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Practice training for “3R” technology

ABC-BioPhosphate production

The 3R zero emission pyrolysis (carbon refinery) is a specific high temperature carbonisation technology, which is high efficient and added value processing of certain bio-based by-products at 850°C material core temperature, such as ABC-BioPhosphate. The 3R carbonization process is based on a **new generation indirectly heated rotary kiln design original solution for reductive thermal decomposition animal bones at 850 °C (1562 °F) material core temperature** in vacuum. **This is a modern and high efficient pyrolysis system in economical industrial scale with comprehensive solution**, which is a highly complex chemical factory with extensive auxiliary installations.

- ✓ **There is no one fit for all pyrolysis process solution and product system.** Different types of designed pyrolysis treatment technology performances/characters with specific process conditions resulting highly different output chars with highly different appearance and properties from the same input material, such as yield, fix carbon content, elemental composition, remaining volatile content, pore structure or porosity, ash content, hardness (abrasion resistance), compressive strength, bulk and true densities, surface area, porosity and pore volume distribution, electrical resistivity and reactivity, a.s.o.
- ✓ **The 3R has been specifically developed for high added value valorisation of those organic by-product streams, which require high material core temperature 850°C^{20min} to convert food grade animal bone by-products into safe, valuable and useful natural products, such as the ABC BioPhosphate.**

The 3R is an original solution and specific carbon refinery pyrolysis design (e.g. carbonization or reductive thermal treatment process) that has been specifically developed in all parts and elements for production of high added value and non-energetic solid carbon products as primarily – core products, while the surplus energy is of secondary interest.

The output char quality and economics are most importantly and primarily impacted by designed pyrolysis treatment technology performances/characters and secondarily reflecting the feed material characters as well. In other words, **pyrolysis technology design quality**



Converting trash into cash: carbon refinery, recovery and recycling of added value organic Phosphate products and performance is the prime key factor that is impacting the output char quality, overall economics and environmental performances as well. Generally carbonization processes have been designed for solid carbon production, while flash pyrolysis and gasification (with high ash burn off character) for oil/gas energetic production.

As usual in all industrial cases, all commercially productive thermal treatment industrial processes in economically viable industrial scale must be technically, economically, environmentally and legally optimized.

CRITERIA 1: As all biochar and ABC-BioPhosphate applications are irrevocable in different European soil and climatic conditions, therefore the high product quality and overall safety must be an unconditional technical criteria for such commercial products above 1 t/y import, placing on the market and manufacturing capacity; also the unconditional legal criteria, such as the Extended Producer Responsibility certificate, mandatory EU regulation based Authority permits, labelling and REACH certificate.

CRITERIA 2: all elements of the ABC BioPhosphate activities in commercial industrial scale, must unconditionally reflect feed material sustainability, high environmental performance during production and comprehensive environmental and climate protection care, high quality and full safety under any application scenario conditions.

CRITERIA 3: while economy is highly important in all commercial production cases, still not more important than unconditional criteria 1 and 2. Any compromise can be made (such as maximized yield, energetic issues, economy, a.s.o.), when technology is selected, but only after unconditional criteria 1 and 2 completely fulfilled, which two elements are the fix basic platforms to successfully build up the biochar industry under market competitive commercial conditions.

To obtain a high quality product, mainly two aspects have to be considered: the **input feed material and the performance of the pyrolysis technology design** that provides the treatment efficiency.

Improvement of the **operating conditions** during pyrolysis (e.g. heat transfer efficiency, heating rate, high treatment temperature, residence time, pressure conditions, flow rate of the inert gas, reactor type and shape) and pre- (e.g. drying) and post- (e.g. sieving, formulation) treatments which can **greatly affect properties and structure**.

The carbonisation core temperature, residence time and input **material quality effects on the end-product quality and safety**.



Converting trash into cash: carbon refinery, recovery and recycling of added value organic Phosphate products

It is highly important to select right material core treatment temperature at specific pyrolysis technology unit with specific heat transfer efficiency, so the material is not insufficiently under heat treated or too much over heat treated (or in the flash pyrolysis and gasification cases high burn off made); whereas both cases negatively affect quality, safety and application value. However, generally the stability of increases as a function of pyrolysis material core temperature whereas the maximum allowable limits of the PAH₁₆ and PAH₁₉ are key process and product quality/safety indicators.

- Under full industrial and commercial conditions **there is no compromise opportunity for lower product quality**, even so the production cost and final product cost are higher, as is irrevocable used in soil, **so minimum but sufficient high quality must be reached**.
- Under full industrial and commercial conditions **there is not compromise opportunity for lower environmental performance**, even so the production cost is higher, as processing under industrial conditions is a chemical factory, which – if not properly designed and operated – may emit hazardous substance into the environment.
- Under full industrial and commercial conditions **there is not compromise opportunity for economical performance**, as processing is a continuous operation that requires significant labour under industrial conditions, therefore processing under commercial conditions must be operated as minimum economical capacity plan sizes, approx. from >5000 t/y throughput and up, optimally 20,800 t/y.

The thermochemical conversion of biomass (carbonaceous matter or a carbon source) into a carbon-rich solid (often as a by-product which may or may not qualify as) can be accomplished by pyrolysis in a reactor generally termed 'carbonizer'. Low temperature carbonization process is a reductive thermal decomposition, whereas no air introduced into the process. The goal of the carbonization process is the extraction of the solids that is the ABC BioPhosphate.

The 3R Pyrolysis is a thermochemical decomposition of biomass in the total absence of oxidizing agents to produce a range of useful ABC BioPhosphate products.



Converting trash into cash: carbon refinery, recovery and recycling of added value organic Phosphate products

Setting up criteria for ABC BioPhosphate specific pyrolysis process. The 3R specific pyrolysis process is characterized by the following criteria:

- 1) **Comprehensive industrial design for treatment and management of all processed material streams in any form;** including technological, mechanical and thermal engineering, electric and electronic design and instrumentation, mass and energy balances, hazard and risk evaluations, occupational health and safety design, storage and logistics, data collection and storage, auxiliary systems, a.s.o. according to the valid EU/MS, US and Australian industrial and environmental standards and mandatory permit conditions.

Energetic, environmental, GHG and economical Life Cycle Assessment of all the system elements and materials recommended. Preparation of sufficient level of training and instructions of the operators, commissioning - operation - maintenance manuals are critically important elements, similarly to the professional standard industrial scale thermal installations.

- 2) **True reductive environment** thermal processing with self sustaining thermal energy supply or electric power generation and full value surplus energy recovery as standard installation. The true value reductive pyrolysis thermal processing means, that no any air is introduced for the process through technology design. However, there are still sources of oxygen from
 - System sealing, which should be such advanced technological design, that not more than 0.01% of the reactor internal volume equivalent air volume introduced into the reactor per hour through sealing, otherwise the hot ABC BioPhosphate material will burn off to ash,
 - Chemically bounded oxygen burn off, which is feed material dependent.
- 2) **Temperature criteria: material core processing temperature at 850°C.**
 - a. Plant based biochar material core processing final treatment carbonization temperature is from >450 to <550 °C at minimum 20 minutes residence time.
 - b. ABC BioPhosphate material core processing final treatment carbonization temperature is at <850 °C minimum 20 minutes residence time.



Converting trash into cash: carbon refinery, recovery and recycling of added value organic Phosphate products

- c. Constant material core temperature and residence time is to be defined and followed by the producer for each mono and multi constituent feed materials, that will result targeted output biochar commercial product quality.
- 3) **Zero emission performance processing** designed, most importantly full processing of the pyrolysis-gas-vapors and energy supply units needed to **fully meet relevant industrial emission standards, including the Industrial Emission Directive**, with the difference that – as main product - is not combusted. Full and added value recycling and reuse of pyrolysis-gas-vapours as higher value organic chemical compounds should optimally be targeted.
- 4) **Resource efficient and sustainable biomass feed materials selected** with total Circular Economical aspects.
- 5) **Fully monitored**, each biochar series identified/labelled data collected and fully documented operations with production records according to the Authority permit specifications. The availability of all records and documents in 5 years. Industrial full process monitoring means that both the **automated process** (such as temperature and pressure differences, residence time, electric and electronic instrumentation data, all material stream weights and volumes, energy balances, production schedules, aso) and the total **environmental** performance data (such as all emissions, storage and handling of hazardous materials, aso) are continuously and measured with validated/Authority permitted instrumentation with validated recording/documentation system.
- 6) **Continuously 7days/24hours operated, 8000 hours/year operated with 3 maintenance stops.**
- 7) **Authority permitted construction and operation** implemented above 1 t/y capacity (usually over 10 Authority permits required with specified terms and conditions)
- 8) **REACH certification and authorization above 1 t/y biochar production** capacity made, related to and pyrolysis oil manufacturing, and/or importing and/or placing on the market. This authorisation requirement ensures that risks from the use of such substances are either adequately controlled or outweighed by socio-economic benefits, having taken into account the available information on alternative substances or technologies.



Converting trash into cash: carbon refinery, recovery and recycling of added value organic Phosphate products

- 9) **Having Extended Producer Responsibility** certificate for the lawful and “fit for purpose” product (full value legal and economical responsibility for the product safety and stated performance).
- 10) **Quality specification and labelling according to the EU 1009/2019 Fertilising Products Regulation** content and format to be applied. Product characteristics, physical-chemical properties, degradability, biological effects, safety standards and specifications specified in SDS safety data sheet according to Regulation (EU) 2015/830, continuous follow up control to meet REACH and legal status, also are public information and cannot be classified as confidential business information.

3R technology performance and operational specification:

Technology name:	3R (Recycle-Reduce-Reuse) zero emission pyrolysis and carbon refinery technology.
Technology IP owner:	Edward Someus (original inventor, industrial designer, biochar S&T senior engineer)
Technology vendor:	3R-BioPhosphate Ltd.
Input material:	Pressure sterilized Category 3 and 2 bone grist mono feed (cattle or pig bone and/or any other type) animal by-product: innovative bio-phosphate fertilizer recovery from food grade animal bone.
Input capacity:	20,800 t/y (2.6 t/h)
Output capacity:	12,500 t/y ABC-BioPhosphate
Operational work shifts	3+1 reserve
Operational personnel:	18-30 depending on the logistical and marketing organisation.
Training of personnel:	Yes in all cases of the 3R tech new adaptation



Converting trash into cash: carbon refinery, recovery and recycling of added value organic Phosphate products

Standards:	Applied industrial, environmental and climate protection norms and standards: EU, Australia and USA.
Operations and maintenance:	As of user manual that is available for contracted partners
Technology insurance:	Technology industrial insurance and re-insurance available

The system works with zero emission, comprehensive recycling and reuse of all process materials and gases. The target of the 3R Zero Emission Pyrolysis Process is the added value upgrading/valorisation of agro/food industrial organic by-products into safe and high value carbon based soil amendment and nutrition products.

Pyrolysis of biomass substances produces solid residue, liquid crude bone-oil (Oleum Animale) and non condensable gases. After refinery of the crude pyrolysis oil surplus energy and bio-oil produced.

The 3R system is also integrated into the novel agro biotechnological – solid state fermentation and formulation, and synthetic biofuel processing units.

The 3R is an fully developed and fully engineered full scale industrial design, that 2002-2019 development under European Commission applied research and demo programmes has been completed recently and now ready for full commercialization and market replication.

The pyrolysis process design quality and technology performance is the most important and primarily factor that impacting end-product quality. Obsolete or energetic application purpose thermal processing technologies with low heat transfer efficiency in most cases cannot manufacture right quality for soil application. The secondarily impacting factor is the feed material characteristics.

The company 3R-BioPhosphate Ltd. is truly Consumer focused for the ABC-BioPhosphate commercialisation strategy, based on 4P (Product policy, Price policy, Place policy, Promotion & exploitation policy) marketing mix, for creating awareness and customer/user loyalty. The formulation of multiple ABC fertilizing products is suitable to meet the most varied and difficult needs of the land. The use of these new ABC and formulated BIO-NPK-C-micronutrient and microbiological organic matrixes, combinations and mixes are highly



Converting trash into cash: carbon refinery, recovery and recycling of added value organic Phosphate products market competitive under different scenario in the targeted temperate climatic zone country markets, EU, Australia, Japan and USA.

Practitioners and Users are highly welcome to contact us with any questions, suggestions and specific requirements to meet and optimise local specific demands in most effective manner, all in order to support sustainable, economical and price competitive productions.

Access to the 3R technology is open on business licensing or franchise basis.

Product portfolio for granulated (1-5 mm) or powdered (0-1 mm) ABC , size variable as user demands

Product portfolio	Brand	Product differentiation	Packaging	Services ¹
"ABC" Animal Bone Char BIO-NPK-C FROMULATE D PRODUCT MIX	BIO-NPK-C – MAGIC BIO-FERTILIZER	Organic BIO-NPK-C fertilizer, growing media, plant growth promotion for horticultural industry	<ul style="list-style-type: none"> • 1 ton in bigbag • 20 kg bag • Sealed pallet 1 ton 50x20kg bags 	"EPR" "ABC-SERVICE" "FOLLOW UP" "REFUND"
Microbiologic ally adapted ABC for horticultural industry	PROTECTOR	Premium product (Organic BIO-NPK-C fertilizer, plant growth promotion, biofertiliser, biostimulant)	<ul style="list-style-type: none"> • 1 ton in bigbag • 20 kg bag • Sealed pallet 1 ton 50x20kg bags 	"EPR" "ABC-SERVICE" "FOLLOW UP" "REFUND"

- ¹:
- "EPR" Extender Producer Responsibility;
 - "ABC-SERVICE" maintaining advisory service;
 - "FOLLOW UP" ABC application follow up documentation and farmers consultations;
 - "REFUND" refund policy.