UNIDO'S innovative approach for utilization of plastic waste from the Indian paper industry as resource under circular economy framework

Dr Rakesh Kumar Jain; Shraddha Srikant; Dr Abhishek Sharma and Dr Raj Kumar

Efficient Collection& Processing of Recovered paper for Achieving Improved Yield and Quality

30th -31th October 2023

Kings Villa , Muzaffarnagar, UP, India

About UNIDO

- **United Nations Industrial Development Organization (UNIDO)** is the specialized agency of the United Nations that promotes industrial development for poverty reduction, inclusive globalization and environmental sustainability.
- 50+ years of technical cooperation in India, particularly in support of MSME development

Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

INDIAN PULP & PAPER INDUS

KEY INDICATORS

1970 ▶ ▶ ▶ **2021** **TODA**

0.2 MTPA
MILLION TONNES
PER ANNUM

22 MTPA
MILLION TONNES
PER ANNUM

THE INDIAN PAPER
PRODUCES DIFF

RAW MATERIALS:

- WOOD
- BAMBOO

MAJOR PRODUCT:
WRITING/PRINTING PAPER

RAW MATERIALS:

73% RECYCLED PAPER
18% WOOD
9% AGRO-RESIDUE FIBRE

TYPES/GRADES O
INCLUDIN

60% PACKAGIN
35% WRITING /
5% NEWSPRI

INDIA IS AMONG THE WORLD'S FASTEST GROWING PULP AND PAPER

GLOBAL RANKING

4%
SHARE OF GLOBAL PRODUCTION

MARKET GROWTH
6-7% ANNUAL RATE

DIRECT JO
~650,0

INCREASING
DEMAND FOR PAPER-BASED P

COMPETITIVENESS AND SUSTAINABILITY
enhance the competitiveness and sustainability of the pu
industry, there is a need to work towards increased producti
cleaner production processes and environmental managem

UNIDO's intervention and technical support toward Paper Plastic Waste Management - Circular Economy approach

- UNIDO's Diagnostic assessment under paper project, spotlighted the issue of generation of high quantities of plastic in Indian RCF based paper mill and challenges in its disposal.

- Highlighting importance of circular economy, the assessment spotlighted importance of sorting in the incoming raw material to remove of plastic at source, exploring methods for the utilization such plastic waste segregated as input raw material to the allied industries

- Circular economy approach through thermo-chemical treatment provide opportunity to convert waste in to resource for rubber industry& generation of diesel grade oil adopting bio-refinery process,thus helping to reduce carbon footprints

Plastic waste generated in Indian Paper Industry & Challenges associated with disposal

Indian paper industry generates more than 0.5 million tons of plastic waste from the recycled waste paper based industry (3% of the production), thus facing challenges in its disposal owing to the regulations and cost involved

Conventional approach and commonly used method include co-processing in the cement production. Such options not considered feasible from economic and logistical point of view

Plastics disposal techniques

Energy Recovery

A. Incineration → Direct burning of waste →

- High capital cost
- Barrier to circular economy
- Air pollution
- High land area required

- co-processing in cement plants has been adopted as an option to fulfil the regulatory requirement, this remains as a challenge in respect to techno economic consideration besides loss of valuable resourc

B. Thermochemical conversion →

Pyrolysis

- Low capital cost
- Sustainable and circular
- Low pollution
- Less land area required

- A promising emerging thermos chemical treatment technology that breaks plastics down into their raw materials.

Resource Recovery
Energy Recovery

UNIDO's Circular economy approach towards paper plastic waste management- Cooperation with IRMRA and Manipal University and IARPMA

- Disposal represents loss of valuable resources with potential for alternative value-adding applications in environment friendly way and converted into resources through the thermo-chemical conversion process.
- UNIDO cooperation with MUJ, IRMRA, and IARPMA working on the development of a potential solution for the utilization of plastic wastes from RCF-based paper mills adopting a circular economy approach
- Current approach includes thermo-chemically treatment and conversation into useful products having significant chemical and fuel value.
- Biochar utilized for various applications such as rubber industry. Gases used for sustaining the heating requirement of the process.

0 environment-friendly

Feed Material (Paper Waste Plastic) Characterization

PURE PLASTIC (%)	MIX (PLASTIC & ALUMINIU (%)	ALUMINIUM (%)	Cellulose (%)	Cloths (%)	OTHERS (%)
49	**42**	5	1	**1**	2





Thermo-chemical conversion process

Syn gas for direct heating

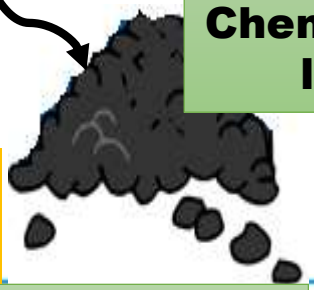
Syn Gas

Plastic Waste

Biofuel and Chemical

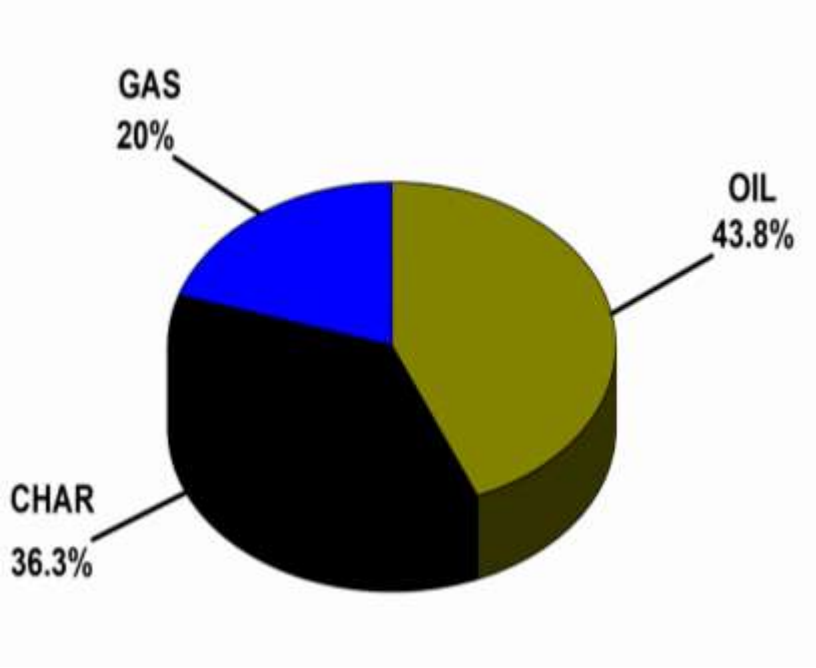
Waste to Energy
Sustainable Process
(Decentralized)

Reactor(Thermo-chemical conversion unit)

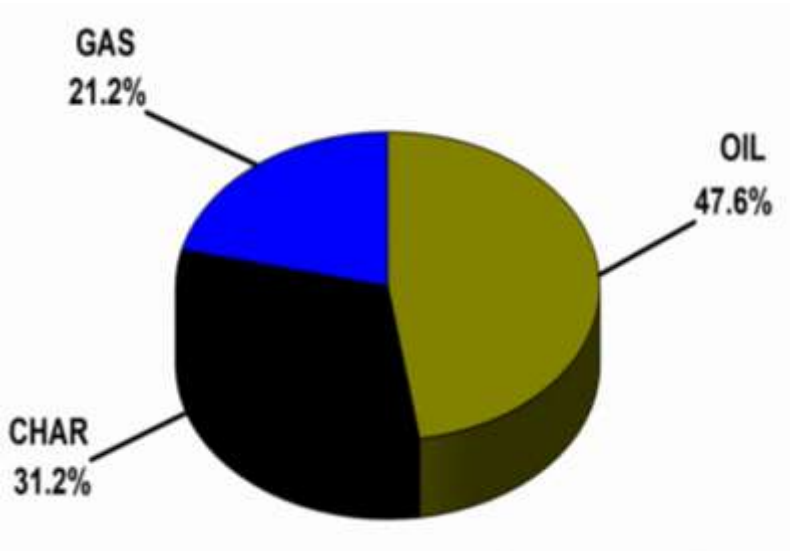


Bio Char

PRODUCT YIELD



PRODUCT YIELD @ 500 ℃



PRODUCT YIELD @ 600 ℃

PRODUCT PHYSICAL STATE

BIOCRUDE

BIO-OIL PHASE

AQUEOUS PHASE

BIOCHAR

CHAR

0.5 µm after sieving

Aluminum Foils

BIO-OIL CHARECTERIZATION

SI.NO	Test Parameters	Unit	Limit (IS 1460:2017)	Results	Test Method
1	Gross Calorific Value (GCV)	K.cal/Kg	11000	7141.4	IS 1448 (Part 7)
2	Total Acid Number (TAN)	Mg of KOH/g	Max 0.20	28.44	IS 1448 (Part 2)
3	Flash Point	℃	Min. 15	<25	IS 1448 (Part 21)
4	Pour Point	℃	Max.15	-6.9	IS 1448 (Part 10)
5	Kinematic Viscosity	cSt.	2.0 to 4.5	5.09	IS 1448 (Part 25)
6	Total organic Carbon	%	Not specified	57.82	JL/CS/STP/89

Product Quality : BioChar and its potential for rubber industry

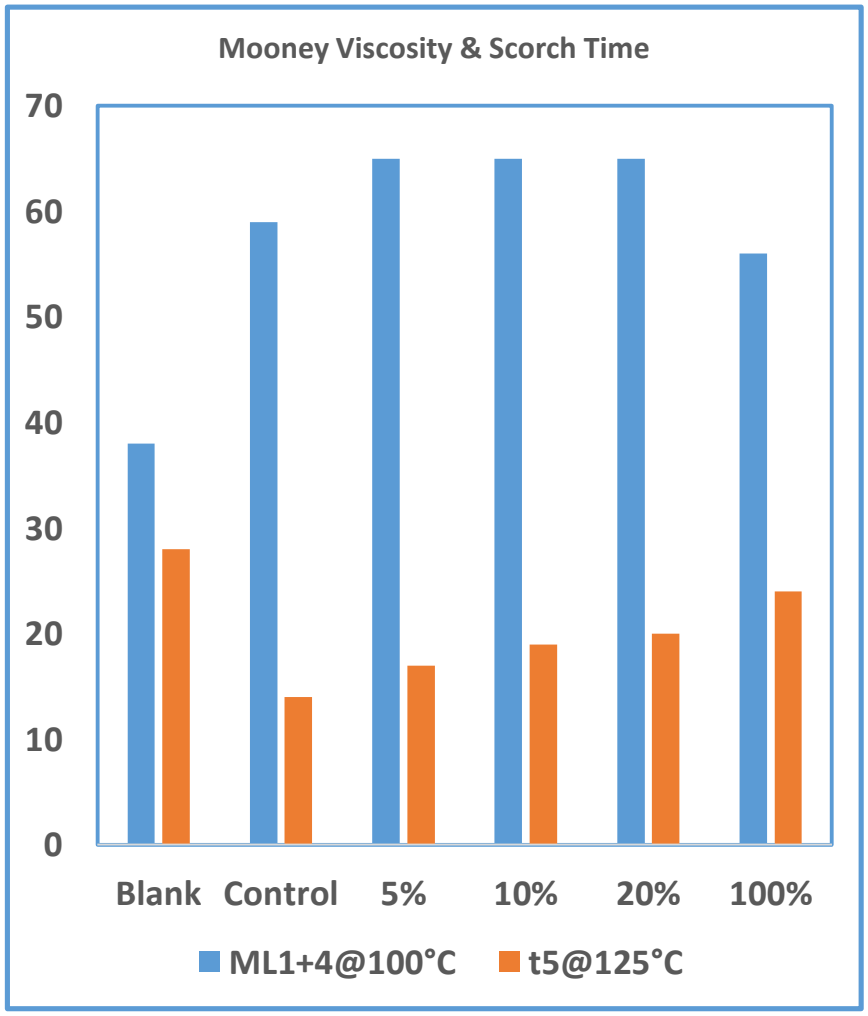
Compounds	LOD @ 110 ^{0}C (%)	Ash @ 800 ^{0}C (%)	Volatile Matter (%)	Fix Carbon (%)	Carbon (%)	Hydrogen (%)	Nitrogen (%)	Sulphur (%)	Oxygen %	Calorific Value (Kcal/kg)
Paper-plastic char	0.73	30.31	52.16	16.8	71.2	2.17	0.99	0.07	25.56	4850

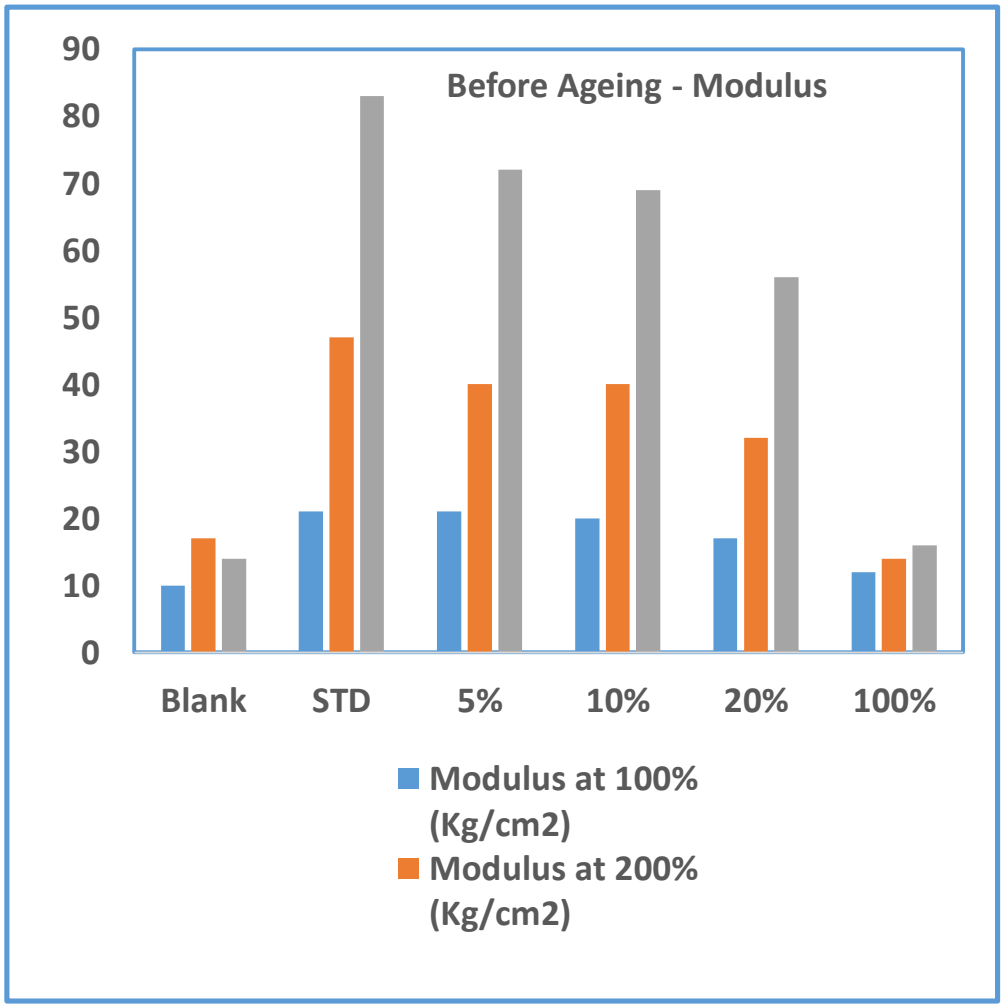
- Char contains good amount of carbon with almost 50% combustibles.
- Char having calorific value of 20-22 MJ/kg.
- Chlorine was present in the char possibly due to some hard plastics (PVC) in the feed, whereas the reason of calcium present in the char was mainly due to paper. Primary analysis showed no toxic metals present in the char
- Char contains no toxic metals like Cd, Pb, Cr and Ni.

Formulation of Rubber compounding - partial replacement of Carbon black with bio char

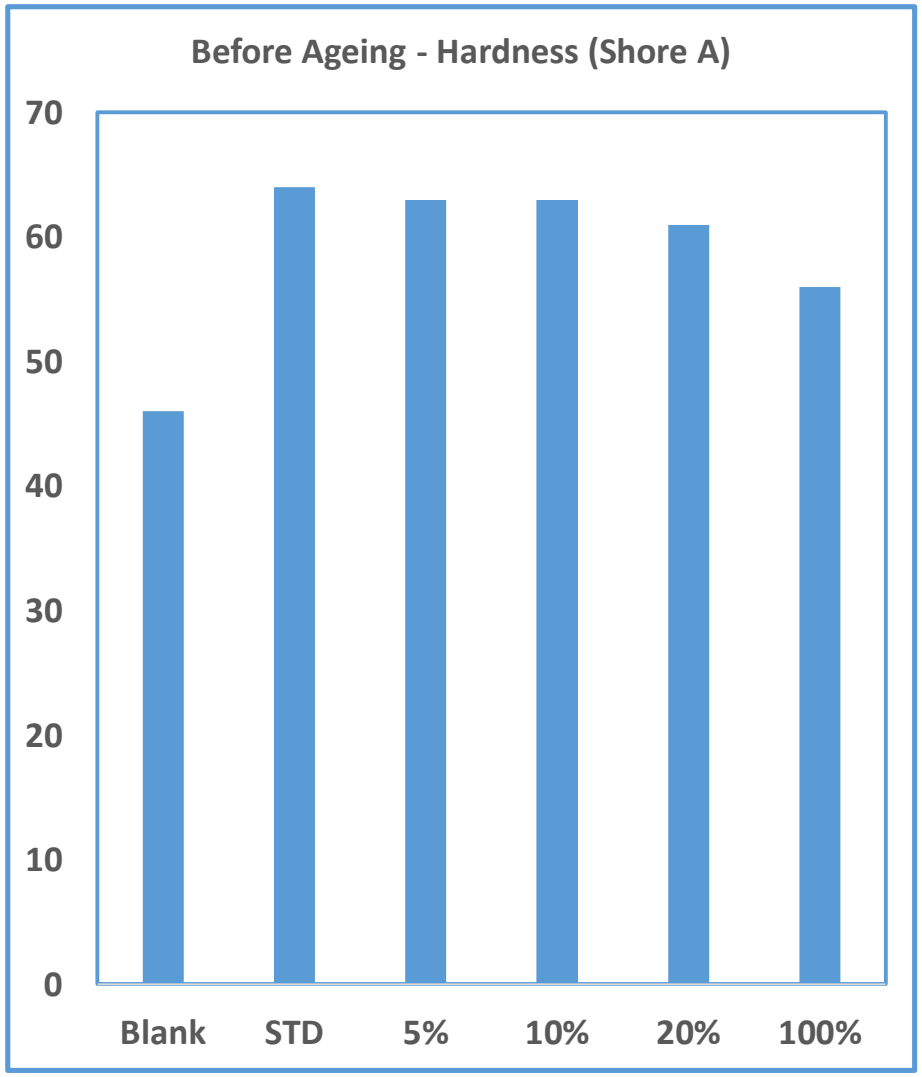
Compounding Ingredient	Blank	Control	5%	10%	20%	100%
SBR1502	100	100	100	100	100	100
Zinc Oxide (ZnO)	3	3	3	3	3	3
Stearic Acid (SA)	2	2	2	2	2	2
Carbon Black- SRF (N774)	0	50	47.5	45	40	0
Biochar	0	0	2.5	5	10	50
Accelerator - CBS	1.5	1.5	1.5	1.5	1.5	1.5
Accelerator - TBBS	1.5	0.5	0.5	0.5	0.5	0.5
Curing agent - Sulphur	1.5	1.5	1.5	1.5	1.5	1.5

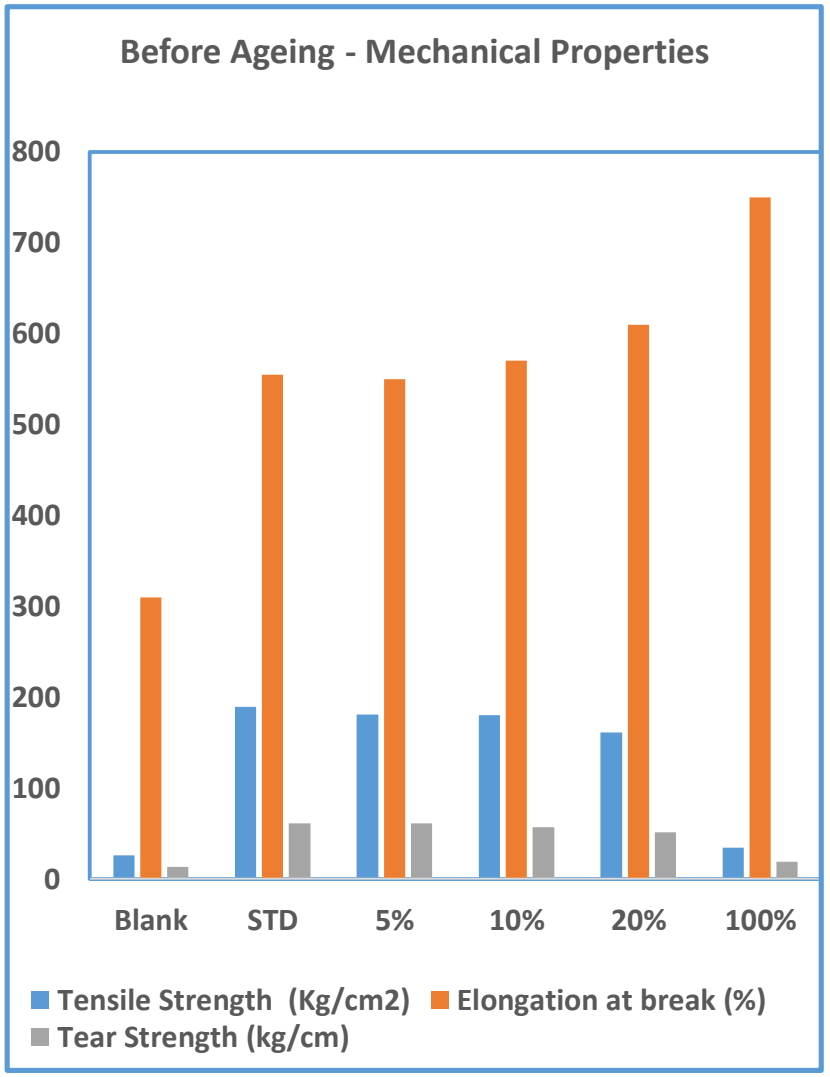
Properties on cured rubber compound sample





Properties on cured rubber compound sample





Potential for replacement of carbon black with Biochar in rubber compounding

- Bio Char filled compound shows improvement in scorch time, as also seen in Rheometric test, indicating improved storage life and processing safety.
- With conventional filler replacement, there is slight increase in Mooney viscosity.
- Replacement of carbon black up to 10-15% with bio char, indicated no variation in most of the important properties like Hardness at Shore, Modulus, Tensile strength and tear, Compression Strength rather there was slight increase in Elongation at break , cut growth resistance with slight drop in abrasion resistance ability requiring some surface treatment for improvement.
- Thus bio char contained good potential to be used as filler material in rubber industries as partial replacement of carbon black.

Conclusion

- Thermo chemical treatment hold great potential for the recovery of value added products like oil, bio char and syn gases,
- Partial replacement of carbon black with bio-char(10-15%), find application in non critical variety of industrial rubber compounds such as such as Conveyor belts, Hoses, Shoe soles, various Molded products like O rings, Gaskets, Sheets, Rubber mats. Conveyor belts, Hoses, heels, Molded products like O rings, Gaskets, Sheets, Rubber mats.
- Around 0.15 million tons per annum of biochar from paper plastic waste- potential to replace 0.0225 million tons/ annum of carbon black
- Reduced dependence of fossil fuel and carbon footprints, 1000 million MJ of energy savings (equivalent 0.025 million tons fuel oil with reduction of 0.075 million of CO_2 /annum, potential for resource conservation and GHG emissions

Thank You

Future From Waste….