National Pollutant Inventory

Emission Estimation Technique Manual

for

Vegetable Oil Processing Industry

First published in June 1999

EMISSION ESTIMATION TECHNIQUES
FOR
VEGETABLE OIL PROCESSING INDUSTRY

TABLE OF CONTENTS

VEGETABLE OIL PROCESSING INDUSTRY

LIST OF FIGURES AND TABLE

1.0 Introduction

The purpose of all Emission Estimation Technique (EET) Manuals in this series is to assist Australian manufacturing, industrial and service facilities to report emissions of listed substances to the National Pollutant Inventory (NPI). This Manual describes the procedures and recommended approaches for estimating emissions from facilities engaged in vegetable oil processing.

The extraction processes described in this Manual are focused upon hexane extraction, however other non-chemical extraction processes such as double pressing, super critical fluid, microwave etc will still fall into the Vegetable Oil Processing Industry.

EET MANUAL:	Vegetable Oil Processing Industry
HANDBOOK:	Oil and Fat Manufacturing
ANZSIC CODES :	2140 and all codes in the 214 ANZSIC code group.

This Manual was drafted by the NPI Unit of the Queensland Department of Environment and Heritage on behalf of the Commonwealth Government. It has been developed through a process of national consultation involving State and Territory environmental authorities and key industry stakeholders.

2.0 Processes and Emissions

The following section presents a brief description of the vegetable oil processing industry and identifies likely sources of emissions.

2.1 Process Description

The industry group producing fats and oils includes cottonseed oil mills, soy bean oil mills, vegetable oil mills (other than corn, cottonseed, and soybean), and other mills. Wet corn mills are the primary producers of corn oil.

The following process description discusses soybean oil manufacture. Corn, cottonseed, and peanut oil processing are similar to soybean processing, except for differences in the soybean preparation for oil extraction. The process for soybeans typically consists of five steps: oil seed handling/elevator operations, preparation of soybeans for solvent extraction, solvent extraction and oil desolventising, flake desolventising, and oil refining.

2.1.1 Oilseed Handling/Elevator Operations

A typical soybean handling/elevator operation that precedes the preparation of soybeans for the solvent extraction process is shown in Figure 1.

Soybeans received at the facility by truck or rail are sampled and analysed for moisture content, foreign matter, and damaged seeds. Then the beans are weighed and conveyed to large concrete silos or metal tanks for storage prior to processing. When the facility is ready to process the soybeans, the beans are removed from the silo or tank and cleaned of foreign materials and loose hulls. Screens are generally used to remove foreign materials such as sticks, stems, pods, tramp metal, sand and dirt. An aspiration system is used to remove loose hulls from soybeans; these hulls may be combined later with hulls from the dehulling aspiration step. The beans are passed through dryers to reduce their moisture content to approximately 10 to 11 percent by weight and then conveyed to process bins for temporary storage and tempering for one to five days in order to facilitate dehulling.

2.1.2 Preparation of Soybeans for Solvent Extraction

Figure 2 is a schematic diagram of the process used to prepare soybeans for the solvent extraction process. The process, which is fairly well standardised, consists of four principle operations: cracking, dehulling/hull removal, conditioning and flaking.

Soybeans are conveyed from the process bins to the mill by means of belts or mass flow conveyors and bucket elevators. In the mill, the beans may be aspirated, weighed, cleaned of tramp metal by magnets, and fed into corrugated cracking rolls. The cracking rolls “crack” each bean into four to six particles, which are passed through aspirators to remove the hulls (processed separately after the removal of residual bean chips). These hulls may be combined with the hulls from the grain cleaning process.

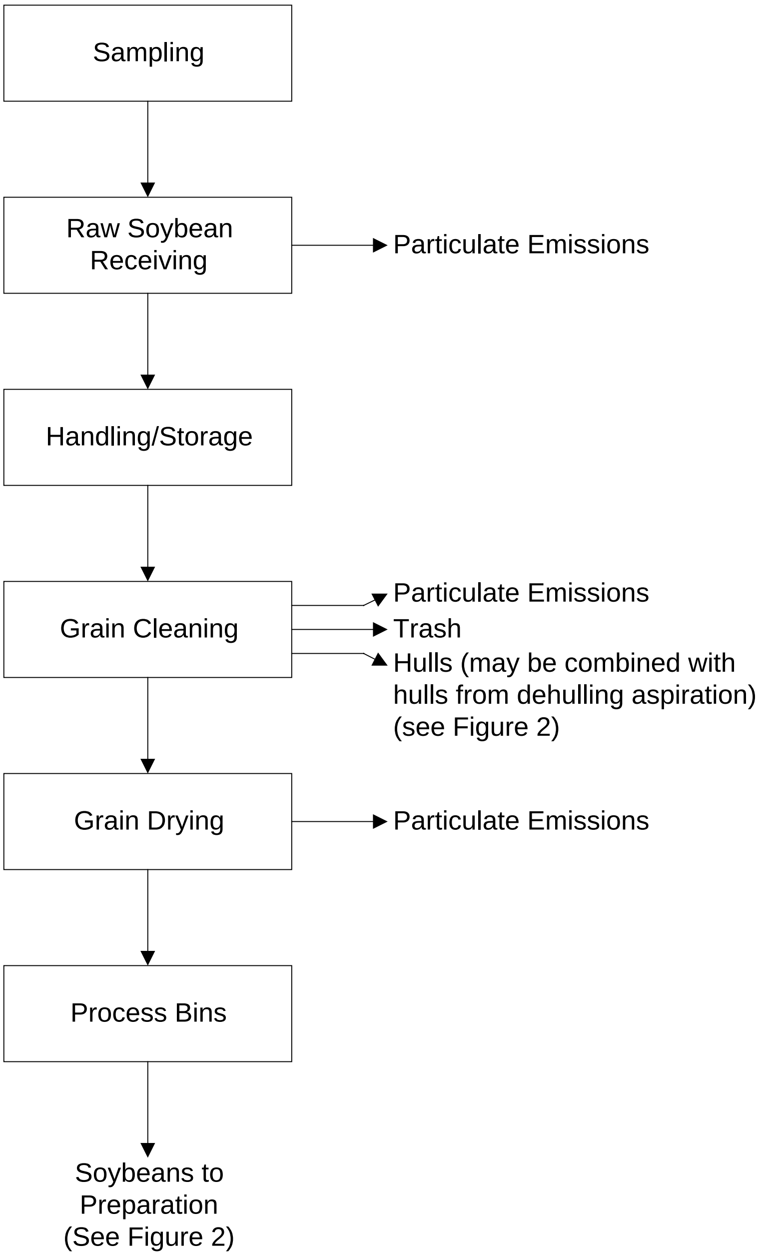

Figure 1 - Flow Diagram of a Typical Soybean Handling/Elevator Operation
Source: USEPA, AP-42, Section 9.11.1, 1995

Next, the cracked beans and bean chips are conveyed to the conditioning area, where they are put either into a rotary steam tubed device or into a stacked cooker and are heated to "condition" them (ie. make them pliable and keep them hydrated). Conditioning is necessary to permit the flaking of the chips and to prevent their being broken into smaller particles. Finally, the heated, cracked beans are conveyed and fed to smooth, cylindrical rolls that press the particles into smooth "flakes", which vary in thickness from approximately 0.2 to 0.51 millimetres. Flaking allows the soybean oil cells to be exposed and the oil to be easily extracted. Figure 3 is a schematic diagram that shows both typical preparation and extraction processes.

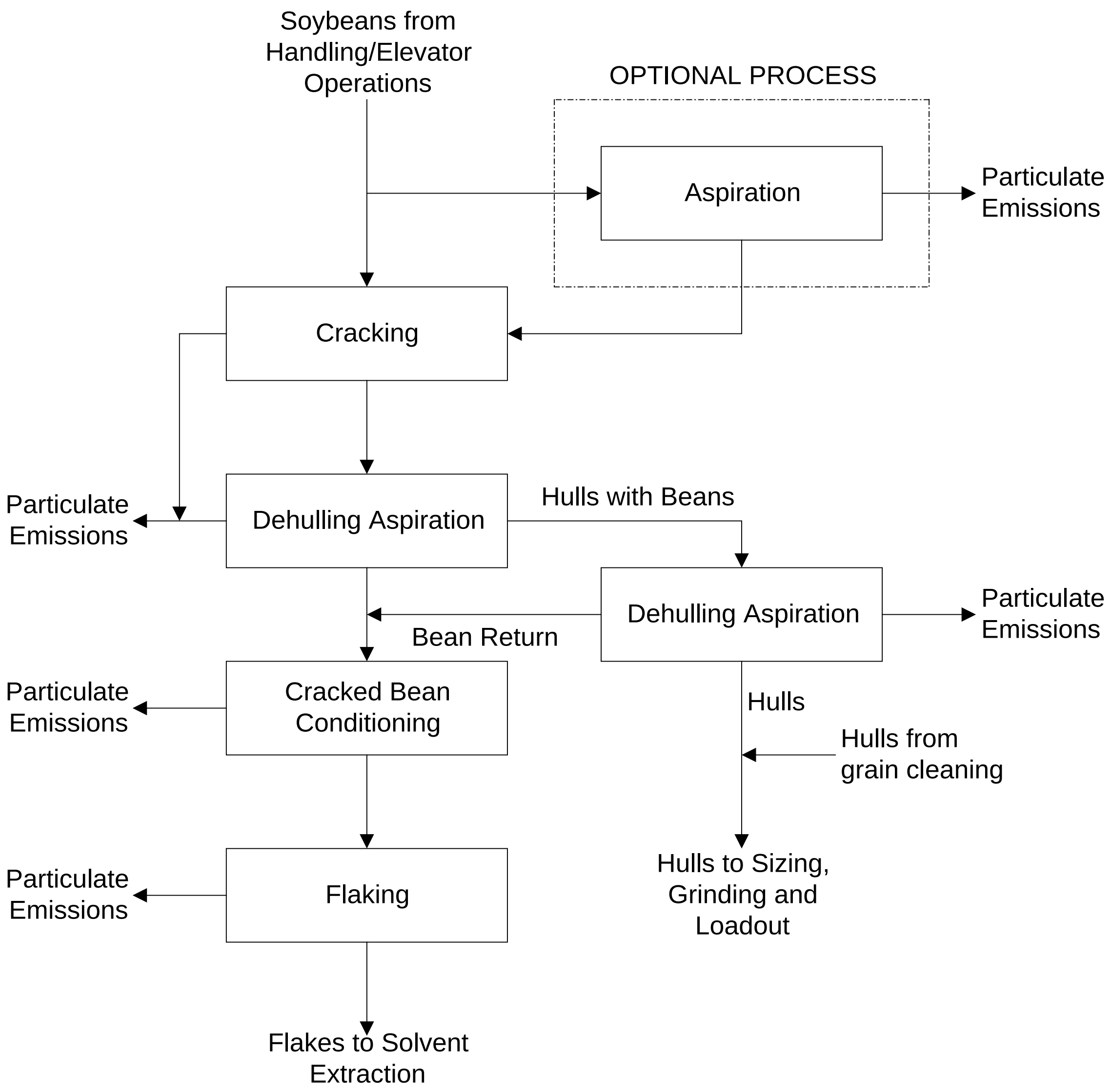

Figure 2 - Flow Diagram of a Typical Process for Preparing Soybeans for Solvent Extraction

Source: USEPA, AP-42, Section 9.11.1, 1995

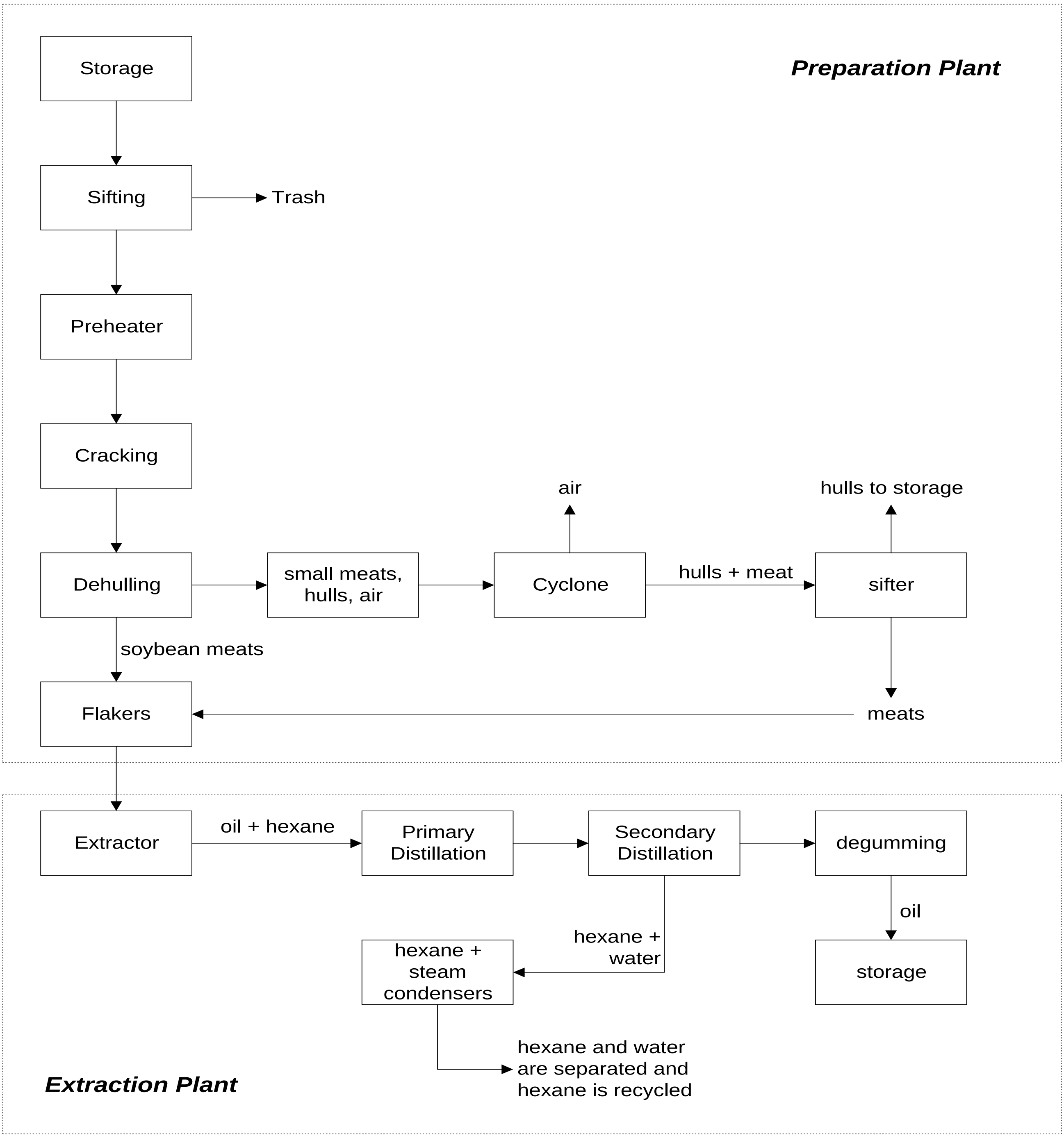

Figure 3 - Typical Preparation and Extraction Plant
Source: Cargill Australia, Newcastle, 1998

2.1.3 Solvent Extraction and Oil Desolventising

The extraction process consists of "washing" the oil from the soybean flakes with hexane solvent in a countercurrent extractor. The solvent is then evaporated (ie. desolventised) from both the solvent/oil mixture (micella) and the solvent-laden defatted flakes (see Figure 4). The oil is desolventised by exposing the solvent/oil mixture to steam (contact and non-contact). Then the solvent is condensed, separated from the steam condensate, and reused. Residual hexane not condensed is removed with mineral oil scrubbers. The desolventised oil, called “crude” soybean oil, is stored for further processing or loadout.

2.1.4 Desolventising Flakes

The flakes leaving the extractor contains up to 35 to 40 percent solvent and must be desolventised before use. Flakes are desolventised in one of two ways: either “conventional” desolventising or specialty (also called “flash”) desolventising. The method used depends on the end-use of the flakes. Flakes that are ‘flash’ desolventised are typically used for human foods, while conventionally desolventised flakes are used primarily in animal feeds.

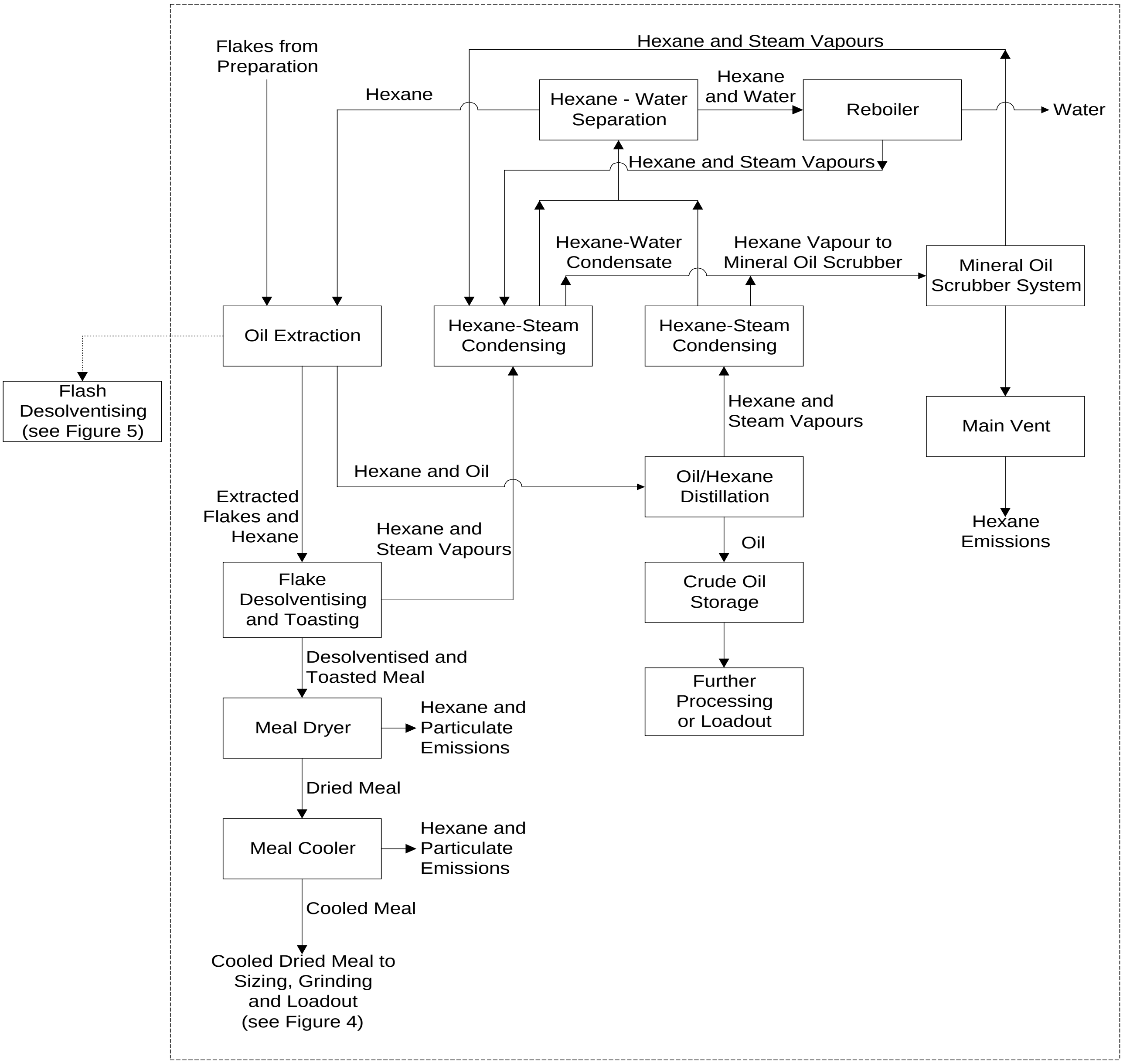

Figure 4 - Flow Diagram of the “Conventional” Solvent Extraction Process
Source: USEPA, AP-42, Section 9.11.1, 1995

Conventional desolventising takes place in a desolventiser-toaster (DT), where both contact and non-contact steam are used to evaporate the hexane. In addition, the contact steam "toasts" the flakes, making them useable for animal feeds. The desolventised and toasted flakes then pass through to a dryer, where excess moisture is removed by heat, and then to a cooler, where ambient air is used to reduce the temperature of the dried flakes. The desolventised, defatted flakes are then ground for use as soybean meal (see Figure 5).

The production of flakes for human consumption generally follows the diagram in Figure 6 for the "conventional" process, except for the desolventising step. In this step, the flakes from the oil extraction step are "flash" desolventised in a vacuum with non-contact steam or superheated hexane. This step is followed by a final solvent stripping step using steam. Both the hexane vapour from the flash/vacuum desolventiser and the hexane and steam vapours from the stripper are directed to a condenser. From the condenser, hexane vapours pass to the mineral oil scrubber and the hexane-water condensate goes to the separator, as shown in Figure 4. The flakes produced by the "flash" process are termed "white flakes". A process flow diagram for the flash desolventising portion of the soybean process is shown in Figure 6. From the stripper, the white flakes pass through a cooker (an optional step) and a cooler, prior to the further processing steps, which are similar to the "conventional" process. A plant that uses specialty or "flash" desolventising requires different equipment and is far less efficient in energy consumption and solvent recovery than a plant that uses conventional desolventising. Given these facts, the solvent emissions are considerably higher for a specialty desolventising process than for a similar-sized conventional desolventising process.

2.1.5 Vegetable Oil Refining

Crude oil is typically shipped for refining to establishments engaged in the production of edible vegetable oils, shortening, and margarine. Crude vegetable oils contain small amounts of naturally occurring materials such as proteinaceous material, free fatty acids, and phosphatides. Phosphatides are removed for lecithin recovery or to prepare the crude oil for export. The most common method of refining oil is by reacting it with alkali solution, which neutralises the free fatty acids and reacts with the phosphatides. These reacted products and the proteinaceous materials are then removed by a centrifuge process.

Following alkali refining, the oil is washed with water to remove residual soap, caused by saponification of small amounts of the triglycerides (oil). Colour-producing substances within an oil (ie. carotenoids, chlorophyll) are removed by a bleaching process, which employs the use of absorbents such as acid-activated clays. Volatile components are removed by deodorisation, which uses steam injection under a high vacuum and temperature. The refined oil is then filtered and stored until used or transported.

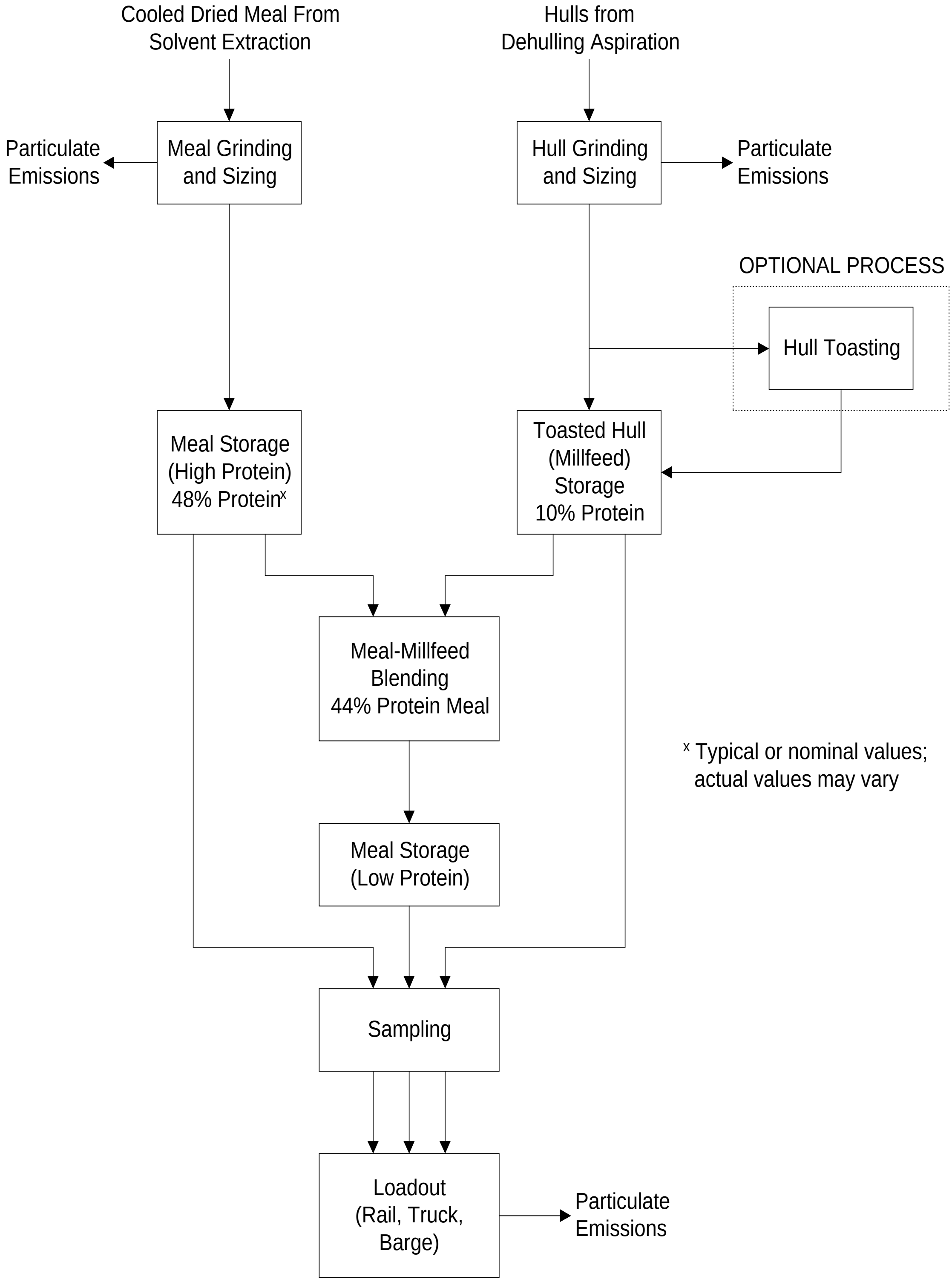

Figure 5 - Flow Diagram of the "Conventional" Process of Dry Material Sizing, Grinding, and Loadout

Source: USEPA, AP-42, Section 9.11.1, 1995

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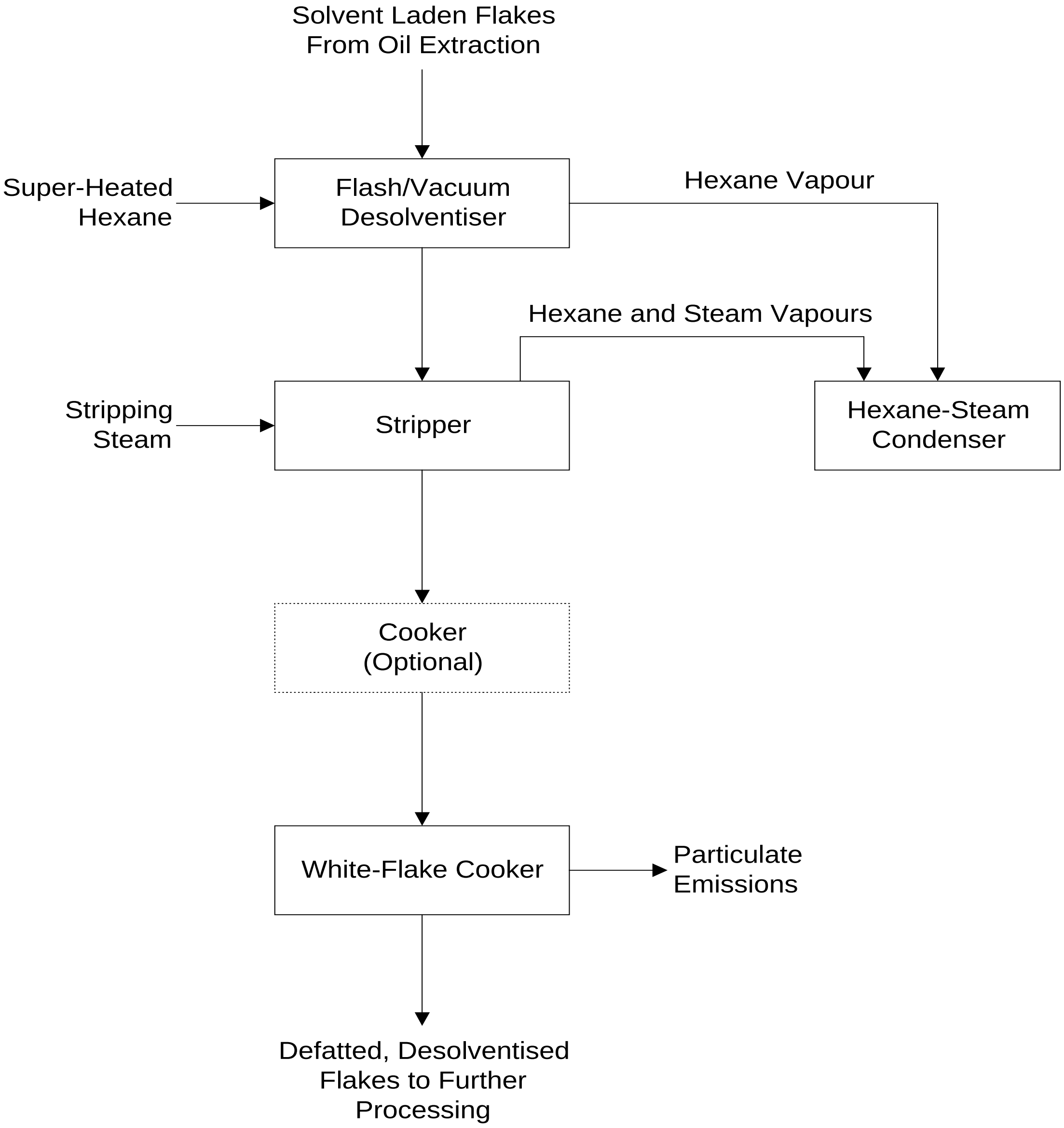

Figure 6 - Flow Diagram of the Flash Desolventising Process
Source: USEPA, AP-42, Section 9.11.1, 1995

2.2 Emission Sources and Control Technologies

2.2.1 Emissions to Air

Air emissions may be categorised as:

Fugitive Emissions

These are emissions that are not released through a vent or stack. Examples of fugitive emissions include dust from stockpiles, volatilisation of vapour from vats, open vessels, or spills and materials handling. Emissions emanating from ridgeline roof-vents, louvres, and open doors of a building as well as equipment leaks, and leaks from valves and flanges are also examples of fugitive emissions. Emission factor EETs are the usual method for determining losses through fugitive emissions.

Point Source Emissions

These emissions are exhausted into a vent or stack and emitted through a single point source into the atmosphere. Table 1 highlights common air emissions from vegetable oil processing. The *Combustion in Boilers* EET Manual, along with other Manuals in this series, is available from State and Territory environment agencies. The *Combustion in Boilers* EET Manual is designed to provide guidance on estimating emissions from combustion sources such as combustion of natural gas, oil, LPG or coal which may be of particular relevance to the vegetable oil processing industry.

Table 1 - Common Air Emissions of NPI-Listed Substances from Vegetable Oil Processing

Substances
Volatile Organic Compounds (VOCs)
Carbon Monoxide (CO)
Oxides of Nitrogen (NO_x)
Sulfur Dioxide (SO_2)
Particulate Matter (PM_{10})
n-hexane
Chlorine (Cl_2) *

Source: Queensland Department of Environment and Heritage, 1998
Chlorine is a common substance used for disinfecting/cleaning purposes, hence a possible emission source.

Air emission control technologies, such as electrostatic precipitators, fabric filters or baghouses, and wet scrubbers, are commonly installed to reduce the concentration of particulates in process off-gases before stack emission. Where such emission abatement equipment has been installed, and where emission factors from uncontrolled sources have been used in emission estimation, the collection efficiency of the abatement equipment needs to be considered. Guidance on applying collection efficiencies to emission factor equations is provided in later sections.

With regards to emission controls for PM_{10} emissions (particulate matter with an equivalent aerodynamic diameter of 10 micrometres or less ie. $\leq 10\mu m$), in the absence of measured data, or knowledge of the collection efficiency for a particular piece of equipment, an efficiency of 90% should be used in the emission factor equation to calculate actual mass emissions. This default should only be used if there is no other available control efficiency.

2.2.2 Emissions to Water

Emissions of substances to water can be categorised as discharges to:

- Surface waters (eg. lakes, rivers, dams, and estuaries);
- Coastal or marine waters; and
- Stormwater.

Because of the significant environmental hazards posed by emitting toxic substances to water, most facilities emitting NPI-listed substances to waterways are required by their relevant State or Territory environment agency to closely monitor and measure these emissions. This existing sampling data can be used to calculate annual emissions.

If no wastewater monitoring data exists, emissions to process water can be calculated based on a mass balance or using emission factors.

The discharge of listed substances to a sewer does not require you to report to the NPI. However, leakage and other emissions (including dust) from a tailings storage facility are reportable. (See also Section Three of *The NPI Guide*.)

2.2.3 Emissions to Land

Emissions of substances to land on-site include solid wastes, slurries, sediments, spills and leaks, storage and distribution of liquids and may contain listed substances. These emission sources can be broadly categorised as:

- surface impoundments of liquids and slurries; and
- unintentional leaks and spills

3.0 Emission Estimation Techniques

Estimates of emissions of NPI-listed substances to air, water and land should be reported for each substance that triggers a threshold. The reporting list and detailed information on thresholds are contained in *The NPI Guide* at the front of this Handbook.

In general, there are four types of emission estimation techniques (EETs) that may be used to estimate emissions from your facility.

The four types described in *The NPI Guide* are:

- sampling or direct measurement;
- mass balance;
- fuel analysis or other engineering calculations; and
- emission factors

Select the EET, (or mix of EETs), that is most appropriate for your purposes. For example, you might choose to use a mass balance to best estimate fugitive losses from pumps and vents, direct measurement for stack and pipe emissions, and emission factors when estimating losses from storage tanks and stockpiles.

If you estimate your emission by using any of these EETs, your data will be displayed on the NPI database as being of ‘acceptable reliability’. Similarly, if your relevant environmental authority has approved the use of EETs that are not outlined in this handbook, your data will also be displayed as being of ‘acceptable reliability’.

This Manual seeks to provide the most effective emission estimation techniques for the NPI substances relevant to this industry. However, the absence of an EET for a substance in this handbook does not necessarily imply that an emission should not be reported to the NPI. The obligation to report on all relevant emissions remains if reporting thresholds have been exceeded.

You are able to use emission estimation techniques that are not outlined in this document. You must, however, seek the consent of your relevant environmental authority. For example, if your company has developed site-specific emission factors, you may use these if approved by your relevant environmental authority.

You should note that the EETs presented in this manual relate principally to average process emissions. Emissions resulting from non-routine events are rarely discussed in the literature, and there is a general lack of EETs for such events. However, it is important to recognise that emissions resulting from significant operating excursions and/or accidental situations (eg. spills) will also need to be estimated. Emissions to land, air and water from spills must be estimated and added to process emissions when calculating total emissions for reporting purposes. The emission resulting from a spill is the net emission, ie., the quantity of the NPI reportable substance spilled, less the quantity recovered or consumed during clean up operations.

The **usage** of each of the substances listed as Category 1 and 1a under the NPI must be estimated to determine whether the 10 tonnes (or 25 tonnes for VOCs) reporting threshold is exceeded. If the threshold is exceeded, **emissions** of these Category 1 and 1a substances must be reported for all operations/processes relating to the facility, even if the actual emissions of the substances are very low or zero.

3.1 Direct Measurement

You may wish to undertake direct measurement in order to report to the NPI, particularly if you already do so in order to meet other regulatory requirements. However, the NPI does not require you to undertake additional sampling and measurement. For the sampling data to be adequate and able to be used for NPI reporting purposes, it would need to be collected over a period of time, and to be representative of operations for the whole year.

3.1.1 Sampling Data

Stack sampling test reports often provide emissions data in terms of parts per million (ppm) or grams per cubic metre (g/m^3) (dry standard). Annual emissions for NPI reporting can be calculated from this data. Stack tests for NPI reporting should be performed under representative (ie. normal) operating conditions. You should be aware that some tests undertaken for a State or Territory license condition may require the test be taken under maximum emissions rating, where emissions are likely to be higher than when operating under normal operating conditions.

This Section shows how to calculate emissions in kg/hr based on stack sampling data, and how to convert this to an annual emissions figure. Calculations involved in determining particulate emissions are used as an example, although the same calculations are applicable for most of the substances listed on the NPI. Use Equation 1 to calculate the concentration of PM_{10} in g/m^3 and use Equation 2 to calculate the hourly emission of PM_{10} in kg/hr.

Equation 1

$$C_{PM} = C_f \ / \ V_{m, STP}$$

where:

C_{PM} = concentration of PM or gram loading (g/m^3)
C_f = filter catch (g)
$V_{m,STP}$ = metered volume of sample at STP (m^3)

Equation 2

$$E_{PM} = C_{PM} * Q_d * 3.6 * [273/(273+T)]$$

where:

E_{PM} = hourly emissions of PM (kg/hr)
C_{PM} = concentration of PM or gram loading (g/m^3)
Q_d = stack gas volumetric flow rate (m^3/s)
T = stack gas temperature (C)

The information from some stack tests may be reported in kilograms of particulate matter per cubic metre of exhaust gas (wet). Use Equation 3 to calculate the dry particulate emissions in kg/hr.

Equation 3

$$E_{PM} = Q_a * C_{PM} * 3.6 * \left(1 - {moist_R}/{100}\right) * \left[{273}/{(273+T)}\right]$$

where:

E_{PM} = hourly emissions of PM in kilograms per hour, kg/hr
Q_a = actual (ie. wet) cubic metres of exhaust gas per second, m3/s
C_{PM} = concentration of PM or gram loading, g/m3
3.6 = 3600 seconds per hour multiplied by 0.001 kilograms per gram
$moist_R$ = moisture content, %
273 = 273 K (0°C)
T = stack gas temperature, °C

Total suspended particulates (TSP) are also referred to as total particulate matter (total PM). To determine PM_{10} from total PM emissions, a size analysis may need to be undertaken. The weight PM_{10} fraction can then be multiplied by the total PM emission rate to produce PM_{10} emissions. Alternatively, assume that 100% of PM emissions are PM_{10}; ie assume that all particulate matter emitted to air has an equivalent aerodynamic diameter of 10 micrometres or less ie. $\leq 10\mu m$.

To calculate moisture content use Equation 4.

Equation 4

Moisture percentage = 100 % * weight of water vapour per specific volume of stack gas / total weight of the stack gas in that volume.

$$moist_R = \frac{100\% * \dfrac{g_{moist}}{(1000 * V_{m,STP})}}{\dfrac{g_{moist}}{(1000 * V_{m,STP})} + \rho_{STP}}$$

where

$moist_R$ = moisture content, %
g_{moist} = moisture collected, g
$V_{m,STP}$ = metered volume of sample at STP, m3
ρ_{STP} = dry density of stack gas sample, kg/m3 at STP {if the density is not known a default value of 1.62 kg/m3 may be used. This assumes a dry gas composition of 50% air, 50% CO_2}

Example 1 – Calculating Moisture Percentage

A 1.2m3 sample (at STP) of gas contains 410g of water. To calculate the moisture percentage use Equation 4.

$$moist_R = \frac{100\% * \dfrac{g_{moist}}{(1000 * V_{m,STP})}}{\dfrac{g_{moist}}{(1000 * V_{m,STP})} + \rho_{STP}}$$

$g_{MOIST} / 1000 * V_{m,STP}$ = 410 / (1000 * 1.2)
= 0.342
$moist_R$ = 100 (0.342 / (0.342 + 1.62))
= 17.4%

3.1.2 Continuous Emission Monitoring System (CEMS) Data

A continuous emission monitoring system provides a continuous record of emissions over time, usually by reporting pollutant concentration.

Once the pollutant concentration is known, emission rates are obtained by multiplying the pollutant concentration by the volumetric gas or liquid flow rate.

It is important to note that prior to using CEMS to estimate emissions, you should develop a protocol for collecting and averaging the data in order that the estimate satisfies your relevant environmental authority's requirement for NPI emissions estimations.

Most food processing industries however, will not be required to use this method of EET for the reporting of substances.

3.2 Mass Balance

A mass balance identifies the quantity of substance going in and out of an entire facility, process, or piece of equipment. Emissions can be calculated as the difference between input and output of each listed substance. Accumulation or depletion of the substance within the equipment should be accounted for in your calculation.

3.3 Engineering Calculations

An engineering calculation is an estimation method based on physical/chemical properties (eg. vapour pressure) of the substance and mathematical relationships (eg. ideal gas law).

3.3.1 Fuel Analysis

Fuel analysis is an example of an engineering calculation and can be used to predict SO_2 and metal emissions based on application of conservation laws, if fuel rate is measured. The presence of certain elements in fuels may be used to predict their presence in emission streams. This includes elements such as sulfur, which may be converted into other compounds during the combustion process.

The basic equation used in fuel analysis emission calculations is the following:

Equation 5

$$E_{kpy,i} = Q_f * \text{pollutant concentration in fuel} * (MW_p / EW_f) * OpHrs$$

where:

$E_{kpy,i}$ = emissions of pollutant i, kg/yr
Q_f = fuel use, kg/hr
MW_p = molecular weight of pollutant emitted, kg/kg-mole
EW_f = elemental weight of substance in fuel, kg/kg-mole
OpHrs= operating hours, hr/yr

For instance, SO_2 emissions from oil combustion can be calculated based on the concentration of sulfur in the oil. This approach assumes complete conversion of sulfur to SO_2. Therefore, for every kilogram of sulfur (EW = 32) burned, two kilograms of SO_2 (MW = 64) are emitted. The application of this EET is shown in Example 2.

Example 2 - Using Fuel Analysis

This example illustrates how SO_2 emissions can be calculated from oil combustion based on fuel analysis results and the fuel flow information from a processing facility. The facility is assumed to operate 1500 hours per year.

$E_{kpy,SO2}$ = may be calculated using Equation 5.

Fuel flow	=	2 000 kg/hr
Weight percent sulfur in fuel	=	1.17

$$E_{kpy,SO2} = Q_f * \text{pollutant concentration in fuel} * (MW_p / EW_f) * OpHrs$$
$$= (2\,000) * (1.17 / 100) * (64 / 32) * 1\,500$$
$$= 46.8 \text{ kg/hr} * 1\,500 \text{ hr/yr}$$
$$= 70\,200 \text{ kg/yr}$$

3.4 Emission Factors

An emission factor is a tool that is used to estimate emissions to the environment. In this Manual, it relates the quantity of substances emitted from a source to some common activity associated with those emissions. Emission factors are obtained from US, European, and Australian sources and are usually expressed as the weight of a substance emitted divided by the unit weight, volume, distance, or duration of the activity emitting the substance.

Emission factors are used to estimate a facility's emissions by the general equation:

Equation 6

$$E_{kpy,i} = [A * OpHrs] * EF_i * [1 - (CE_i/100)])$$

where :

$E_{kpy,i}$ = emission rate of pollutant i, kg/yr
A = activity rate, t/hr
OpHrs= operating hours, hr/yr
EF_i = uncontrolled emission factor of pollutant i, kg/t
CE_i = overall control efficiency of pollutant i, %.

Emission factors developed from measurements for a specific process may sometimes be used to estimate emissions at other sites. Should a company have several processes of similar operation and size, and emissions are measured from one process source, an emission factor can be developed and applied to similar sources. You are required to have the emission factor reviewed and approved by State or Territory environment agencies prior to its use for NPI estimations.

3.4.1 Industry-Wide Emission Factors

Table 2 presents emission factors for total PM emissions resulting from handling and processing soybeans in vegetable oil manufacturing. Emission factors are provided for PM-generating processes for the meal production process, including meal drying and cooling.

Table 2 - Total Particulate Emission Factors for Soybean Milling[a, b, c]

Process	Control Device	Emission Factor (kg/tonne)
Receiving	None	0.075
Handling	ND	ND
Cleaning	ND	ND
Drying	ND	ND
Cracking/Dehulling	Cyclone	0.18
Hull Grinding	Cyclone	0.10
Bean Conditioning	Cyclone	0.005
Flaking Rolls	Cyclone	0.018
White Flake Cooler	Cyclone	0.475
Meal Cooler	Cyclone	0.095
Meal Dryer	Cyclone	0.09
Meal Grinding/Sizing	Cyclone	0.17
Meal Loadout	None	0.135

Source: USEPA, AP-42, section 9.11.1, 1995

[a] Emission factors are based on kilograms per tonne of soybean processed by the unit. Factors represent controlled emissions, excepted as noted. ND = No Data

[b] Emission factor uncertainty rating = E

[c] Utilisation of emission factors from this table will over-estimate the calculation of PM_{10} emission for your facility (conservative estimate as PM_{10} would probably account for 30 - 50% of total particulate matter)

Example 3 - Using Emission Factors

Table 2 shows that 0.10 kg of particulate matter are emitted from hull grinding from a soybean mill, for each tonne of soybean processed by the unit. The overall control efficiency of the pollutant is 50%. If it is assumed that the facility operates 260 days per year, then

EF_{PM} = 0.10 kg/t
Activity rate = 100 t/d * (1d/8hr)
= 12.5 t/hr
OpHrs = 8hr/d * 260 d/yr
= 2080 hr/yr
CE = 50%

$E_{kpy,PM}$ = $[A * OpHrs] * EF_i * [1 - (CE_i / 100)])$
= 12.5 * 2080 * 0.1 * 0.5
= 1300 kg/yr

3.4.2 Predictive Emission Monitoring (PEM)

Predictive emission monitoring is based on developing a correlation between pollutant emission rates and process parameters. A PEM allows facilities to develop site-specific emission factors, or emission factors more relevant to their particular process.

Based on test data, a mathematical correlation can be developed that predicts emissions using various parameters.

4.0 Emission Estimation Techniques: Acceptable Reliability and Uncertainty

This section is intended to give a general overview of some of the inaccuracies associated with each of the techniques. Although the National Pollutant Inventory does not favour one emission estimation technique over another, this section does attempt to evaluate the available emission estimation techniques with regards to accuracy.

Several techniques are available for calculating emissions from vegetable oil processing facilities. The technique chosen is dependent on available data, available resources, and the degree of accuracy sought by the facility in undertaking the estimate. In general, site-specific data that is representative of normal operations is more accurate than industry-averaged data, such as the emission factors presented in Section 3.4.1 of this Manual.

4.1 Direct Measurement

Use of stack and/or workplace health and safety sampling data is likely to be a relatively accurate method of estimating air emissions from vegetable oil processing facilities. However, collection and analysis of samples from facilities can be very expensive and especially complicated where a variety of NPI-listed substances are emitted and where most of these emissions are fugitive in nature. Sampling data from a specific process may not be representative of the entire manufacturing operation and may provide only one example of the facility’s emissions.

To be representative, sampling data used for NPI reporting purposes needs to be collected over a period of time, and to cover aspects of production of vegetable oil products.

In the case of CEMS, instrument calibration drift can be problematic and uncaptured data can create long-term incomplete data sets. However, it may be misleading to assert that a snapshot (stack sampling) can better predict long-term emission characteristics. It is the responsibility of the facility operator to properly calibrate and maintain monitoring equipment and the corresponding emissions data.

4.2 Mass Balance

Calculating emissions from a vegetable oil processing facility using mass balance appears on the surface to be a straightforward approach to emission estimations. However, it is likely that few Australian vegetable oil processing facilities consistently track material usage and waste generation with the overall accuracy needed for application of this method. Inaccuracies associated with individual material tracking or other activities inherent in each material handling stage can often result in large deviations of total facility emissions. Because emissions from specific materials are typically below 2 percent of gross consumption, an error of only ± 5 percent in any one step of the operation can significantly skew emission estimations.

4.3 Engineering Calculations

Theoretical and complex equations or *models* can be used for estimating emissions from vegetable oil processes.

Use of emission equations to estimate emissions from vegetable oil processing facilities is a more complex and time-consuming process than the use of emission factors. Emission equations require more detailed inputs than the use of emission factors, but they do provide an emission estimate that is based on facility-specific conditions.

4.4 Emission Factors

Every emission factor has an associated emission factor rating (EFR) code. This rating system is common to EETs for all industries and sectors and therefore, to all Industry Handbooks. They are based on rating systems developed by the United States Environmental Protection Agency (USEPA), and by the European Environment Agency (EEA). Consequently, the ratings may not be directly relevant to Australian industry. Sources for all emission factors cited can be found in Section of this Manual. The emission factor ratings will not form part of the public NPI database.

When using emission factors, you should be aware of the associated EFR code and what that rating implies. An A or B rating indicates a greater degree of certainty than a D or E rating. The less certainty, the more likely that a given emission factor for a specific source or category is not representative of the source type. These ratings notwithstanding, the main criterion affecting the uncertainty of an emission factor remains the degree of similarity between the equipment/process selected in applying the factor, and the target equipment/process from which the factor was derived.

The EFR system is as follows:

A - Excellent
B - Above Average
C - Average
D - Below Average
E - Poor
U - Unrated

5.0 References

Cargill Newcastle , August 1998, *Written Communication from: Monica McGahey to Rene Batchelor.*

National Pollutant Inventory Homepage
http://www.npi.gov.au

USEPA, 1995, *Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, fifth edition, AP-42. Section 9.11.1 Vegetable Oil Processing,* United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, USA.
http://www.epa.gov/ttn/chief/ap42.html

The following Emission Estimation Technique Manuals referred to in this are available at the NPI Homepage and from your local environmental protection agency (see the front of the NPI Guide for details):

- Emission Estimation Technique Manual for Combustion Engines; and
- Emission Estimation Technique Manual for Fuel & Organic Liquid Storage.