

NORIT® Powdered Activated Carbons for purification of vegetable and marine oils

1. Introduction

Crude vegetable and marine oils can be polluted by health hazardous substances such as carcinogenic Polycyclic Aromatic Hydrocarbons (PAH) and/or with persistent organic pollutants (POP) such as dioxins & furans (PCDD/F), Polychlorinated biphenyls (PCB), pesticides, herbicides, plasticizers, mineral oils (MOSH/MOAH), 3-MCPD and Glycidyl esters (GE). The refined or detoxified oils may be used for human consumption respectively animal feed. Depending on crude the oil type and quality the various contaminants are originating from smoke drying of copra, drying of seeds by combustion gases, environmental pollution, packaging materials, use mineral oils in oil processing equipment, or created in oil processing.

European legislation is in place to regulate several health hazardous substances in the oils and fats. Powdered activated carbons (PAC) are dosed to vegetable or marine oils to adsorb PAH, PCDD/F and PCB in such a way that these oils comply with the EU regulated limits or directives.

After contact with the oil the spent PAC is separated from the oil by filtration over pulse tube filters or pressure leaf filters and disposed, depending on the geographical situation and type of contaminants spent filter cake with the activated carbon is usually incinerated or going to biogas plants.

Apart from the EU regulated PAH, PCDD/F (non-ortho) non-ortho PCB contents which are well adsorbed from the triglycerides, the other contaminants listed are not well adsorbed; other refining techniques should be applied, or one should prevent such contaminants are present/created in the oils by using food safe utilities.

In edible oil refining processes activated carbon is mostly used in combination with bleaching earth to adsorb those components bleaching earth will not adsorb. Bleaching earth on the other hand can protect PAC from fouling enabling PAC to use its adsorptive capacity to adsorb the target contaminants. Apart from its property to improve the quality of the oil to refine and to protect PAC from fouling, bleaching earth also acts as filter aid for PAC, hence there is synergy in purification effect when bleaching earth and AC are combined.

Powdered activated carbon may also be used as bleaching aid, either to support bleaching earth with the elimination of plant pigments and persistent colorants, or as only bleaching aid without bleaching earth in case of processing biological oils.

The use of activated carbon for purification/detoxification to comply with the relevant EU regulations for food stuffs and directive for animal feed is detailed discussed in a powerpoint presentation which is available upon requests. This Technical Infosheet summarizes the use of NORIT® Powdered Activated Carbons for this application segment.

2. Activated carbon in process

2.1 The removal of PAH from vegetable oils

In order to comply with EU regulation 835/2011 on BaP and PAH4, PAC is used to remove of PAH in the vegetable oil refining industry. Detailed information in a PowerPoint presentation available upon request.

Most of the present light PAH (up to 4-rings) in contaminated oils is usually volatile enough to be stripped off during the deodorization process step along with other volatile compounds following the activated carbon treatment. The balance of low volatile light PAH with remaining non-volatile heavy PAH (5-rings and higher) must be removed by activated carbon to comply with the EU regulated limits on PAH.

PAC is mostly used in conjunction with bleaching earth in the bleaching step. The bleaching step is following refining steps up stream such as degumming, de-acidification and followed by vacuum steam distillation (deodorization).

Spent activated carbon is disposed of in combination with spent bleaching earth. In case the spent bleaching earth is to be mixed with the meal from seeds after extraction of the oil for animal feed, then the activated carbon treatment should follow the bleaching earth treatment in a separate treatment step and its filter cake should be disposed separately.

Typical PAC treatment conditions for PAH removal depending on the crude oil and PAH contamination level:

- Temperature 80 – 110 °C
- Contact time 1 hour under vacuum together with bleaching earth or separate from bleaching earth in case spent bleaching earth is mixed with the meal after oil extraction for animal feed.
- Dosing rate 0.5 kg/ton for slight contaminated oils up to 15 kg/ ton for heavy PAH contaminated oils

2.2 The removal of dioxins, furans and polychloro biphenyls from marine oils and fatty acid distillates

In order to comply with EU regulations 1881/2006 and 1259/2011 on food stuffs and EU directive 2006/13/EC on animal feed, PAC is used to remove dioxins & furans (PCDD/F) and dioxin like and non-dioxin like polychloro biphenyls (DL-PCB, NDL-PCB).

When the marine oil is used for producing concentrated omega-3 products for human consumption, PAC is used together with bleaching earth in a full refining process like described for vegetable oil refining above. Via transesterification and molecular distillation, the food grade omega-3 products are obtained meeting the food safety standards.

When the marine oil or fatty acid distillate is destined for animal feed (fish feed, PET food), the activated carbon is directly used on the oil /fatty acid to remove PCDD/F and PCB without having a full refining process around.

Typical PAC treatment conditions for PCDD/F and PCB removal depending on POP contamination level and destination of the purified oil: for human consumption or for animal feed:

- Temperature 80 °C
- Contact time 1 hour under vacuum together with bleaching earth
- Dosing rate 3 kg/ton up to 15 kg/ton depending on POP contamination level and degumming.

Typical PAC treatment conditions for PCDD/F and PCB removal depending on POP contamination level and precleaning of the crude oil: for animal feed:

- Temperature 80 °C
- Contact time 1 hour under vacuum
- Dosing 3 kg/ton up to 7 kg/ton depending on contamination level and degumming.

Granular activated carbon (GAC) is occasionally considered as “polisher” for PAH removal on low PAH contaminated oils or to purify fatty acid distillates. Implementation of a GAC step may be complex with respect to the handling of GAC, please contact us to discuss if such a GAC polishing step is considered.

3. Critical carbon properties

- Adsorptive properties: dedicated porous structure for PAH, PCDD/F, PCB and/or bleaching depending on the targets. NORIT® SA PAH powdered carbons have specified values on PAH adsorption reported for each manufactured lot on each certificate of analysis.
- pH/reaction: no acid reaction permitted to maintain the composition of the oil; chloride free carbons preferred to avoid potential formation of the hazardous 3-MCPD esters in the refining process.
- Purity: The carbon should not contribute to leach of traces PCDD/F, PCB and PAH in the oil to treat. NORIT® SA PAH carbons are lot-to-lot controlled on presence of heavy hydrocarbons (Fluorescent substances test). The carbons should comply with most stringent food safety standards for purification agents. The recommended NORIT powdered carbons are produced under the scope of a certified FSSC 22000 quality management system. FSSC 22000 certificate and food grade statements available upon request.
- Filterability: high filterability carbons are preferred to ensure high filtration throughputs and lowest risk for bleed through of carbon fines in the filtrate.

4. Recommended NORIT powdered carbon grades

Preferred use depending on purification tasks and cost efficiency required:

Preferred to use for...	NORIT SA ULTRA PAH	NORIT SA 4 PAH(HF)	NORIT SA 5 PAH-HF	NORIT D ULTRA
Bleaching only	→D ULTRA	→D ULTRA	→D ULTRA	Best
Bleaching + PAH removal	Best	better	good	→ SA PAH
PAH removal only	Best	better	good	→ SA PAH
PCDD/F removal	Better	Better	good	Best

Caution: For health and safety related aspects of a NORIT activated carbon, please refer to the corresponding Material Safety Datasheet (MSDS), which is available on request.

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