

Environmental Waste International CTO Presents Latest Technology at rCB Conference in Amsterdam



EWI Chief Technology Officer, Steve Kantor, presented EWI's Microwave Hybrid Process at the Recovered Carbon Black Conference in Amsterdam, November 23, 2021.

The Microwave Hybrid full presentation is attached to this document.

Also, exciting news from Bridgestone and Michelin regarding their requirements for rCB. Click to see their joint website www.rcbrubber.com



MICROWAVE HYBRID PROCESSING

An Overview from Environmental Waste International

Steve Kantor

Chief Technology Officer

Recovered Carbon Black Conference, November 2021

An Introduction to Microwave Hybrid Processing



Microwave rubber processing has existed since 1990,

and in the time since has seen some significant evolution.

In 2010, Environmental Waste International (EWI) built an operating pilot scale facility in Sault Ste. Marie, ON, Canada which operated from 2011 to 2016.

OUR RESEARCH LED TO THE HYBRID PROCESSING APPROACH.

EWI's Microwave Background

EWI already had a background in developing microwave systems.
Previous systems were designed for:



**Medical waste
treatment**



**Wastewater
sterilization**



**Wood
drying**



**Food
dehydrating**

The knowledge developed in these projects allowed EWI to develop new processes for used tires at the pilot plant.

Testing at the Pilot Plant

The focus of testing that occurred at the pilot plant was to develop EWI's patented microwave reverse polymerization process for used tires.

The goal was to create a system capable of operating continuously and efficiently, producing high-quality products.

TESTS WERE SPLIT INTO TWO CATEGORIES:

01 Types of materials processed

- Shred with and without metal
- Various sizes of shred
- Crumb rubber
- Whole tires

02 Methods of heating materials processed

- Microwave only
- Direct preheating of feed material
- Indirect preheating of material and process tunnel
- Indirect post heating of recovered carbon
- Hybrid direct microwave and indirect heating of the process

Testing Results

EWI's testing resulted in three notable benefits of the hybrid microwave process.



Increased microwave absorption



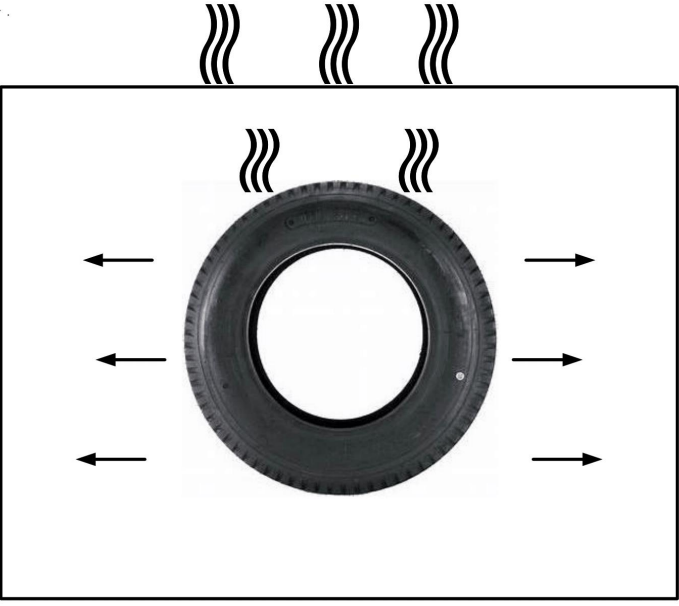
Improved product quality



Increased efficiency of process

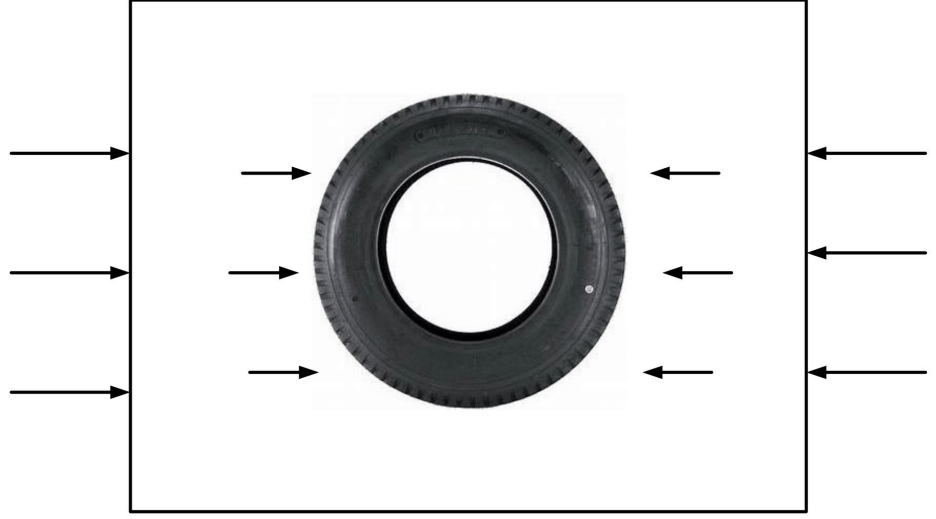
Microwave versus Conventional External Heating

It is important to clarify the difference between microwave versus external heating.



MICROWAVE DIRECT HEATING

Microwave heats the material, and the resulting energy heats the process vessel.



EXTERNAL INDIRECT HEATING BY SYNGAS

External methods heat the vessel, and the energy gets transferred to the material.

Benefits of Microwave Processing

Microwave-only systems rely on the energy released from the breakdown of the rubber to heat the processing tunnel to operating temperature.

- Heating the rubber becomes a very efficient process as a result, but microwaves alone are inefficient at heating the entire processing tunnel.

Benefits of External Indirect Heating

External indirect heating is highly beneficial for heating the process chamber in a consistent manner

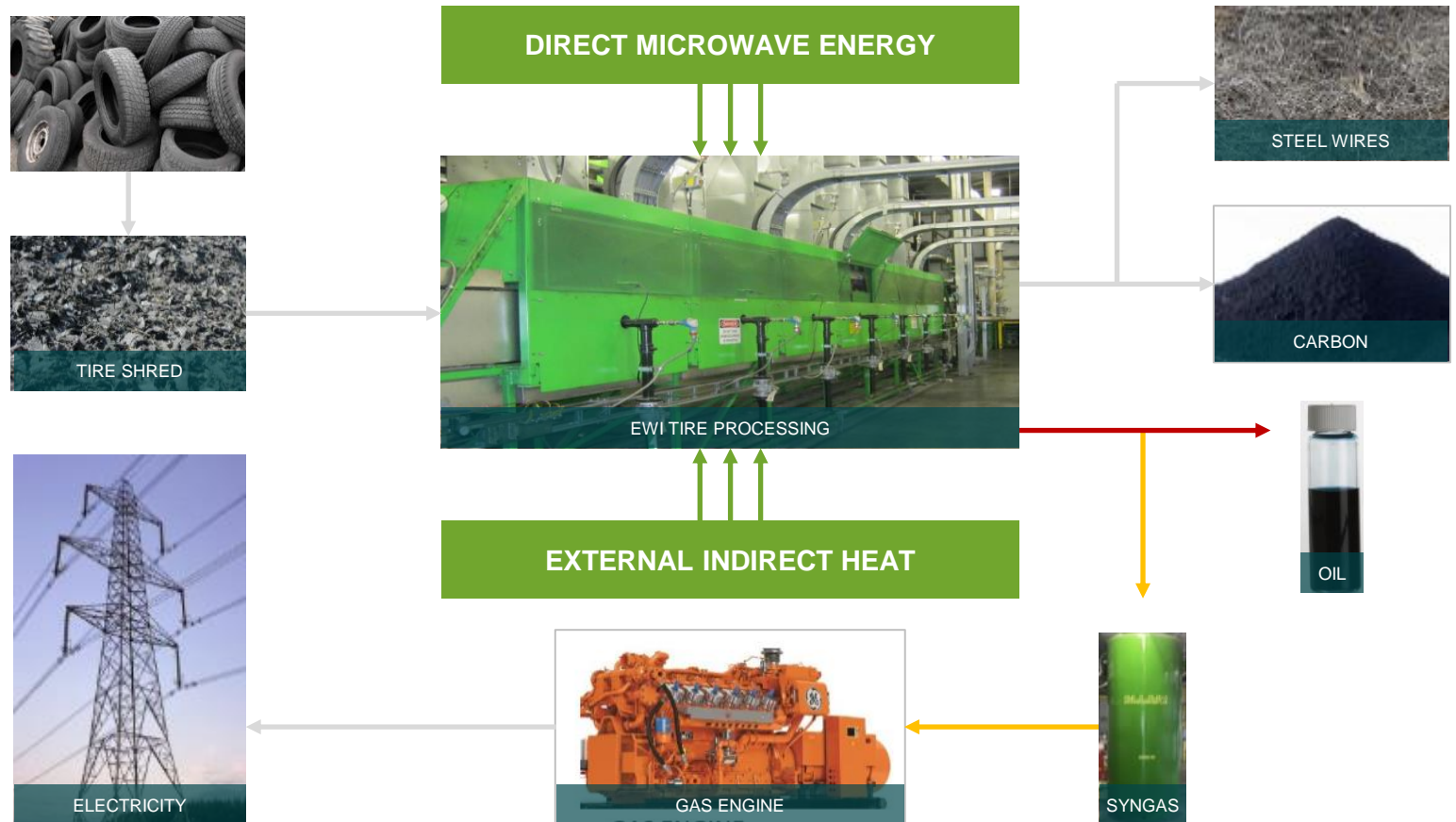
though heating the rubber inside the processing tunnel itself becomes an inefficient process.

The Microwave Hybrid Process

Utilizing EWI's expertise in microwave technology and an international furnace manufacturer's expertise in indirect heating

We have been able to develop the Microwave Hybrid Process. The hybrid microwave process balances the benefits of microwave processing with external indirect heating.

EWI HYBRID PROCESS DIAGRAM



Increased Efficiency

Before the process begins, the tires are shred for an even material distribution, resulting in improved microwave absorption, and heat and mass transfer.

Preheating the tire shred further enhances the microwave absorption.

THE HYBRID MICROWAVE PROCESS BALANCES THE BENEFITS OF MICROWAVE PROCESSING WITH EXTERNAL INDIRECT HEATING.



Microwave heating increases the efficiency of heating the tires



External heating increases the efficiency of heating the process tunnel walls while maintaining heat in the processing tunnel

Process Improvements



The hybrid microwave process is able to achieve superior processing and quality results

THE HYBRID MICROWAVE PROCESS IS ABLE TO ACHIEVE SUPERIOR PROCESSING AND QUALITY RESULTS BECAUSE OF:

- A continuous process that eliminates heat cycling and improves process control
- It can process shred material that contains metal and fibers
- An even distribution of materials, resulting in consistent thermal profile
- Lower process operating temperatures
- No agitation of the material during heating, resulting in no dust being created

Improved Product Quality: rCB

With the hybrid microwave process, you can control the level of volatiles in the recovered carbon, virtually eliminating PAH if needed.

PAH Compound	F03278A
Benz(a)anthracene	0.11
Chrysene	0.12
Benzo(b)fluoranthene	0.10
Benzo(j)fluoranthene	0.06
Benzo(k)fluoranthene	0.03
Benzo(e)pyrene	0.18
Benzo(a)pyrene	0.25
Dibenz(a,h/a,c)anthracene	0.05
Total of 8 EU PAHs	0.9 ppm

Table 1: 8 PAH compounds according to EU No 1272/2013 (values in ppm).

Improved Product Quality: Oil

When using hybrid microwave processing, there's no need to filter the oil. Instead, it can be recovered as one oil stream or in multiple fractions.

	Unit	Test Results	Test Method
Density @ 15°C	kg/m ³	905.9	ISO 12185
Viscosity @ 50°C	mm ² /s	2.370	ISO 3104
Water	%V/V	0.05	ASTM D6304-C
Micro Carbon Residue	%m/m	0.61	ISO 10370
Sulfur	%m/m	0.91	ISO 8754
Total Sediment Potential	%m/m	< 0.01	ISO 10307-2
Ash	%m/m	< 0.010	LP 1001
Vanadium	mg/kg	< 1	IP 501
Sodium	mg/kg	< 1	IP 501
Aluminum	mg/kg	< 1	IP 501
Silicon	mg/kg	< 1	IP 501
Iron	mg/kg	10	IP 501

	Unit	Test Results	Test Method
Nickel	mg/kg	< 1	IP 501
Calcium	mg/kg	< 1	IP 501
Magnesium	mg/kg	< 1	IP 501
Zinc	mg/kg	2	IP 501
Phosphorus	mg/kg	1	LP 1101
Potassium	mg/kg	< 1	IP 51
Pour Point	degC	< 0	IP 501
Flash Point	degC	< 40	LP 1101
Net Specific Energy ¹	MJ/kg	42.02	ISO 3016
CCAIO (Ignition Quality) ¹	-	866	ISO 8217
Aluminum + Silicon	mg/kg	< 2	ISO 8217
Acid Number	mg KOH/g	2.26	ASTM D664

¹Calculated Value
Note: Flash Point is less than 40°C

In Review:

To sum it up, here's why EWI continues to emphasize the hybrid microwave process

WHY IT IS SO BENEFICIAL?



Improved efficiency



Greater product quality



Safe operation



Environmentally sound



Reduction of greenhouse gases

The Next Steps



EWI's hybrid microwave process and capabilities are continuing to evolve.

We are currently upgrading our pilot facility to operate commercially with the hybrid microwave process and are working with Elysium Nordic to build the very first commercial system in Europe at its facility in Nyborg, Denmark.

Conclusion

For more information about our hybrid microwave process, contact our team today.

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