

7.36 Vegetable oil and animal fat extraction and vegetable oil refining

7.36.1 Coverage

Activities covered relate to the vegetable oil and animal fat extraction and vegetable oil refining activities. The definition is as follows [1]: Any activity to extract vegetable oil from seeds and other vegetable matter, the processing of dry residues to produce animal feed, the purification of fats and vegetable oils derived from seeds, vegetable matter and/or animal matter.

However, presently, due to the problem of bovine spongiform encephalopathy, the solvent extraction of animal fat from dead cows and other animals, for producing animal meals is not more carried out according to [4]. This chapter consequently covers only vegetable oil extraction.

7.36.2 Emission sources

The production of crude vegetable oil from oilseeds (e.g. soya beans, sunflower seeds or rapeseed) is a two-stage process:

- The first process step is cleaning, preparation (i.e. drying) and in some cases dehulling, flaking and conditioning and pressing of the oilseeds. Pressing takes place in one or two steps, resulting in crude pressed oil and a cake.

Beans (with 20% oil or less) are not pressed, because of the lower fat content, but are extracted directly after cleaning and preparation.
- The second process step is the extraction of oil from the pressed cake or flaked beans using hexane as a solvent. Extraction takes place in counter-current flow desolventiser-toaster (DT) by means of direct or indirect steam.

The mixture of hexane and oil, called miscella, is further processed in a distillation process, to separate the hexane from the vegetable oil. The solvent is re-used in the extraction process. Oil is further refined to become consumable.

The hexane remaining in the cake is recovered by a stripping process, using steam. This desolventising-toasting process also reduces the enzyme and micro organism activity in the meal.

The meal is dried and cooled by air before storage in silos or before loading.

Refining consists in several operations which can be physical or chemical. Conventional chemical refining includes degumming for the removal of phospholipids, neutralization for the removal of free fatty acids (ffa) and bleaching for decolourisation and deodorization.

VOCs emissions arise from the oil extraction process. Fugitive and stack emissions occur. The refining process is not the main source of VOC emissions however VOC emissions arise from the neutralisation and the deodorisation steps. Dust emissions arise from the drying of desolventised and toasted meals. Excess moisture is removed by heated ambient air and after, by cooled ambient air. The exhaust air contains dusts [3].

7.36.3 BAT, Associated Emission Levels (AEL)

For the extraction of vegetable oil and the refining of vegetable oil, several VOC emission reduction options are available.

Batch and continuous processes are to be distinguished in terms of emission relevance, the former are more relevant. By introducing the so-called Schumacher-type desolventizer-toaster-dryer-cooler in the edible and non-edible oil extraction sector, VOC emissions can be reduced significantly.

For reducing emissions, several techniques can be used [2] and associated and are constituted of:

Process optimisation: the counter current flow Desolventizer-Toaster (DT) allowing to minimize the solvent losses and steam consumption, the heat integration of DT vapour stream with miscella distillation in the extraction process leading to an optimisation of the energy consumption, the mineral oil scrubbing system to reduce VOC emissions and the reboiler minimising solvent losses.

Use of secondary measures by Condensation/Physical Separation/Distillation: the hexane and steam vapours coming from the meal desolventising/toasting, from the miscella (crude vegetable oil and hexane) distillation, from the reboiler and from the stripping column of the mineral oil system, all pass through a condenser system. The condensed vapours (hexane-water condensate) go to the hexane-water separator where the undissolved hexane is separated by means of gravitational phase separation. The hexane is re-circulated to the extraction process. Any residual solvent content in the aqueous phase of the hexane/water separator is distilled off in the so-called re-boiler. The resulting hexane/water vapours from the reboiler are condensed together with the vapours from the distillation stage.

After boiling the almost hexane-free water is fed to the waste water system. This technology also ensures the explosion safety of this downstream system.

Use of secondary measures by Absorption/Desorption

The components that cannot be condensed by the condenser are treated further by an absorption technique, the so-called mineral oil scrubbing system, where residual hexane is absorbed. The mineral oil system consists of an absorption column, where the hexane is absorbed by cold, food grade mineral oil. The hexane is then recovered by steam stripping the hexane laden mineral oil in a stripping column. The stripped mineral oil is cooled down and reused in the absorption column.

The final emissions from the mineral oil system consist of the non-condensables with traces of hexane.

The hexane and steam vapour from the mineral oil stripping column are condensed in the condenser system. The hexane-water condensate then goes to the hexane-water separator (see above). The total recovered hexane is reused in the extraction process.

Dusts are removed by cyclones for safety reasons. The use of fabric filters and electrostatic precipitators increase the fire hazard and cannot be used.

BAT for this sector is consequently to [3]:

- Use of a counter flow desolventizer toaster (Schumacher type as example)
- Use the vapour generated in the desolventiser toaster in the first step of the miscella distillation pre-evaporator,
- Use water ring pumps to generate an auxiliary vacuum for oil drying, oil degassing or minimising oxidation of oil,
- Use a mineral oil scrubber to recover hexane from incondensable vapours from meals desolventising toasting, miscella distillation, the reboiler and from the stripping column of the mineral oil system,
- Use cyclones to reduce wet dust emissions arising from vegetable oil extraction, to achieve a wet dust emission level of less than 50 mg/Nm³,
- Better control deviations from normal operating conditions and avoid start-ups and shut-downs [2] (this is however depending on the number of different types of seeds to treat in the year and much more difficult if this number high).

[Achievable emission levels were defined in the EGTEI background document assuming biofiltration use. However, according to FEDIOL, biofiltration is not feasible due to the very limited water solubility of hexane. The achievable emission level given in the previous Gothenburg Protocol guidance document III has also been modified according to data defined in the EGTEI background document [2]].

Table 1: Control measures with VOC associated emission levels for extraction of vegetable oil

Emission source	Combination of control measures	BAT associated emission levels for VOC [Defined for the following averaging period: yearly for total AEL]
Extraction of oil from seed, continuous process from rapeseeds, sunflower seeds and soya beans.	Process optimization and counter flow desolventizer-toaster-dryer-cooler and condensation with further absorption (mineral oil scrubbing system) and other techniques described above	0.5 g/kg seed processed [2]
Extraction of oil from other seeds such as safflower seed, mustard seed, cotton seed and vegetable material		3 g/kg seed processed [as in [3]]
Extraction of seeds in batch process		4.0 g/kg seed processed
All fractionation processes : excl. degumming: Degumming:		1.5 g/kg seed processed 4.0 g/kg seed processed [as in [3]]

7.36.4 Cost data for emission reduction techniques

Costs have been defined in the EGTEI documents [2]. Abatement costs defined are negative as investments lead to hexane consumption reduction.

Caution: these documents are susceptible to evolve if new updated data are available.

7.36.5 Emerging techniques

No data is available.

7.36.6 References used in chapter 7.36

[1] Directive 1999/13/EC of 11 March 1999 on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain activities and installations

[2] EGTEI background document/synopsis sheet: Fat edible and non-edible oil extraction – 2003/2005

[3] European Commission - reference document on BAT for the food, drink and milk industries August 2006

[4] M. GESLIN from National federation of fat compounds (Fédération Nationale des Corps Gras) – Information to CITEPA – September 2008

