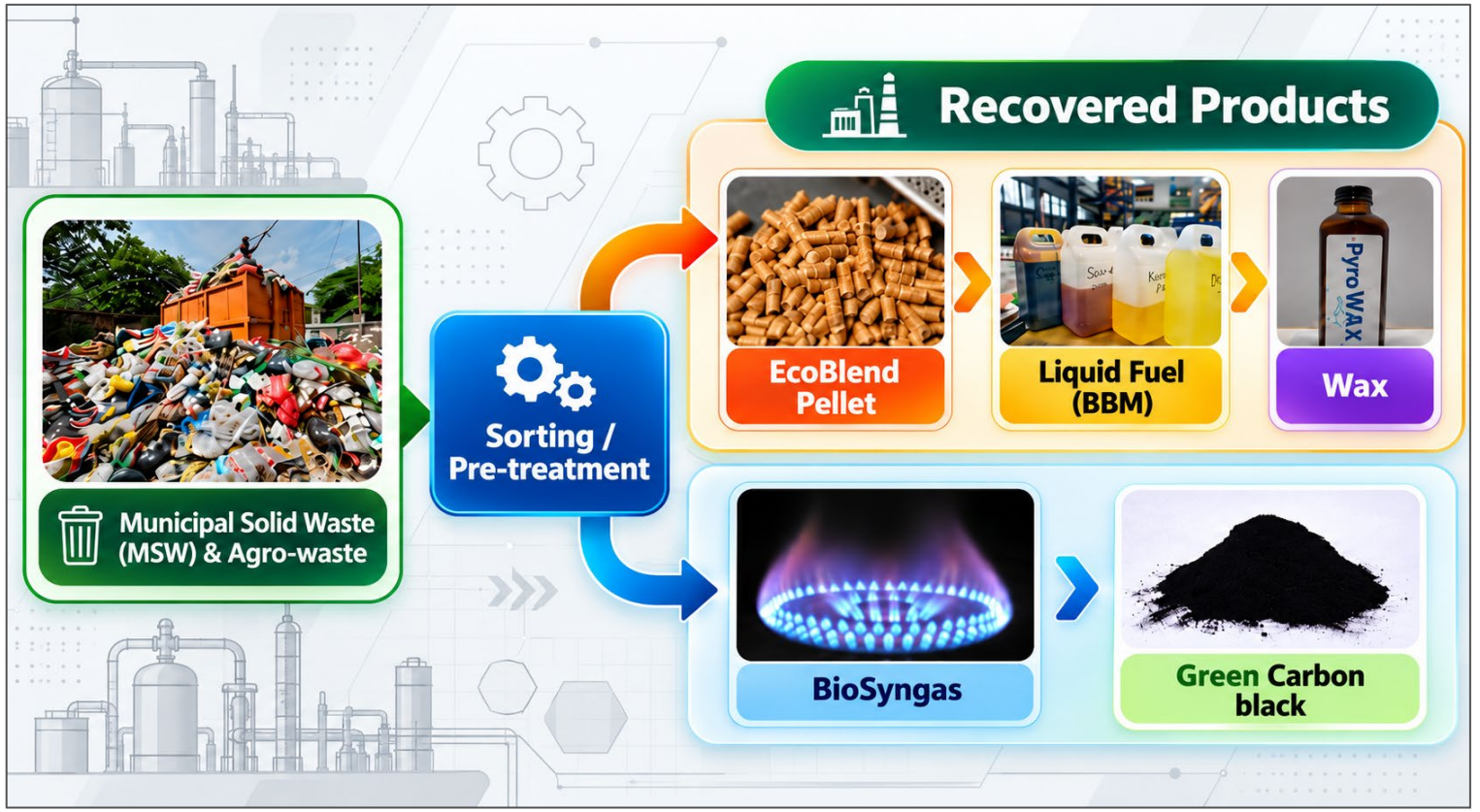
RD20 institution latest research on synthetic fuels :

Sustainable Production of Syngas and Liquid Fuels from Domestic Waste and Agro-Industrial Biomass Residues



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RD20

The 8th RD20 Conference
Accelerating Clean Energy Innovation:
From Africa to the World

Tuesday, October, 20th, 2026

BRIN ORGANIZATIONAL STRUCTURE

BRIN
NATIONAL RESEARCH AND INNOVATION AGENCY

STEERING BOARD

- **Chair:** Representative from the BPIP Steering Board
- **Vice Chair:** Coordinating Minister for Economic Affairs
- **Secretary:** Professional and/or academic representative in the field of research
- **Members:** 6 professional and/or academic representatives in the field of research

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BRIDA
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Data and Information Center

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Nuclear Technology Polytechnic

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- Research Organization for Aeronautics and Space
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- Research Organization for Nanotechnology and Materials
- Research Organization for Governance, Economy, and Community Welfare
- Research Organization for Electronics and Informatics

Research Center for Energy Conversion Technology

Global Agro-Industrial Residues in 2025: An Untapped Circular Resource

Agro-industrial residues are generated worldwide from crop and food processing, representing a major opportunity for a circular and low-carbon bioeconomy.

Americas

~ 550 million tonnes/year


Sugarcane bagasse


Maize stover


Soybean husks


Coffee residues

Europe

~ 350 million tonnes/year


Wheat straw


Rapeseed press cake


Beet pulp


Wood processing offcuts

Asia

~ 1,000 million tonnes/year


Rice husk and straw


Oil palm empty fruit bunches (EFB)


Coconut shells


Sugarcane bagasse

Africa

~ 250 million tonnes/year


Sugarcane bagasse


Cocoa pod husks


Coffee stalks

Australia & Oceania

< 30 million tonnes/year


Sugarcane bagasse


Wheat straw


Forestry processing residues



GLOBAL RESEARCH ESTIMATES

(published 2025; not a measured 2025 total)



Sugarcane bagasse

~ 549 million tonnes/year



Oil-palm processing by-products

~ 170 million tonnes/year

Key Message



Large volumes; uneven collection, moisture, seasonality and competing uses. **Feedstock-specific preprocessing** enables pellets, gasification/syngas and other value-added products.

Source: Organic Matter Database, ESSD (2025); IEA (2025).

Global Municipal Waste in 2025:
A Shared Challenge Across Continents

Municipal solid waste is a global issue — but quantities and management conditions vary widely.

Americas
~ 550 million tonnes/year

High per-capita generation and continued pressure on collection and disposal systems.



Europe
~ 350 million tonnes/year

Smaller total volume than Asia and Americas, but generally stronger waste separation, recycling and energy recovery systems.



Asia
~ 1,000 million tonnes/year

Largest waste generator, driven by large population and rapid urban growth.



Africa
~ 250 million tonnes/year

Lower total volume today, but one of the fastest-growing regions due to urbanization, population growth, and limited waste infrastructure.



Australia & Oceania
< 30 million tonnes/year

Smallest share globally, but faces challenges related to long transport distances, landfill dependence, and circular economy transition.





Global Municipal Solid Waste (MSW)

~2.2 billion tonnes/year in 2025



Key Message

Municipal solid waste is a **shared global challenge**. The problem is not only how much waste is generated, but also how well it is **sorted and managed** in each region.

Landfill Management Insight

Landfill management remains uneven worldwide. In many regions, landfill systems are still not well managed, with issues such as open dumping, limited leachate control, methane emissions, and weak monitoring.

Current Condition of Municipal Solid Waste and Existing Management Practices

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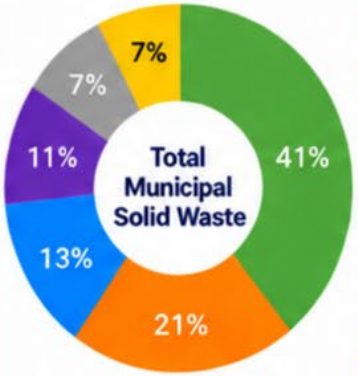


Waste in landfills



Waste in drainage systems

Composition of Municipal Solid Waste and Public Behavior



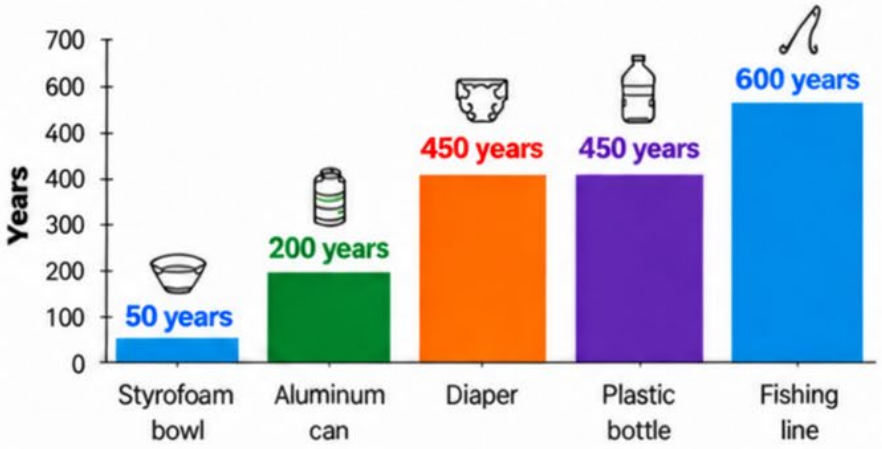
- 41% Food waste
- 21% Plastic waste
- 13% Wood & branches
- 11% Paper
- 7% Metals, textiles + leather + glass
- 7% Other wastes

Only around 40% of waste has been managed/treated.
Source: SIPSN (2022)

Food waste can be handled at the household level, for example through composting. However, low public awareness and weak sorting habits often cause it to be mixed with other waste and sent to landfills.

Persistence of Non-Organic Waste

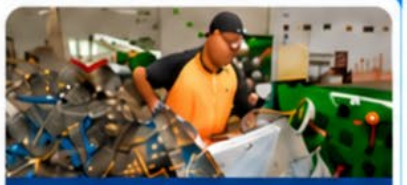
How long does it take to disappear naturally?



Source: NOAA / Woods Hole Sea Grant

Current Challenges and Waste-to-Energy Opportunity

- Uncontrolled open burning is **prohibited** under Indonesia's waste management regulation.
- Without proper treatment capacity, waste continues to accumulate.
- Several landfill sites have started converting residual waste into **Refuse Derived Fuel (RDF)**.
- RDF is used as a supplementary fuel (co-firing) in cement plants and power plants.
- Typical calorific value **> 3,500 kcal/kg.**
- However, its selling price remains low, around IDR 300–400 per kg (~US$0.02–0.03/kg), reducing investor interest.
- Pellet RDF may offer higher value, but product quality is often still inconsistent.



RDF waste processing



Pellet RDF

Recommended Waste Management Strategies

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Several efforts and recommendations proposed by BRIN for waste management

a) Kitchen waste (wet organic waste) should ideally be handled at the household or communal level, producing compost, maggots, and other useful products. Waste that still accumulates at temporary collection sites (TPS) and final disposal sites (TPA) can be utilized for biogas (BG) production and organic RDF as fuel.

b) In addition to being one source of RDF, processing clean sorted non-organic plastic waste for recycling is promising. However, this plastic has relatively low value, often priced at only around IDR 1,200 per kg (~US$0.07/kg). If the plastic is converted into fuel oil, its selling value can be up to 10 times higher.

c) Plastic oil from pyrolysis, synthetic gas, and tar waste from gasification can also be utilized to produce carbon black materials, which have the highest selling value—more than 30 times the price of clean plastic per kg—as well as low-cost hydrogen-rich gas.

d) Wood waste and branches (dry organic waste) can be separated and processed into pellets as a sustainable solid-fuel source, especially for high-efficiency combustion and gasification processes. Mixing pellets with plastic can also significantly increase the calorific value.

e) Metal waste and other valuable recyclable materials (paper, valuable plastics, etc.) can be fully absorbed by scrap collectors and recycling traders.

f) Residual waste that cannot be utilized may be incinerated so that accumulated waste can be reduced substantially.

Biomass Management Based on Its Classification

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Classification helps determine the most effective methods for handling, storage, and utilization of biomass.

1 Based on Moisture Content

Wet Biomass



- High moisture content
- **Examples:** fresh organic waste, sludge, food waste
- **Suitable for:** biodigesters, fermentation, initial drying

Dry Biomass



- Low moisture content
- **Examples:** husks, sawdust, dry straw
- **Suitable for:** combustion, gasification, pellets / briquettes

2 Based on Source

Biomass from Industrial & Plantation By-products



- **Origin:** agroindustry and agriculture
- **Examples:** empty fruit bunches, bagasse, shells, straw, wood waste
- **Potential:** fuel, raw materials, derivative products

Municipal Biomass Waste (Domestic)



- **Origin:** household activities and urban areas
- **Examples:** food waste, leaves, garden waste, market organic waste
- **Requires sorting** to improve utilization quality

Management Implications

Initial sorting › Moisture reduction when needed › Selection of appropriate conversion technology › Higher added value and sustainability

Note

Biomass can also be further classified based on shape, particle size, composition, and energy potential.

Dry Organic Waste Processing

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Processing Pure Dry Organic Waste or Dry Organic Waste Mixed with Plastic for EcoBlend Pellet Production

1 **Municipal waste from the TPST facility**









2 **Leaves, twigs, and plastic are separated and collected, then dried and shredded**



3 **Shredding is carried out to obtain a particle size < 20 mm**



4 **Pelletizing can be carried out using 100% leaves and twigs, or with added plastic waste to obtain a higher calorific value**







Produces EcoBlend pellets with higher calorific value as an environmentally friendly alternative fuel.

Pellet Calorific Value Analysis

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Comparison of Leaf-Plastic (LP), Twig-Plastic (TP) and Pure Biomass Pellets

No.	Pellet Sample (diameter 8 mm)	Code	Ptr	Calorific Value (kcal/kg)
1.	100% leaf waste + 40% plastic waste (multi layer)	LP	Ptr	5126
2.	100% leaf waste + 70% plastic waste (multi layer)	LP	Ptr	5784
3.	50% leaf waste + 50% plastic waste (single layer)	LP	Ptr	4558
4.	75% leaf waste + 25% plastic waste (single layer)	LP	Ptr	4683
5.	100% leaf waste (without plastic)	L	-	3672
6.	50% leaf waste + 50% plastic waste (single layer)	LP	-	5143
7.	75% twig waste + 25% plastic waste (single layer)	TP	Ptr	4762
8.	85% twig waste + 15% plastic waste (single layer)	TP	Ptr	4418
9.	100% twig waste (without plastic)	T	Ptr	4102
10.	100% twig waste (without plastic)	T	-	3684
11.	50% twig waste + 50% leaf waste (without plastic)	LT	-	3414

Code Explanation:

- L = Leaf waste (without plastic)
- T = Twig waste (without plastic)
- LT = Leaf + Twig waste (without plastic)
- LP = Leaf waste + Plastic (Leaf-Plastic)
- TP = Twig waste + Plastic (Twig-Plastic)

Ptr Explanation:

- Ptr = Pretreatment

Plastic type:

- ML = Multi layer plastic waste
- SL = Single layer plastic waste



EcoBlend Pellet (Leaf/Twig + Plastic)

Compared with coal



Coal

Proximate Analysis of Coal (wt%, db)		
Higher Heating Value (AR)	kcal/kg-f	4.687
Total Moisture Content (AR)	wt%	24,47
Fixed Carbon Content (AR)	wt%	28,92
Volatile Matter (AR)	wt%	35,5
Ash Content (AR)	wt%	11,11
Total	wt%	100

Proximate Analysis (wt%, db)

Parameter	Unit	TP	LP
Moisture	wt%	8.47	6.38
Volatile Matter	wt%	57.18	62.68
Fixed Carbon	wt%	18.22	15.81
Ash	wt%	6.13	15.14

Ultimate Analysis (wt%, daf)

Parameter	TP	LP
Carbon	46.16	45.43
Hydrogen	6.43	6.30
Nitrogen	0.53	1.47
Oxygen	40.57	31.40
Sulfur	0.26	0.26

Lignocellulosic Composition (wt%)

Component	TP	LP
Hemicellulose	9.99	6.29
Cellulose	9.54	3.50
Lignin	52.59	41.83

Note: The pellet referred to here is the TP (Twig-Plastic) type, which contains lower ash content but higher lignin content, indicating higher fixed carbon and potentially higher tar formation compared to coal.

Joint Research with Partners for EcoBlend-Pellet Testing





- High demand for pellet fuel, but limited suppliers.
- Pellet feedstock mainly comes from distant agricultural and forestry residues, leading to high transportation costs.



Video

Standard Specifications for Solid Recovered Fuel (SRF) for Power Generation

No	Testing parameters	Unit min./maks.	Category			Testing Method
			1	2	3	
1.	Organic Matter Content[a)]	% (min)	Organik ≥95	87,5≤Organik<95	80≤Organik<87,5	
2.	Sizing (Pellet)					
	- Diameter	mm (min)	6 ± 1,0	6 ± 1,0	6 ± 1,0	
		mm (max)	10 ± 1,0	12 ± 1,0	12 ± 1,0	
	- Length	mm	3,15≤P≤40	3,15≤P≤40	3,15≤P≤40	
3.	Density (Pellet)	g/cm^3 (min)	0,8	0,7	0,6	SNI 8021
4.	Moisture [b)]	%-wt	<15	<20	<25	SNI 01-1506
5.	Ash content [b)]	%-wt	<15	<20	<25	SNI 06-3730
6.	Volatile matter [b)]	%-wt (max)	65	70	75	SNI 06-3730
7.	Fixed Carbon [b)]	%-wt	>15	>10	>5	SNI 06-3730
8.	Net Calorific Value (NCV) [b)]	MJ/kg (mean [d)])	≥20	≥15	≥10	SNI 01-6235
9.	Total Sulphur [b)]	%-wt	≤1,5	≤1,5	≤1,5	
10.	Total Chlorine [b)]	%-wtt (mean [d)])	≤0,02	≤0,03	≤0,08	
11.	Total Mercury (Hg) [b)]	mg/MJ (median [d)])	≤0,02	≤0,03	≤0,08	
		mg/MJ, 80th percentile [d)]	≤0,04	≤0,06	≤0,16	
12.	Total Kalium (dalam K_2O)	%-wt (max)	5	10	15	
13.	Total Natrium (dalam K_2O)	%-wt (max)	2,5	2,5	2,5	
14.	Hardgrove Grindability Index (HGI)	HGI (min)	35	35	35	
15.	Ash Melting Point	^oC (min)	1200	1180	1180	

Remarks :

[a)] : Combustible Organic Content

[b)] : As received

[c)] : Combustible Organic Matter in Pellets for PC Boilers

[d)] : Sampling Quantity as Agreed Upon by the Producer and Consumer

Video





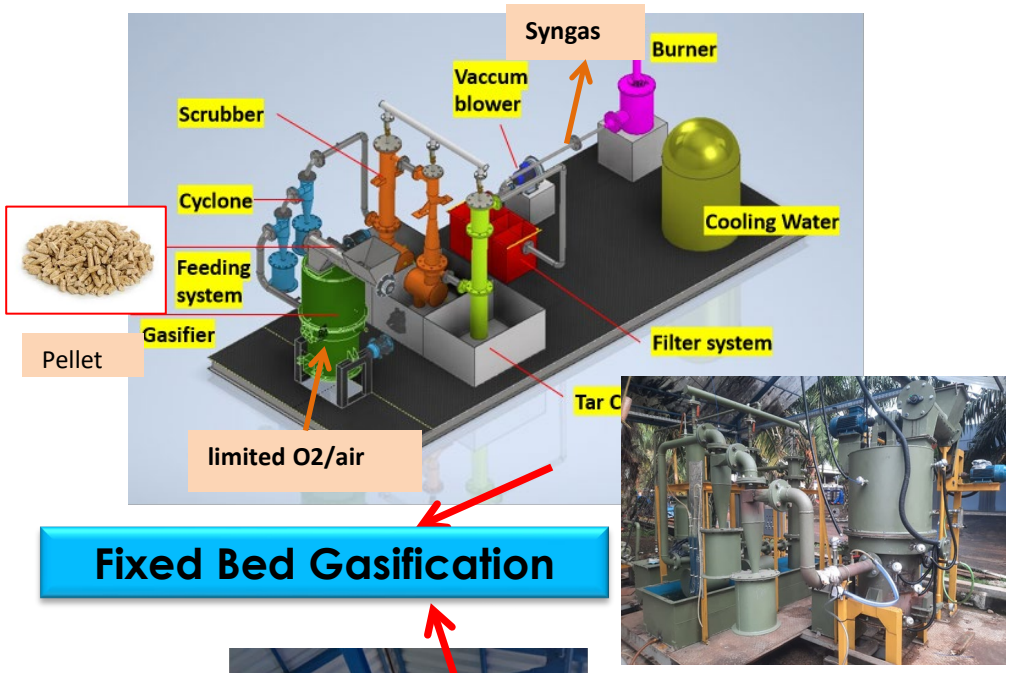
Video

- The burner requires a long flame to ensure stable combustion while minimizing agglomeration in the ash residue.
- Pellet blends containing ≥75% biomass and ≤25% plastic can be safely combusted without significant agglomeration.

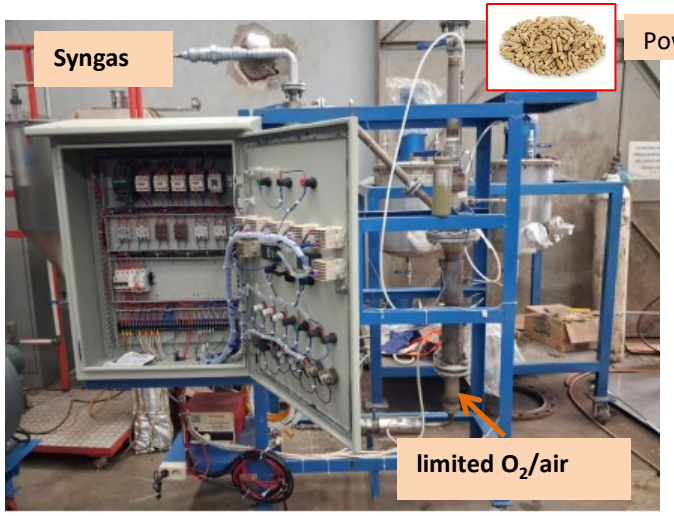


Video

Utilization of Pellets as Feedstock for Syngas Production



Fixed Bed Gasification

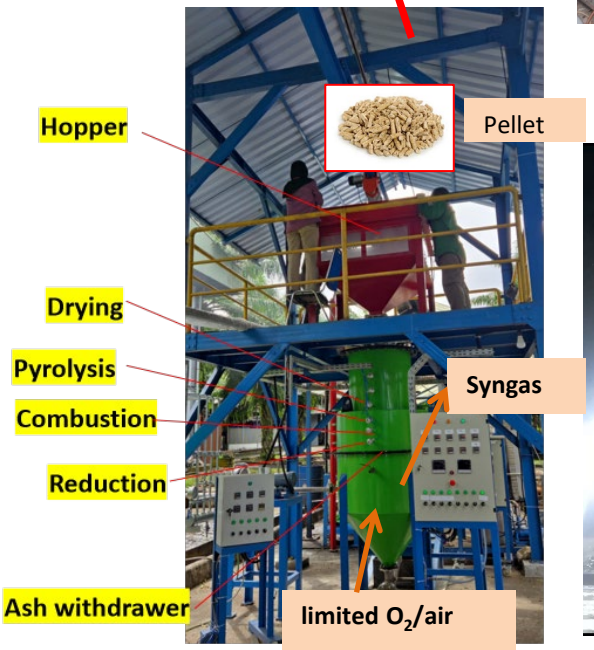


Fluidized Bed Gasification

- Gasification is a rapid thermochemical conversion process in which biomass (Eco-Pellet) is heated under limited oxygen/air supply to produce combustible gases (syngas), primarily H_2, CO, CH_4, and other gases.

Gasification Rx. : $CxHy + 1/2\ O_2$ ---> $CO + H_2 + CH_4 + CO_2$, emission ↓

In contrast to combustion, which produces $CO_2 + H_2O$, emission ↑





- Two gasification technologies have been developed Fixed-Bed Gasification (the fuel remains stationary while reacting) and Fluidized-Bed Gasification (the fuel particles are continuously fluidized and react while moving). Fluidized-bed gasification provides higher heating value and a higher H_2/CO ratio than fixed-bed gasification, offering greater potential as a syngas precursor for methanol (MeOH) and dimethyl ether (DME) production
- Gasification of Eco-Pellets at a feed rate of 65–100 kg/h can continuously produce combustible syngas for 2.5 hours, with a flame temperature of approximately 1,000°C (see Video)

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Example of BBG (syngas) utilization from gasification for aluminium ingot smelting



Plastic Waste Processing into Fuel Oil (Fuels)

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Plastic Pyrolysis

- **Pyrolysis** is a chemical decomposition process at high temperature without oxygen or with very limited oxygen supply.
- **Plastic pyrolysis** → produces plastic oil; the process is carried out using selected plastic waste.



PET (Polysthylene Terephthalate) ✗



HDPE (High Density Polyethylene) ✓



LDPE (Low Density Polyethylene) ✓



PS (Polystyrene) ✓



PC (Polycarbonate) ✗



PP (Polypropylene) ✓



PVC (Polyvinyl Chloride) ✗



1 Preparation of fuel and plastic waste

2 Heating Furnace



Video

3 Input and pyrolysis of sorted plastic waste



Video

Plastic Waste Pyrolysis Process Flow

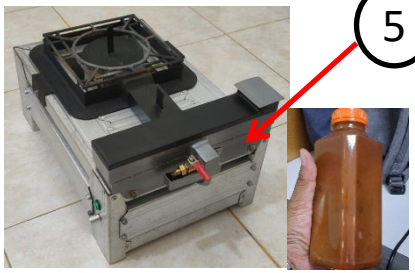
- **Pyrolysis can be conducted as a continuous or batch process** within the 200–400°C temperature range, yielding a mixture known as crude plastic oil
- Continuous operation also yields **wax**, which has the potential to be utilized as fuel.
- The quality of plastic-derived oil improves as the oxygen content decreases, making it more comparable to commercial-grade fuels. Polystyrene showed the most favorable elemental composition, containing C,H, O, N, S are 92.7;7.9;0;0; and 0 % wt. respectively

4 Plastic oil condensation

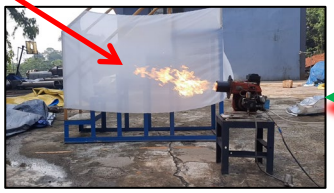


Video

5 Direct use



MinWax Stove



Fuel Oil

Video



6 Fraksinasi lanjutan menjadi diesel, bensin, dan Mitan

7 The other products from No. 3 (syngas + biochar) are reused internally and for soil improvement.

Batch (Non-Continuous) Plastic Pyrolysis Production System

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Partner: TPS3R Blitar



No Wax, because the plastic is reacted for a long period (4–5 hours) so that it is fully decomposed into plastic oil.

Capacity	10 kg	25 kg	50 kg	100 kg
Plastic Type: HDPE & LDPE				
Diesel	4–5 L	11–12 L	25–30 L	55–60 L
Kerosene (Diesel Oil)	1–2 L	7–8 L	7-10 L	15–20 L
Gasoline (Petrol)	1 L	2–3 L	4–5 L	10-12 L
Plastic Type: PP				
Diesel	5–6 L	11–12 L	25–30 L	55–60 L
Kerosene (Diesel Oil)	2–3 L	7–8 L	7-10 L	20-25 L
Gasoline (Petrol)	1 L	3–4 L	4–5 L	10-12 L



Operation of a batch-scale pyrolysis machine



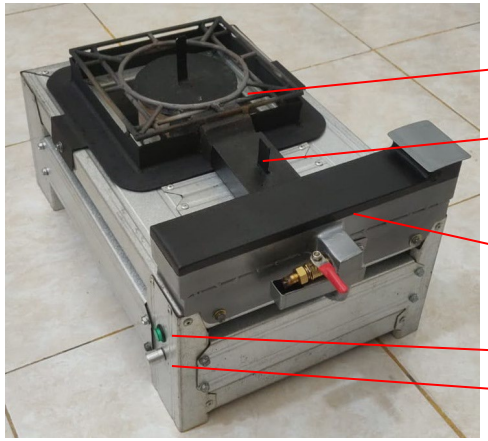
Testing of diesel fuel from plastic oil into the car

Innovation of an Oil or Wax-Fueled Stove (MinWax)

Partner : PT. Repyra Teknologi Hijau



Video



- This stove can be directly applied for household and small-scale industrial applications. The fuel supply is reliable because plastic waste is widely available and abundant.

Transforming Plastic and Organic Waste into Value-Added Materials



DOMESTIC WASTE



RDF Organic/Biomass

2





Syngas

Gasification

Tar

T- 500-800°C

O_2

Solid residue

1



RDF Plastic



Pyrolysis

T- 200-500°C

Furnace

Biomass

Pyrolysis gas



Mixer

Substituted

Substituted

Substituted

Oxygen

LPG

Fossil Oil

Carbon Black Furnace

Hydrogen

Green Carbon Black

T= 1000-1600°C

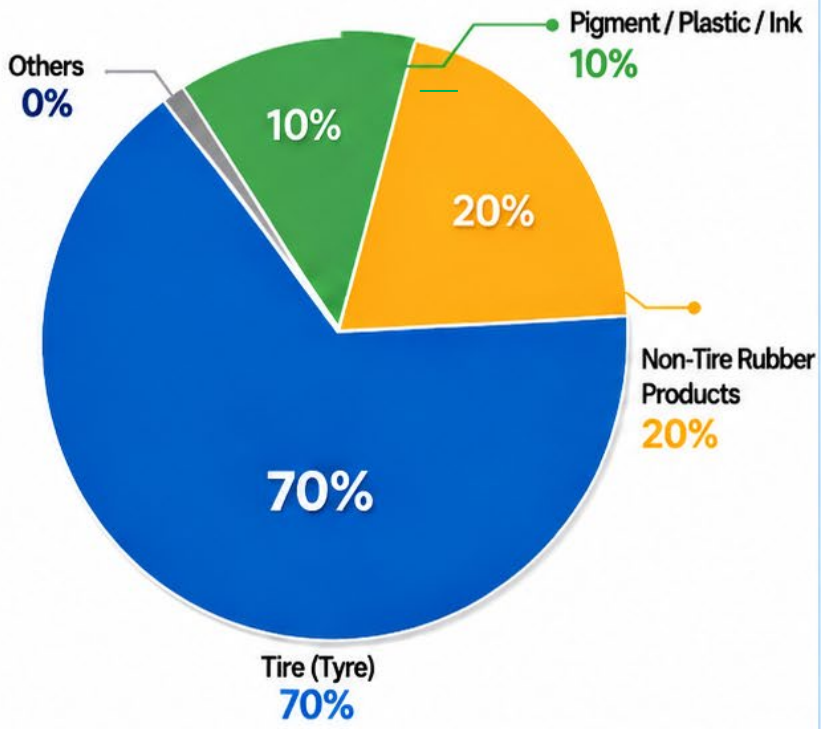
3



Carbon Black Market

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CARBON BLACK MARKET SHARE



MAIN APPLICATION SECTORS



Carbon black is a high-purity carbon material produced through controlled combustion at very high temperatures.

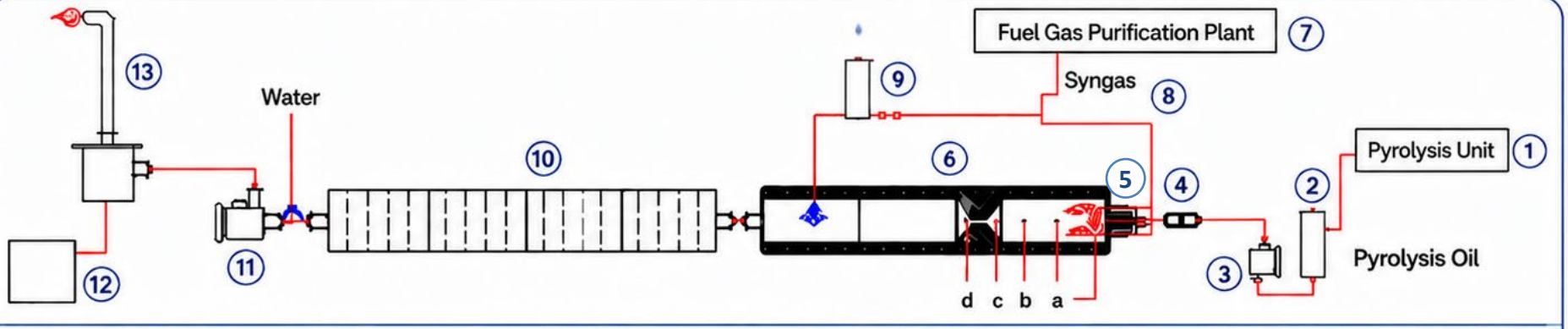
Major user industries
of carbon black: automotive and paints.

Current market price
of carbon black:
US$ 1.74/kg or approximately **IDR 30,000/kg.**

Prospect: Production of ***green carbon black*** from waste at a large scale has the potential to generate higher profits because the raw material (waste) is still much cheaper compared to the fossil-based raw materials currently used.

Overview of the Process in a Carbon Black Furnace

Simplified flow of carbon black production in a furnace system

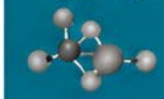


1. Pyrolysis oil from the pyrolysis unit is used as the initial feedstock.
2. The pyrolysis oil is vaporized in a vaporizer to change its phase to gas.
3. The oil is pumped to higher pressure before entering the reactor.
4. The vaporized oil and combustion air are mixed and introduced into the reactor.
5. After the reactor reaches the desired temperature, the feedstock is injected slowly with a very short residence time.
6. LPG or natural gas (syngas) is burned with oxygen to provide the heat required in the carbon black reactor.
7. LPG or natural gas (syngas) is supplied from the fuel gas purification plant.
8. The syngas is directed to the burner and combusted with oxygen.
9. The reaction can be stopped by injecting preheated steam (using LPG or syngas).
10. The carbon black is quickly drawn out to the carbon black collector and filtered through several layers of wire mesh.
11. A portion of the carbon black that passes the wire mesh is sprayed with water.
12. The water-wetted carbon black is collected in a column for further drying.
13. The gas rich in hydrogen is then released through the stack together with the carbon black.

MAIN FLOW

Preheated oil → Vaporizer → Carbon black reactor → Quench system → Collector → Blower → Gas purification unit → Stack

Carbon black formation reactions

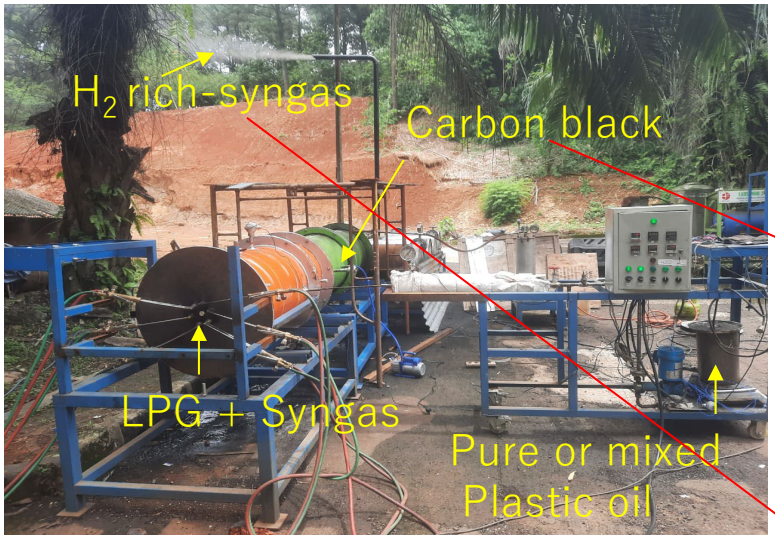




(11) $C_xH_y \rightarrow xC + \frac{1}{2}y\,H_2$

(12) $3C_xH_yO \rightarrow xC + 3yH_2 + xCO + xCO_2 + \text{other gases}$

Carbon Black Production System & Resulting Products





Carbon Black & H_2-Rich Syngas Production System



Video



Video

Carbon Black Production Process

Carbon Black Surface Area (SSA)

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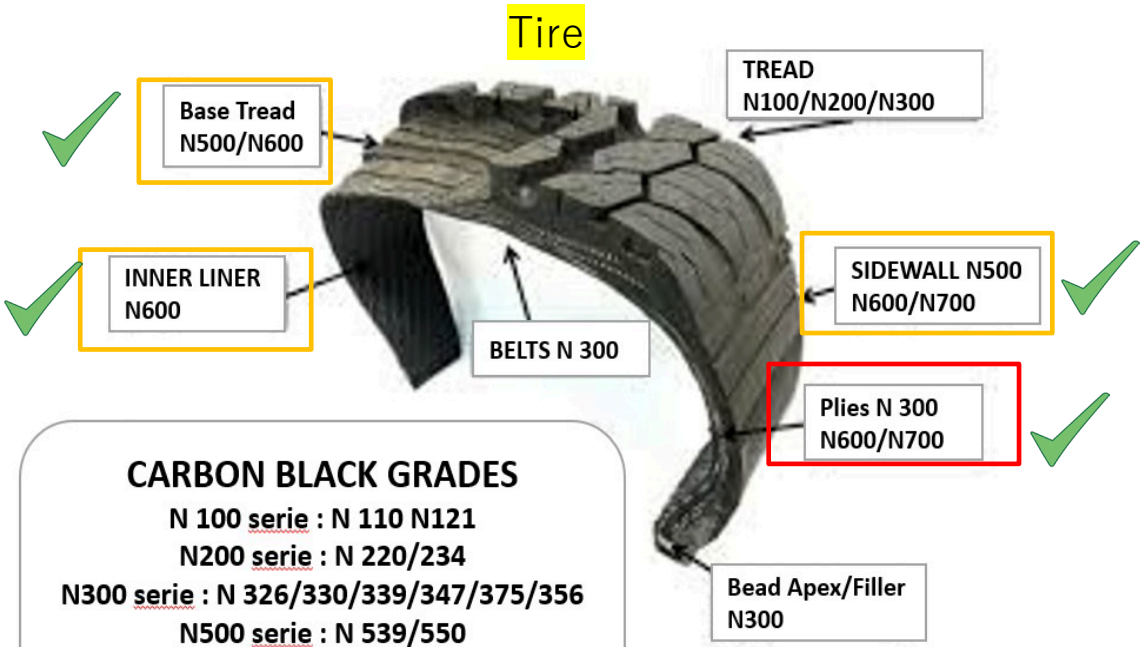
BET analysis

Grade	Specific Surface Area N_2 BET (m^2/g)
N110	140.0
N220	118.0
N326	83.2
N330	76.5
N330	80.0
N347	85.8
N550	39.7
N550	43.2
N660	39.4
N762	32.5
N762	24.0
N774	29.0
N880	12.3
N990	7.9
N990	10.3

Specific Surface Area (SSA) of Carbon black for rubber based on ASTM D1765 standard

BET summary

Slope =	56.128 1/g
Intercept =	5.164e+00 1/g
Correlation coefficient, r =	0.995379
C constant=	11.869
Surface Area =	56.818 m^2/g

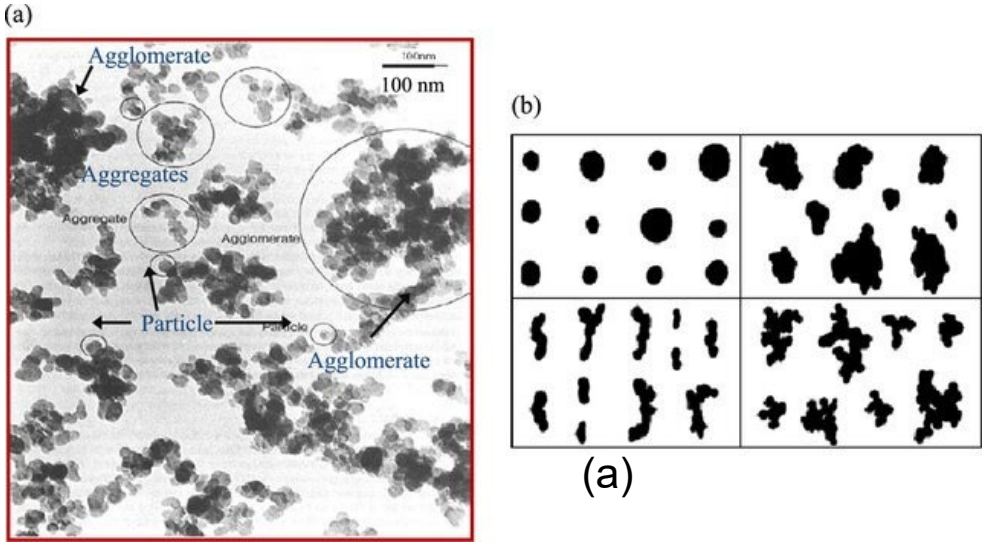


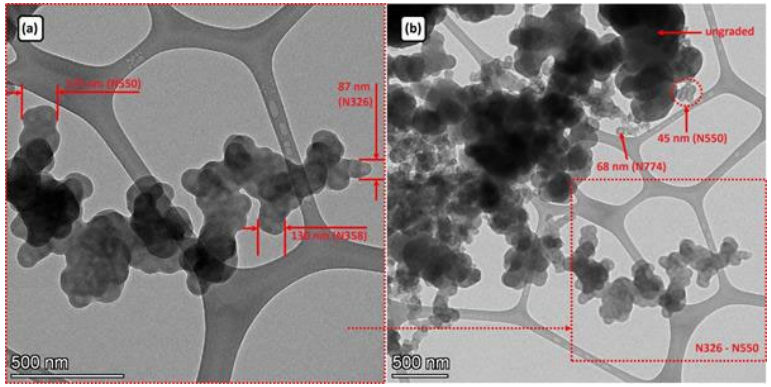
CARBON BLACK GRADES

N 100 serie : N 110 N121
N200 serie : N 220/234
N300 serie : N 326/330/339/347/375/356
N500 serie : N 539/550
N600 serie : N 650/664
N700 serie : N 774/765

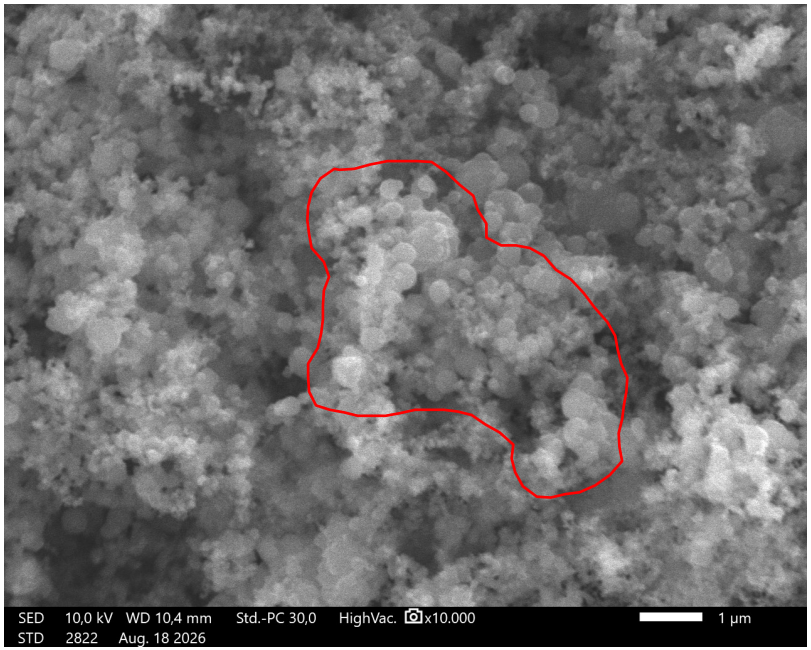
Carbon Black Microscopic size

TEM & SEM analysis





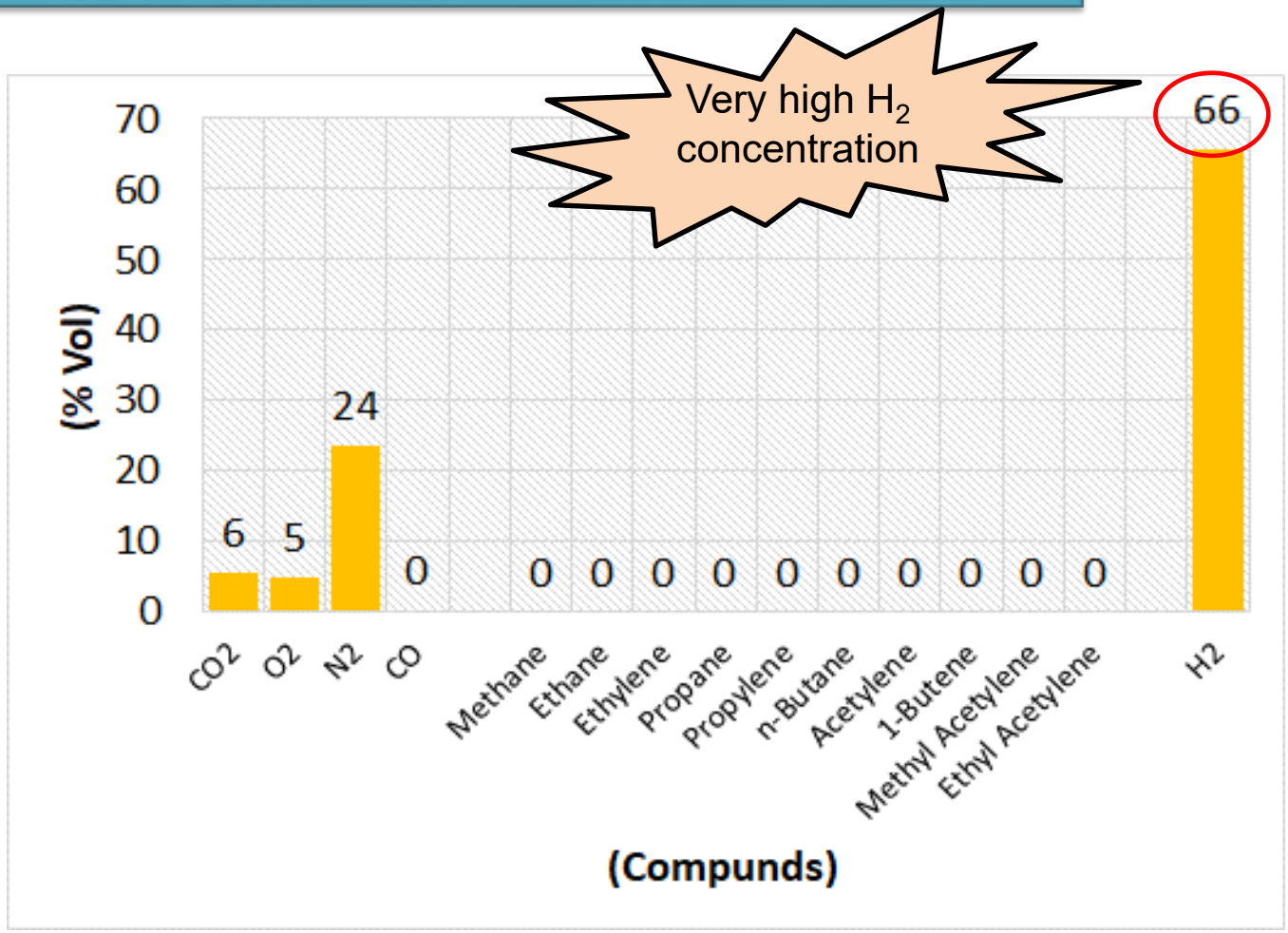
Comparison of Carbon Black Morphology Based on TEM Characterization: (a) Standard Reference Sample and (b) Sample Produced at 1300°C



Visualization of Carbon Black Forming Oval-Shaped Aggregates (Grape-Like Clusters) Observed by SEM at 10,000× Magnification

H_2-Rich Syngas Content as a By Product of Carbon Black Synthesis

GC analysis



Composition of H_2-Rich Syngas as a By Product of Carbon Black Synthesis, with the Potential to Produce Low-Cost Hydrogen for Electricity Generation and as a Fuel Substitute for Vehicles

BRIN BADAN RISET DAN INOVASI NASIONAL

Kemurnian Carbon Black

Ultimate analysis

The results of the C, H, N, and S composition analysis showed that the carbon (C) content of the produced carbon black was high, reaching 96%. This value exceeds the reference standard of 95% carbon content.

Parameter	Method	Result
Carbon,%wt	ASTM D5373	96,06
Hidrogen, %wt		1,04
Nitrogen, %wt		-
Sulfur, %wt		0,02
Oksigen,%wt *(sisa)*		2,88

Joint Research with Industry for Carbon Black Application in Tires

Partner: PT. IRC Inoac Indonesia

BRIN
NATIONAL RESEARCH AND INNOVATION AGENCY

PT. IRC INOAC INDONESIA
RESEARCH AND DEVELOPMENT COMPOUND
MATERIAL PROPERTIES TEST RESULT

DOC. NO. : 000/MP-E70/XI/2024 Date : 11-Nov-24

REQUIRED FOR : ☐ New Item ☐ Layout Inspection √ Others.

COMPOUND	ITEM	PART NAME	PART NUMBER	CUSTOMER	SPECIFICATION
EPDM 70	-	HOSE AIR CLEANER	-	GENERAL	CUSTOMER SPEC

MATERIAL		E-70 REG	E-70 BRIN
R	EPDM	●	●
F	FEF	●	●
	SRF	50	-
	SAMPLE CARBON BLACK (Ex. BRIN)	-	50
	CLAY	●	●
O	PARAFINIC OIL	●	●
V/BO	ACTIVATOR	●	●
V/SO	ACCELERATOR	●	●

Test Method		Standard	E-70 REG	E-70 BRIN	Adjustment
1. Mooney 125°C					
Vmin	MU	-	59,8	53,1	Reported
T5	min:s	-	5:58	6:48	Reported
2. Rheometer 160°C x 12'					
ml	dnm	-	0,60	0,57	Reported
mh	dnm	-	21:21	16:33	Reported
Ts2	min:s	-	3:08	2:36	Reported
T10	min:s	-	2:42	2:23	Reported
T90	min:s	-	8:28	6:28	Reported
3. Basic properties					
Hardness	Type-A	73 ($^{+5}$ / $_{-5}$)	71	70	OK
Tensile strength	Mpa	10.78 min	12,8	9.8	NG
Elongation	%	270 min	370	424	OK
TRB	Kgf/cm	Report	30	32	Reported
4. Aging resistance 100°C x 72h					
Change in hardness	Point	0 ~+8	+5	+3	OK
Change rate of tensile strength	%	-25 min	-2	-1	OK
Change rate of elongation	%	-35 min	-35	-22	OK
5. Compression set resistance 100°C x 24h					
	%	50 max	38	31	OK
6. Oil IRM 903 resistance 100°C x 72h					
	%	+60~+110	+98	+98	OK
7. Ozone 50 pphm, 40°C					
Static : 20 % elongation x 72h	-	no crack	no crack	no crack	OK
8. Volume Resistivity					
	Ω.cm	1 x 10⁸min	2,3 x 10^{12}	1.6 x 10^{12}	OK
9. Paint film staining					
	-	non staining	non staining	non staining	OK

Remark :

Dari hasil pengujian diatas, dapat disimpulkan bahwa :
- Sample Carbon Ex. BRIN secara Rheology tidak ada perbedaan yang signifikan jika dibandingkan dengan Carbon SRF
- Secara Material Properties sample Carbon Ex. BRIN memiliki hasil Tensile Strength yang lebih rendah jika dibandingkan dengan Carbon SRF.
- Secara keseluruhan Sample Carbon Ex. BRIN bisa menggatikan SRF dengan adjusment recipe.

Prepared	Checked	Acknowledged
A. Bastari	Wahyu Aji	Yayut W
RDC Staff	RDC Asst.Manager	R&D Manager





Activities & Collaboration

- A site visit and initiation of collaboration were conducted with PT. IRC Inoac Indonesia for the application of carbon black in tire production.
- Collaboration focused on material testing and the potential utilization of waste-based carbon black.

Material/Test Results

- Based on rheological tests, the BRIN carbon black sample shows significant differences compared to commercial carbon black (SRF).
- The BRIN carbon black sample indicates a lower overall level of impurities compared to commercial carbon black (SRF).
- Overall, the BRIN carbon black shows potential to replace the use of commercial carbon black (SRF) with appropriate recipe adjustment.

The quality of carbon black derived from waste has the potential to replace the use of commercial carbon black.

Research and Development of PCM Carbon Black for Heat-Resistant Jackets and Vests

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1 What is PCM?

PCM (Phase Change Material) is a material capable of absorbing, storing, and releasing thermal energy through a change of phase.

2 Background

- The use of jackets/vests helps to keep field workers cool in high-temperature environments.
- Peak ambient temperatures can reach 43–44°C, increasing the risk of heat stroke.
- A more practical and preventive solution is needed compared to traditional cooling methods.

3 Main Results

- PCM materials are generally in the form of ice gel and VCO.
- The addition of 0.5% carbon black can reduce the surface temperature of the fabric by around 3°C.
- The use of 8–10% carbon black can maintain a normal skin temperature for 6–7 hours.
- Carbon black materials have the potential to improve cooling performance more economically.

4 Product Output

Heat-resistant jacket



Generation 1

Generation 1 for outdoor heat control.

Heat-resistant vest with PCM pack



Generation 2

Generation 2 for direct heat exposure segments.

Conclusion: Carbon black-based PCM has the potential to be a more effective and economical solution for heat protection for field workers.

- Reduces the risk of heat stroke
- Improves worker comfort & safety
- More effective & economical

Research and Development

Process of Converting Furnace Carbon Black into Toner Ink

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NATIONAL RESEARCH AND AND INNOVATION AGENCY

1 Carbon Black Production

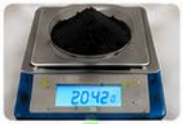




Furnace black

Furnace carbon black is produced as the main raw material for toner.

2 Demineralization



Weigh 20 g CB



Add 200 mL HCl
Heat at 60°C, 1 hour, 400 rpm



Wash with deionized water and filter



Adjust pH to 6–8



Repeat the same treatment with 5M NaOH



Oven at 105°C, 24 hours

3 Toner Powder Production



Dry CB is milled using a mixer mill



Sieve using 100 mesh



Mix according to formulation



Mixing at 80.5°C, 300 rpm, for 60 minutes



Wash with deionized water



Filter using Whatman 41 filter paper



Oven until completely dry for 24 hours

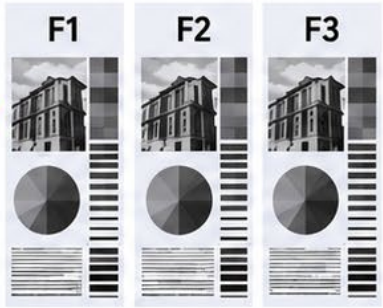


Toner ready to use

4 Toner Printing Test



Printer: LaserJet HP P1102



- The developed toner has been successfully used for printing.
- Further quality improvements are ongoing to achieve performance comparable to commercial toner products.

Furnace carbon black can be processed into toner ink **ready for printing**, with further quality improvements to achieve performance comparable with commercial toner products.

BEFORE



AFTER – BRIN SOLUTION



Our Shared Vision

Uncontrolled waste accumulation, high pollution risks

Integrated and environmentally friendly waste management

Clean environment, prosperous community

From Problems to Hope

When science, innovation, and collective awareness come together,
waste is no longer a burden, but a valuable resource for the Earth and human life.
Together, we create a sustainable environment
for today's generation and a more meaningful future.

Let us continue moving forward, caring for the Earth, and creating benefits.
Because the Earth is our shared responsibility, and the future belongs to all of us.

Thank You

Research Center Energy Conversion Technology
Research Organization for Energy and Manufacture
National Research and Innovation Agency (BRIN)

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