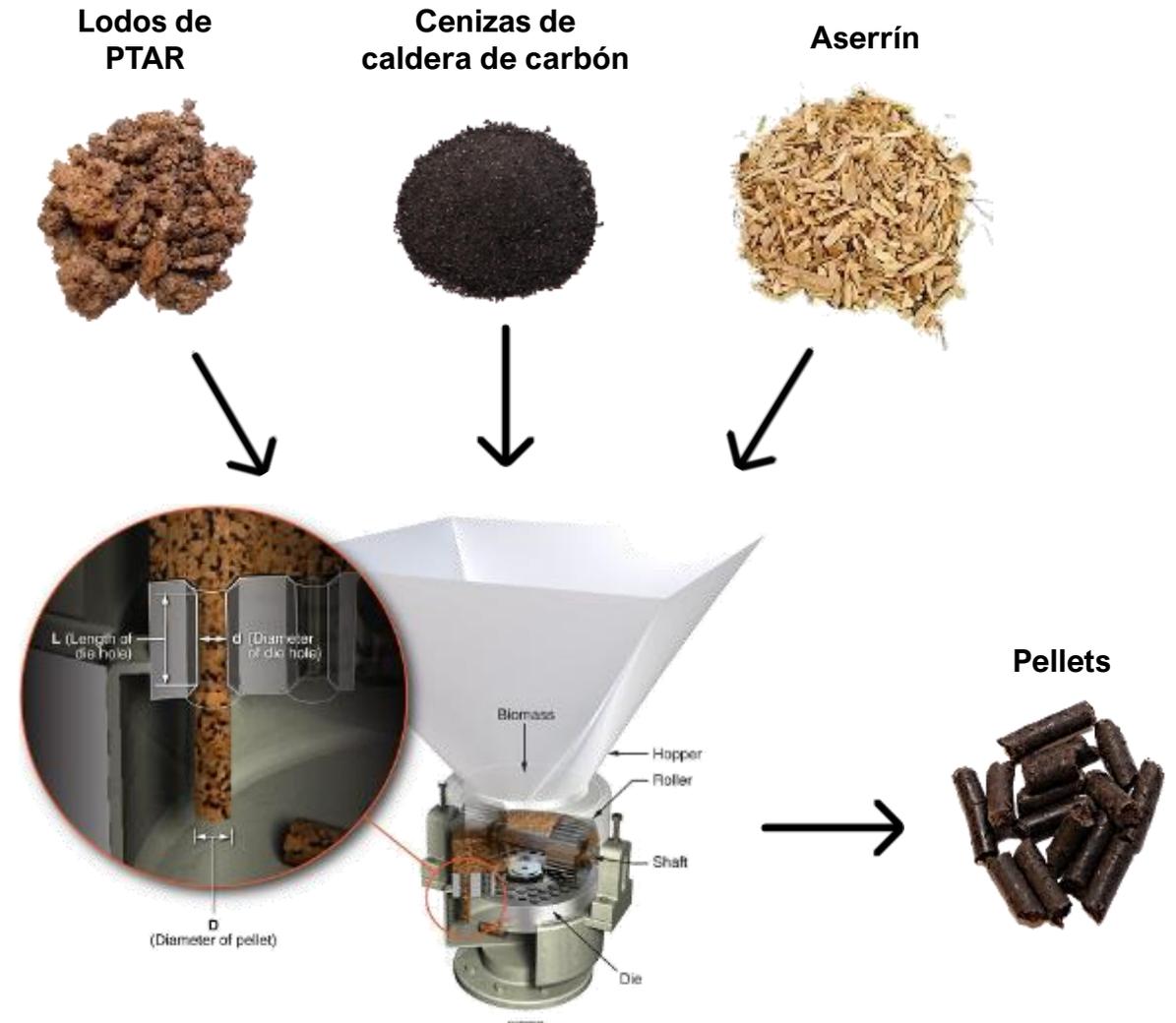
Pellets

Peletizándolos juntos se aumenta en más de 80% su densidad energética.

Estudios con la UNAL

2014 – 2018

- Pellets con mezcla de los tres residuos principales:
 - 66% lodos húmedos (@50%)
 - 33% cenizas
 - 1% aserrín
- HHV: 9 – 14 MJ/kg
 - Carbón HHV: 20 – 30 MJ/kg



Emisiones teóricas

Restricciones legales en: SO₂, NO_x, furanos y dioxinas.

Del estudio con la universidad se concluyó:

- No se identificaron furanos ni dioxinas durante la combustión.
- Las emisiones de SO₂ y NO_x estuvieron por debajo de los límites legales.
- A pesar de que las cenizas contenían sulfuros, este no se volatiliza, quedándose en las cenizas finales.

Publicaciones

Applied Thermal Engineering

Applied Thermal Engineering 124 (2017) 191–201



Contents lists available at ScienceDirect

Applied Thermal Engineering

journal homepage: www.elsevier.com/locate/apthermeng



Research Paper

Energy evaluation of pelletized mixtures of IWTP sludge and coal-fired boiler ashes by co-combustion: Identification of synergistic effects



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HIGHLIGHTS

- Mixture solid waste with good characteristics for co-combustion was developed.
- The pellets co-combustion at high temperatures is governed for rate of reaction.
- Developed techniques represent a synergic opportunity to assess industrial residues.

ARTICLE INFO

Article history:
Received 10 April 2017
Received in revised form 2 June 2017
Accepted 3 June 2017

Keywords:
Co-pelletization
IWTP primary sludge
Coal-fired boiler ashes
Pellets quality
Volumetric energy density
Synergy in residues

ABSTRACT

In order to reduce the amount of solid industrial residues of a factory and to harness its thermal potential, a co-combustion technique has been developed. This technique aims to co-pelletize Industrial Wastewater Treatment Plant (IWTP) primary sludge, and non-reactive fly ashes with high loss of ignition coming from an industrial coal chain-grate stoker boiler. This technique represents a synergistic opportunity to capitalize the heating power within each residue, in two main ways: first, pelletization on its own has proven benefits on energy densification, in terms of volume reduction for transport and storage; second, the reactivity of fly ashes increase with the volatile matter contribution of the primary sludge, improving the thermal properties of the mixture and its performance under combustion. The later was demonstrated by thermogravimetric analysis of the different mixture ratios evaluated. Furthermore, it was demonstrated that the char co-combustion of the pellets is dominated by the reaction rate, while the previous process of devolatilization is dominated by mass and heat transfer phenomena simultaneously with the kinetic reaction.

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1. Introduction

(At this time, the efficient use of solid residues for energy is limited by technical constraints and by the intrinsic characteristics of the sources, such as low density and heterogeneity. These characteristics difficult transport and storage, but even more important, derives in poor energy density due to its intrinsic low calorific value, compared to fossil fuels [1,2]. In order to overcome a primary constraint, mandatory in order to improve its value added, Mechanical Pelletizing and briquetting are two of the most applied processes. Pressure is exerted on the material to compact it into pellets or briquettes, increasing the density from a range of 150 kg/m³ to 600–1400 kg/m³ [3]. This process significantly lowers,

inter alia, higher energy density (MJ/m³), lower moisture content, better dust and ash control, lower transport and storage costs, and more uniform material sizes and composition. The latter facilitates the adaptation to feed systems of both domestic and industrial equipment [4,5].

Other alternative to increase the energetic worth of the solid residues is the co-combustion with other fuels, mainly coal. The advantages of both the biomass and its mixtures with other carbonaceous residues have begun to gain relevance in research and business, due to the environmental sustainability reasons [8,15–18].

Conventionally, there is an increasingly strong competition for conventional sources materials for pellets, as are forestry and agro-industrial residues; due to the already developed market of wood pellets biotuels in Europe and North America [5,16], and the interest of paper industry in other raw materials [19–21].

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<https://doi.org/10.1016/j.apthermeng.2017.06.007>
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Waste Management

Waste Management 101 (2020) 54–65



Contents lists available at ScienceDirect

Waste Management

journal homepage: www.elsevier.com/locate/wasman



Co-gasification and co-combustion of industrial solid waste mixtures and their implications on environmental emissions, as an alternative management



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ARTICLE INFO

Article history:
Received 15 April 2019
Revised 3 September 2019
Accepted 26 September 2019
Available online xxxxx

Keywords:
Co-pelletization
Thermal co-processing
Primary sludge
Wood waste
Coal Boiler Ashes

ABSTRACT

The primary sludge produced by the wastewater treatment plant of a pulp and paper mill has high physicochemical heterogeneity, which limits the efficiency of thermochemical methodologies for the final disposal of this residue. As a solution, co-pelletization of the Primary Sludge (PS) with two other principal Industrial Solid Residues (ISRs) of the plant, Coal Boiler Ashes (CBA) and Wood Waste chips (WW), was proposed as a way to valorize the PS for energy use, while reducing dewatering costs. The energy potential was evaluated through a series of thermal co-processing tests of disaggregated and pelletized mixtures. Due to their differing fixed-carbon-to-volatile-material ratios, combining the ISRs resulted in a reduction of up to 45% of the mass of the ISR generated, improving the disposal conditions and achieving a minimum thermal power of 5.0 MJ/Nm³ through gasification. Finally, the environmental implications of the thermal co-processing of the wastes were assessed, finding very low impacts due to pollutant emissions, in accordance with the legal environmental regulations in force in Colombia.

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1. Introduction

The pulp and paper industry has primarily used sanitary landfills for the final disposal of sludge coming from its industrial wastewater treatment plants (IWTPs), and for other industrial

Solid Residues (ISRs). In Colombia, Smurfit Kappa (SK) company's IWTP generates around 320 tons/day of Primary Sludge (PS) with 12 wt% of solids, which contains a large amount of organic matter, such as waste paper and cardboard, accompanied by inorganic material from the effluent of the Cauca River, the source of the process water. Other wastes produced by SK include around 13 tons/day of Wood Waste chips (WW) and 40 tons/day of Coal Boiler Ashes (CBA), which lacks reactivity. The disposal of these residues of SK that require sustainable alternatives represents around 90 tons/day.

The primary sludge produced by urban wastewater treatment systems requires similar final disposal options. The city of Bogotá produces 131,400 tons/year of primary sludge, which is disposed in 15 of the nine main urban centers in the city. However, the main

difficulties of this disposal mechanism are related to the environmental requirements (treatment of leachates and secondary pollution) and the criteria of economic sustainability of the final disposal sites (Mahmood and Elliott, 2006; Strezov and Evans, 2009; Chanaka Udayanga et al., 2018).

In accordance with the above, composting and thermal treatment have become of great importance as solutions to these disposal needs (Fonseca et al., 2012; Bajpai, 2013). Composting, even when multiple soil improvement benefits are reported (Lu et al., 2012; Bajpai, 2015; Hazarika et al., 2017; Hazarika and Khowarazim, 2018), has disadvantages related to: (i) the need for large areas to process the waste volumes generated by the industry, (ii) long processing times (minimum 60 days), (iii) the need to manage large quantities of greenhouse gases (CH₄ and CO₂) and other undesirable substances during processing (Sinha and Kalita, 2014; Hazarika et al., 2017; Hazarika and Khowarazim, 2018), and (iv) the need to guarantee the absence of heavy metals that are bioaccumulative (Sinha and Kalita, 2014; Hazarika et al., 2017). In addition to this, limited amounts of residues from debarking, pulping, and paper screening are compostable (Bajpai, 2015).

In contrast, thermal treatments, depending on the thermal severity at which they occur, have greater effectiveness in the

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<https://doi.org/10.1016/j.wasman.2019.09.037>
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Biomass Conversion & Biorefinery

Biomass Conversion and Biorefinery
<https://doi.org/10.1007/s13399-021-01826-x>

ORIGINAL ARTICLE



Experimental analysis of the effect of the physicochemical properties of paper industry wastes on the performance of thermo-conversion processes: combustion and gasification

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Received: 15 February 2021 / Revised: 23 July 2021 / Accepted: 26 July 2021
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Abstract

This work analyzes the energy performance implications of the physicochemical properties and the mineralogical elemental composition of agro-industrial wastes in the form of pellets (ISR pellets) and pine bark chips (PBCh). ISR pellets were made from a mixture of industrial wastewater treatment plant (IWTP) primary sludge, coal boiler ashes (CBA), and wood waste chips (WW), which are wastes rich in inorganic material and with a usable energy potential. All these residues were obtained from the production processes of paper company (Smurfit Kappa Colombia). ISR pellets and PBCh were tested as individual and mixed fuels in the thermochemical gasification and combustion processes. Several synergistic effects were found through the co-processing of these fuels, resulting in improvements in the performance indices normally used for the energy assessment of waste, as well as substantial environmental impact and operational behavior improvements. These effects were predicted through fusibility correlations from the elemental composition of the inorganic content, particularly the low melting point salts precursor species and fusibility temperature, as developed for coal ashes. The results of experimental co-processing validated these predictions.

Keywords Thermo-conversion · Sintering · Slag · Environmental pollutant emissions · Co-processing

1 Introduction

The use of biomass as a fuel for heat and electrical power and as an input for the generation of value-added products are some of the most common methodologies for reducing dependence on fossil fuels and sustainable waste management. Currently, biomass gasification and combustion are the most mature thermochemical technologies [1–4] with established environmental standards [5], which consequently have been considered to significantly reduce CO₂ emissions

per unit of energy as compared to fossil fuels. However, the energy exploitation of biomasses through thermo-conversion processes still presents challenges, such as environmental emissions (SO_x, NO_x, organochlorines, particulate matter, among others), competitive reactions promoting undesirable by-products (tars), and reactions with ashes (slagging, staking, and corrosion of heat transfer surfaces), as well as agglomeration and sintering in the bed [6].

In this regard, the gaseous emissions of the thermo-conversion of biomass have been widely studied [7–9], finding that both the physicochemical composition of the biomass and the thermochemical process used affect the emissions [10–12]. Consequently, each type of biomass requires different studies to establish the cause-effect relationship between the biomass characteristics and the competing reactions, contrary to the process interest, and the problems related to ash formation and sintering. Therefore, selecting the process most suitable for the thermochemical conversion of biomass requires a physicochemical characterization of the fuel, while also impacting operational and financial decision-making during the scaling and implementation phases.

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Published online: 16 August 2021



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PRUEBAS INDUSTRIALES



Nueva prensa de lodos

Prensa de tornillo

A mayor sequedad, mayor eficiencia

- Productividad: 2.2 ton/mes
- Inversión: 2.2 MUSD
- Consistencia de salida: 40% – 50%
- Operativa en Diciembre 2019

Peletizadora piloto

Se adquirió una peletizadora para pruebas en planta:

- Capacidad: 150 kg/h

Inversión

- Equipo: 2000 USD
- Operario: 500 USD

Platos perforados

- Huecos: 212 huecos
- Diámetro: 8 mm
- Espesor: 25 mm



Producción de Pellets

Validación de resultados



Primer Ensayo de Combustión

Marzo 2021

Compatibilidad con el equipo actual

Alimentación manual de
pellets en cangilones y
fogoneros



Alimentación y quemado en parrilla viajera

Se verificó que los pellets
no atravesaran la parrilla



Combustión completa de los pellets

Los pellets quemaron
completamente



Suspensión del peletizado

Abril 2021



Se decide no peletizar y alimentar los residuos a granel

3

IMPLEMENTACIÓN

Co-combustión de biomasa

Antes



300
ton/día
Carbón



Ahora



230
ton/día
Carbón

+

60 ton/día Madera

40 ton/día Lodos

16 ton/día Cenizas



-17%
CO₂

Co-combustión de biomasa

Conclusiones iniciales

- La generación de la caldera disminuyó en 20%.
- No se ha incrementado la temperatura de la caldera (parrilla y sobrecalentador).
- La biomasa podría incrementar la escoria y el ensuciamiento en el hogar de la caldera a futuro, sin embargo, después de 6 meses de operación, no se ha evidenciado esto.

CANALETA 4

Co-combustión de biomasa

Ahorros



Carbón:

Mezcla de residuos:

LHV

Cost

28 MJ/kg

174 USD/ton

16 MJ/kg

71 USD/ton



4,5 USD/GJ

vs

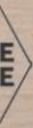
6,2 USD/GJ

150
kUSD/mes

4

PROYECCIONES

OPEN THE
FUTURE





Descortezadora y Caldera de biomasa

- Inversión: US \$92.7m
- Mejora de EBITDA: US\$21.2 m/año
16.9% IRR, con 5.2 años de retorno



Smurfit Kappa