Resource for Greening Petroleum and Coal Products Manufacturers
Pollution Prevention Information

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Greening Petroleum and Coal Products Manufacturers

Toronto's ChemTRAC program includes an Environmental Reporting and Disclosure Bylaw (Municipal Code Chapter 423) that requires local businesses to track and report their use and release of 25 priority substances. The ChemTRAC program provides an opportunity for you to identify strategies for improving your environmental performance. Strategies include those that reduce the use and release of the 25 priority substances. Strategies may also reduce the use and release of other chemicals that may have a health and/or an environmental impact. This Greening Resource for Petroleum and Coal Products Manufacturers will help you understand the chemicals that you are using and find ways to reduce or eliminate their use. For additional resources, including a Guide to Reporting visit http://www.toronto.ca/chemtrac/.

Petroleum and Coal Products Manufacturers

Petroleum and Coal Products Manufacturers transform crude petroleum or coal into intermediate and end products, such as fuels (e.g., gasoline, diesel, and kerosene), finished non-fuel products (e.g., solvents, greases, and asphalt) and feedstocks for the petrochemical industry. The dominant process for this industry is petroleum refining.

Priority Substances

Toronto Public Health has identified 25 substances of priority health concern that are commonly used and released by businesses in the City of Toronto. As part of ChemTRAC, the Environmental Reporting and Disclosure Bylaw requires businesses and facilities to track and report on any of the listed priority substances that a facility manufactures, uses or releases to the environment if the amounts are equal to or above the reporting limits. In addition to the priority substances, industrial processes commonly use and release other chemicals of concern that may have a health and/or an environmental impact that are not subject to the by-law.

The Petroleum and Coal Products Manufacturing sector may use and produce some of these priority substances and other chemicals of concern. Each of these chemicals may have an impact on human health and/or the environment. This is not an exhaustive list.

Note: Facilities for the retail sale, storage and distribution of fuels (gas stations, for example) are NOT required to report under the Environmental Reporting and Disclosure Bylaw. Other facilities related to petroleum manufacturing may have to report.

In the city of Toronto, asphalt recycling is a common process that is related to petroleum and coal products manufacturing. This process uses finished petroleum products as a feedstock for the manufacture and recycling of asphalt. Asphalt recycling is included in this guide as a specific example of the petroleum and coal products manufacturing industry.

Below are the substances that may be used or produced by your facility and its operations.

Substances that may be used or produced by your petroleum and coal products manufacturing facility and its general operations

Chemical Sources	Priority Substances Tracked by ChemTRAC	Other Chemicals of Concern*
Air emissions (from decoking, process boilers, regeneration of catalyst, heater stack gas, vents, etc.):	• VOCs (toluene, xylene) • Particulate matter ($PM_{2.5}$) • Nitrogen oxides (NOx) • Benzene • 1,3-butadiene • Heavy metals: - Nickel - Lead - Chromium - Manganese - Cadmium • Formaldehyde • Acrolein	• Carbon monoxide (CO) • Carbon dioxide (CO_2) • Sulphur oxides (SOx) • Hydrogen sulphide (H_2S) • Ammonia (NH_3) • Hydrogen chloride (HCl)
Wastewater (from separation and conversion processes):	• VOCs (toluene, xylene) • Benzene • 1,3-butadiene • Heavy metals: - Nickel - Lead - Chromium - Hexavalent chromium - Manganese	• Liquid hydrocarbons • Hydrogen sulphide (H_2S) • Ammonia (NH_3) • Phenols
Solid waste items:	• Heavy metals: - Chromium - Lead - Cadmium - Nickel - Mercury • VOCs (toluene, xylene) • Benzene • 1,3-butadiene	• Hazardous and non-hazardous incinerator ash
Asphalt recycling:	• VOCs • Nitrogen oxides (NOx) • Polycyclic Aromatic Hydrocarbons (PAHs) • Chromium • Lead • Nickel	• Particulate matter (PM_{10}) • Sulphur dioxide (SO_2) • Carbon monoxide (CO) • Zinc
Equipment cleaning and maintenance operations may use or produce:	• VOCs	

Notes:

* Chemicals that may have a health and/or an environmental impact.

1. VOCs are emitted as gases from certain solids or liquids. Smog forms when VOCs are combined with nitrous oxides (NOx) in sunlight.
2. Particulate matter (PM) consists of airborne particles in solid or liquid form (e.g., dust). $PM_{2.5}$ is airborne particulate matter with a mass median diameter less than 2.5 micrometre

Understanding Your Company's Impacts: Petroleum and Coal Products Manufacturing

In petroleum and coal products manufacturing, there are several activities or processes that contribute to the use and release of priority substances and other chemicals of concern. The use and release of chemicals depends on the type of process, as well as the equipment and chemicals that are used.

Petroleum Refining (Figure 1)

Receipt and Storage of Raw Materials

The major feedstock in petroleum and coal products manufacturing is crude oil. Refineries must receive and store crude oil on a regular basis to ensure adequate inventory of feedstock. Handling procedures, such as loading, unloading and storage, must be planned and executed properly to prevent spills and leaks before refining operations begin.

Refining Operations

Specific refining processes may differ between each refinery, depending on the crude oil feedstock and the products produced. Regardless of these differences, priority substances and other chemicals of concern may be found throughout the refining operations.

Separation Processes (Figure 2)

The distillation of crude oil is a key source of air and wastewater contamination and can contribute to the release of several priority substances and other chemicals of concern. Before crude oil can be manufactured into different products it must first be desalted and separated into fractions. Distillation involves heating, vaporization, fractionation, condensation and cooling of crude oil feedstock.

Conversion Processes (Figure 3)

Conversion processes can consist of catalytic cracking, alkylation, polymerization, isomerisation, coking and visbreaking. The multiple processes used to convert crude oil into intermediate or end products require several chemical additives and significant energy input, which produces direct and fugitive emissions that contain priority substances and several other chemicals of concern. Examples include NOx from the catalytic cracking process and oily wastewater from the coking process. The majority of wastes produced from refining operations are air emissions, wastewater, and liquid waste. Air emissions are primarily due to the combustion of gas and fuel oil in boilers, turbines and other engines for heat generation.

Treatment Processes (Figure 4)

Treatment can occur at the intermediate or end product stage of the refining process. The primary purpose of the treatment process is to remove unwanted sulphur compounds and to upgrade the quality

of the desired petroleum or coal product. Further distillation, catalyst additives, and heat are generally required for several of the treatment processes, potentially resulting in air and water contamination.

Auxiliary or Supporting Operations

Several processes involved in petroleum and coal products manufacturing do not directly contribute to the production of the intermediate or end products, but serve a supporting role that is important to refinery operations. Many of these operations require significant amounts of energy and chemical inputs that can result in the release of material to air, water and landfills if not handled properly. The use of boilers, process heaters, gas treatment and sulphur recovery are examples of such operations.

Asphalt Recycling (Figures 5 & 6)

Asphalt recycling can occur onsite during roadwork or at a facility. The Environmental Reporting and Disclosure Bylaw only applies to the facilities. Two common asphalt recycling processes that occur in facilities include Hot Recycling and Cold Central Plant Recycling (CCPR). Both processes use reclaimed asphalt pavement (RAP) and other suitable asphalt products as inputs for the recycling operations. In Hot Recycling, asphalt products are combined with asphalt binder, virgin aggregates and emulsified recycling agents and are heated to produce the recycled asphalt. CCPR also uses emulsified recycling agents, but uses foamed asphalt without the presence of heat.

Releases of priority substances and other chemicals of concern may occur from leaks and spills during handling and storage procedures. As well, combustion during the recycling process may produce air emissions containing priority substances and other chemicals of concern, such as nitrogen oxides (NOx) and polycyclic aromatic hydrocarbons (PAHs).

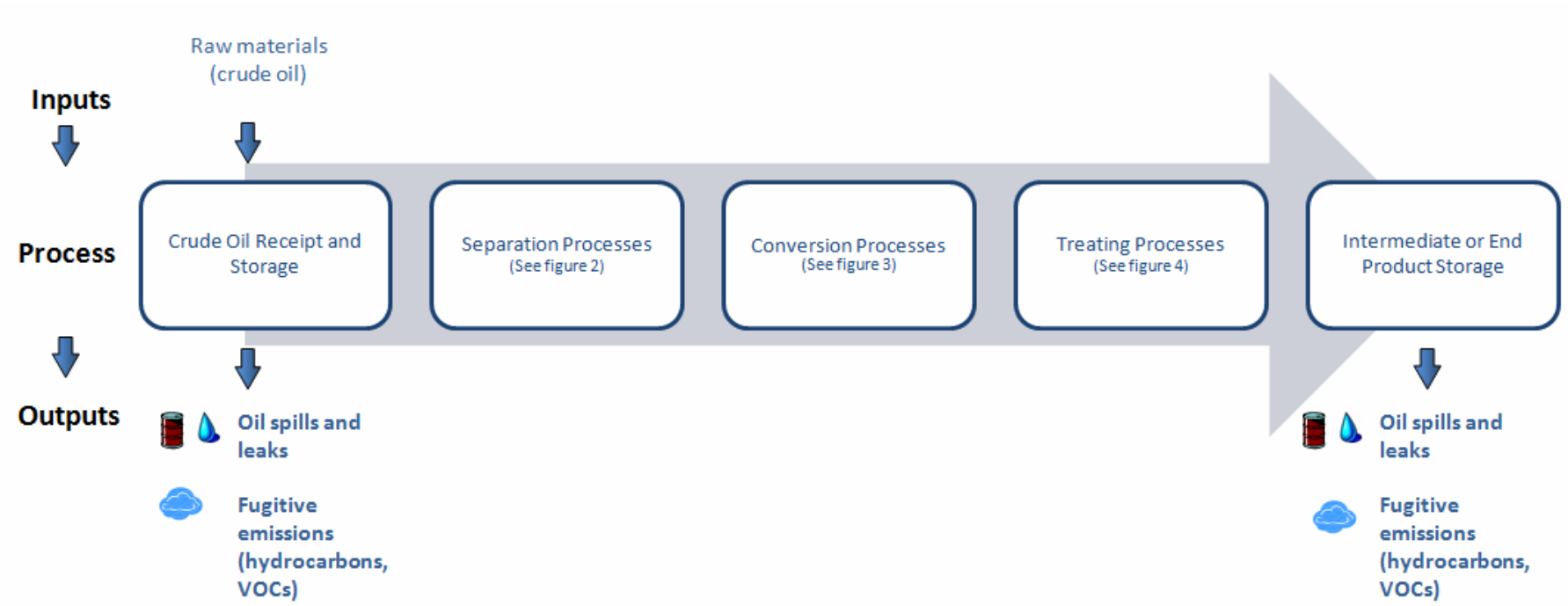
Equipment Cleaning and Maintenance

Solvents and other cleaning products used to clean and maintain equipment and work areas can contribute to air and water pollution.

The following diagrams show the raw materials that may go into each process and the pollution that comes out of each process. This guide outlines the general processes for petroleum and coal product refining, as well as the processes for Hot Recycling and Cold Central Plant Recycling. Your facility may have more specialized processes or only engage in a subset of these processes; however, it is possible that these priority substances and chemicals of concern may still be present. Symbols show whether the wastes typically go to air, landfill, sewer systems and/or treatment facilities (as liquid or hazardous wastes).

Petroleum Refining

Figure 1: Petroleum Refining



Symbols used in the flow diagram

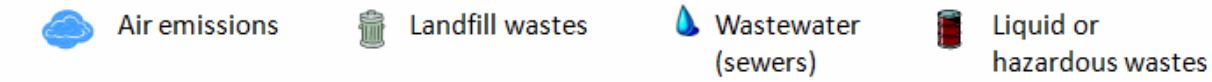
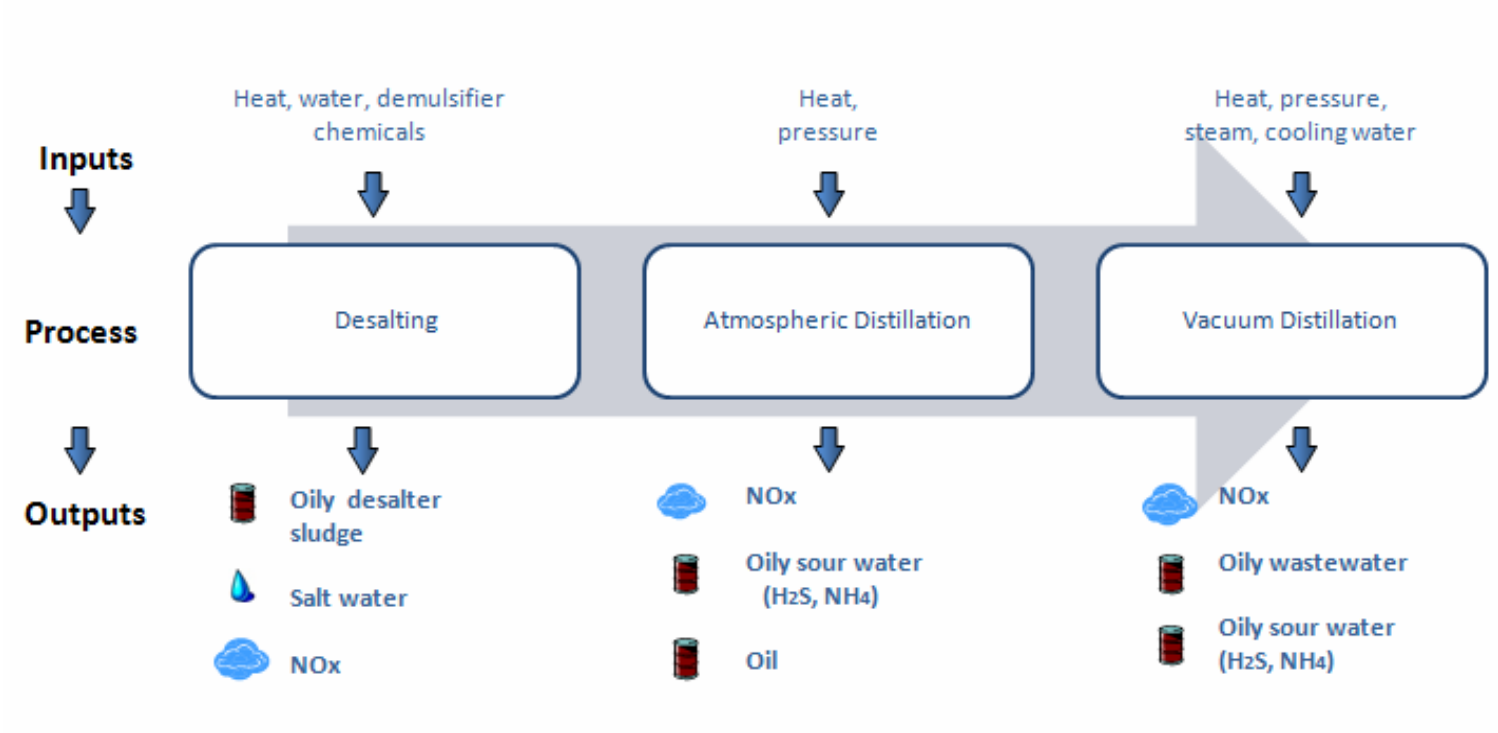
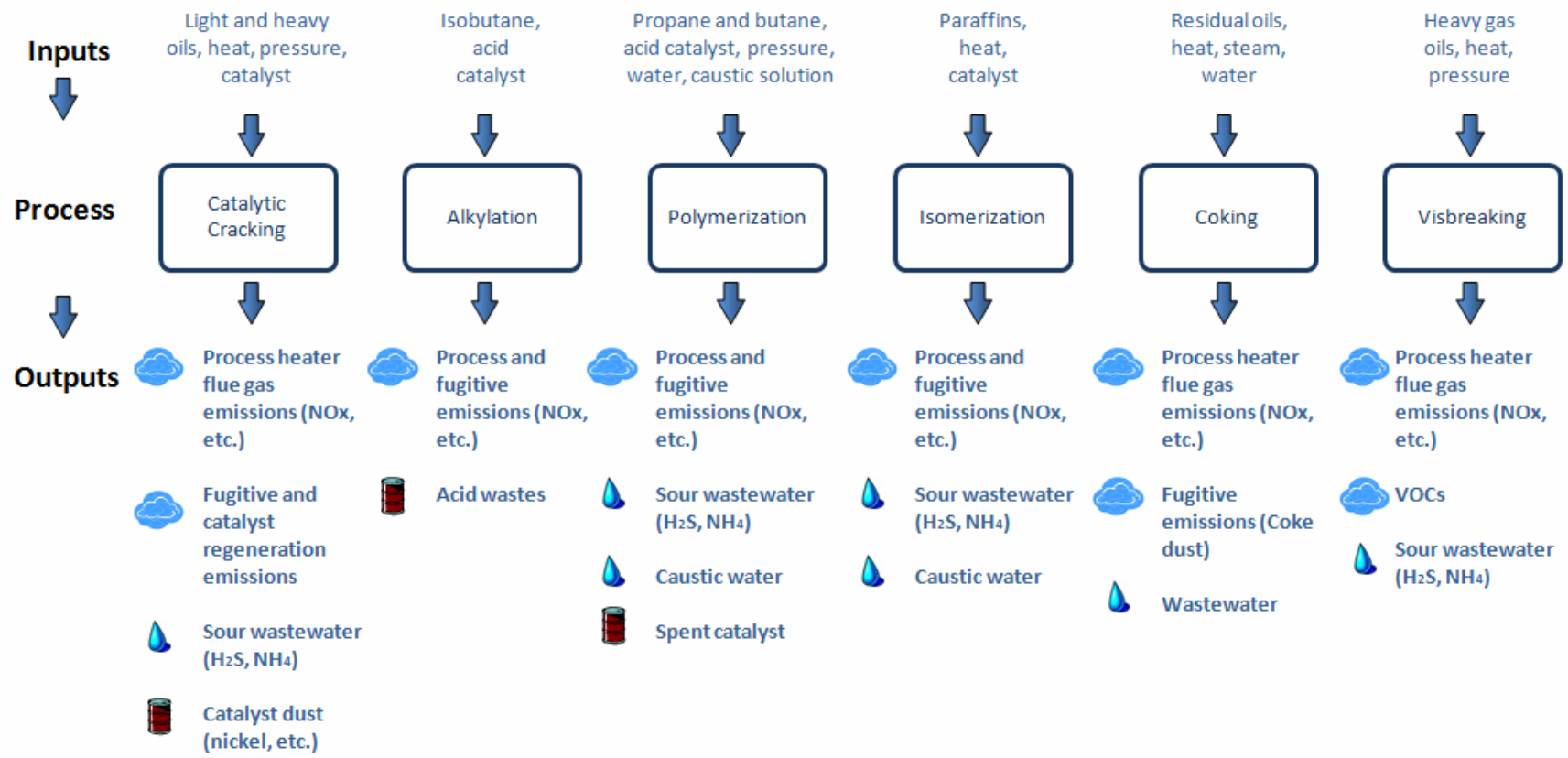


Figure 2: Separation Processes



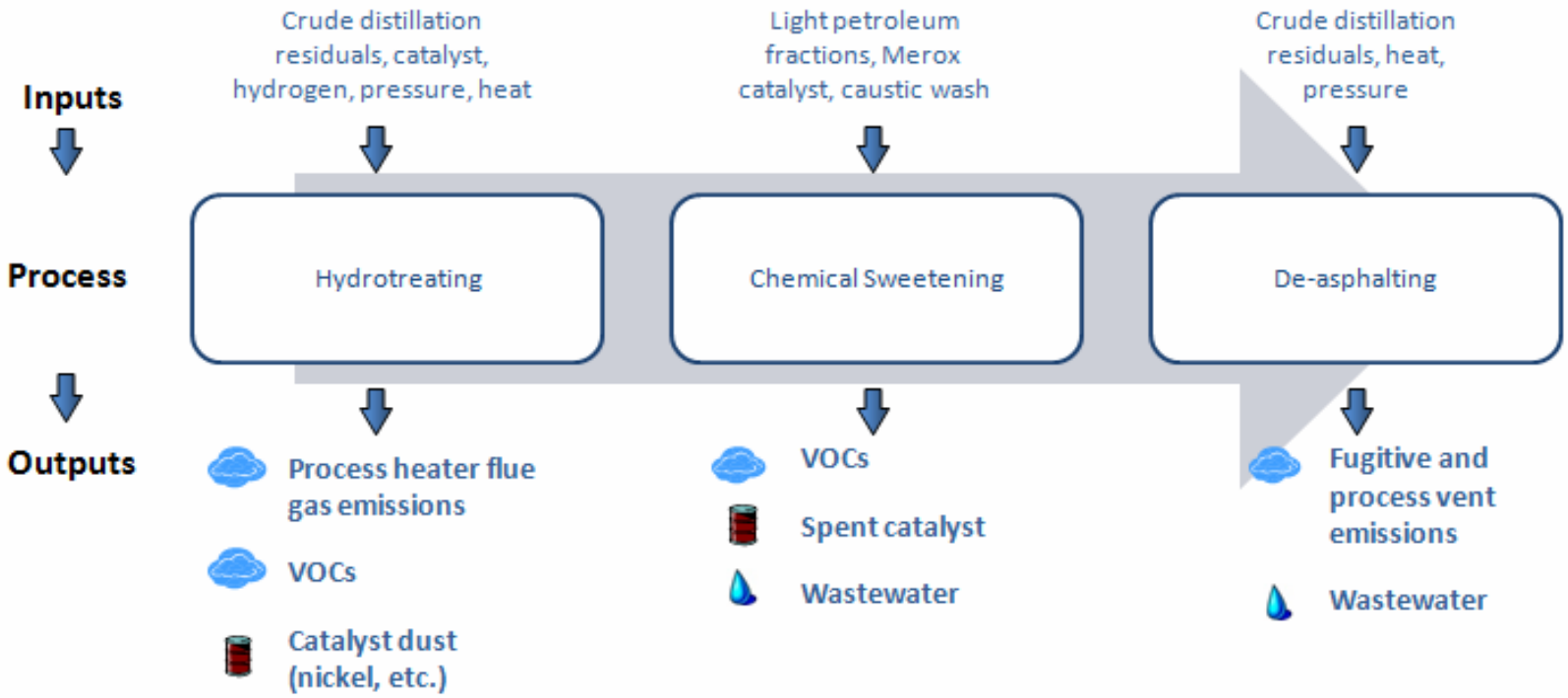
Symbols used in the flow diagram

Figure 3: Conversion Processes

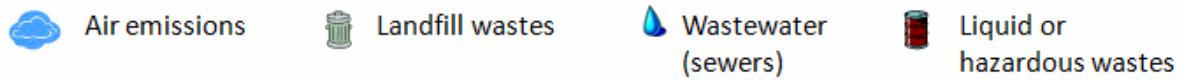


Symbols used in the flow diagram

Figure 4: Treating Processes

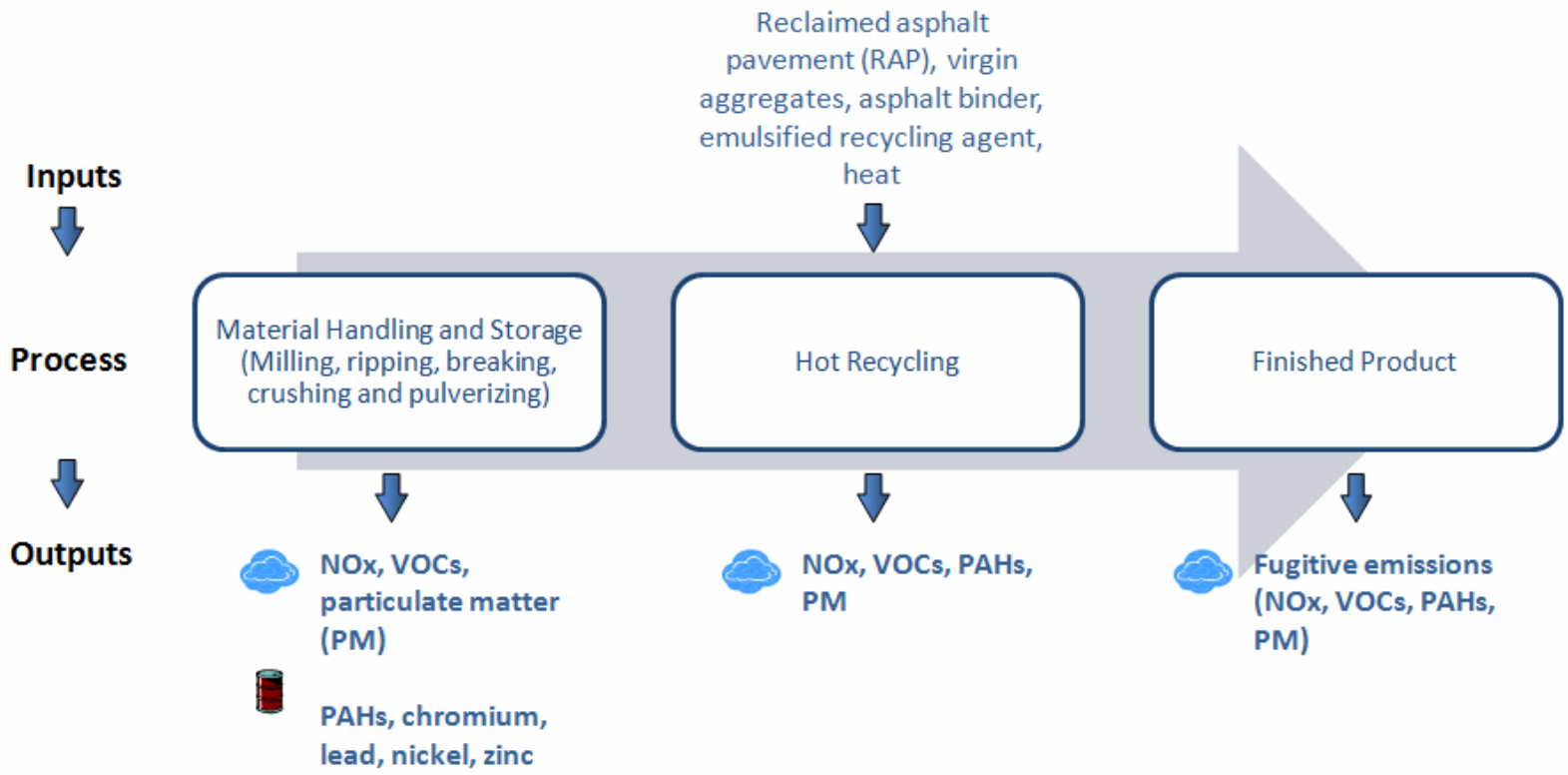


Symbols used in the flow diagram



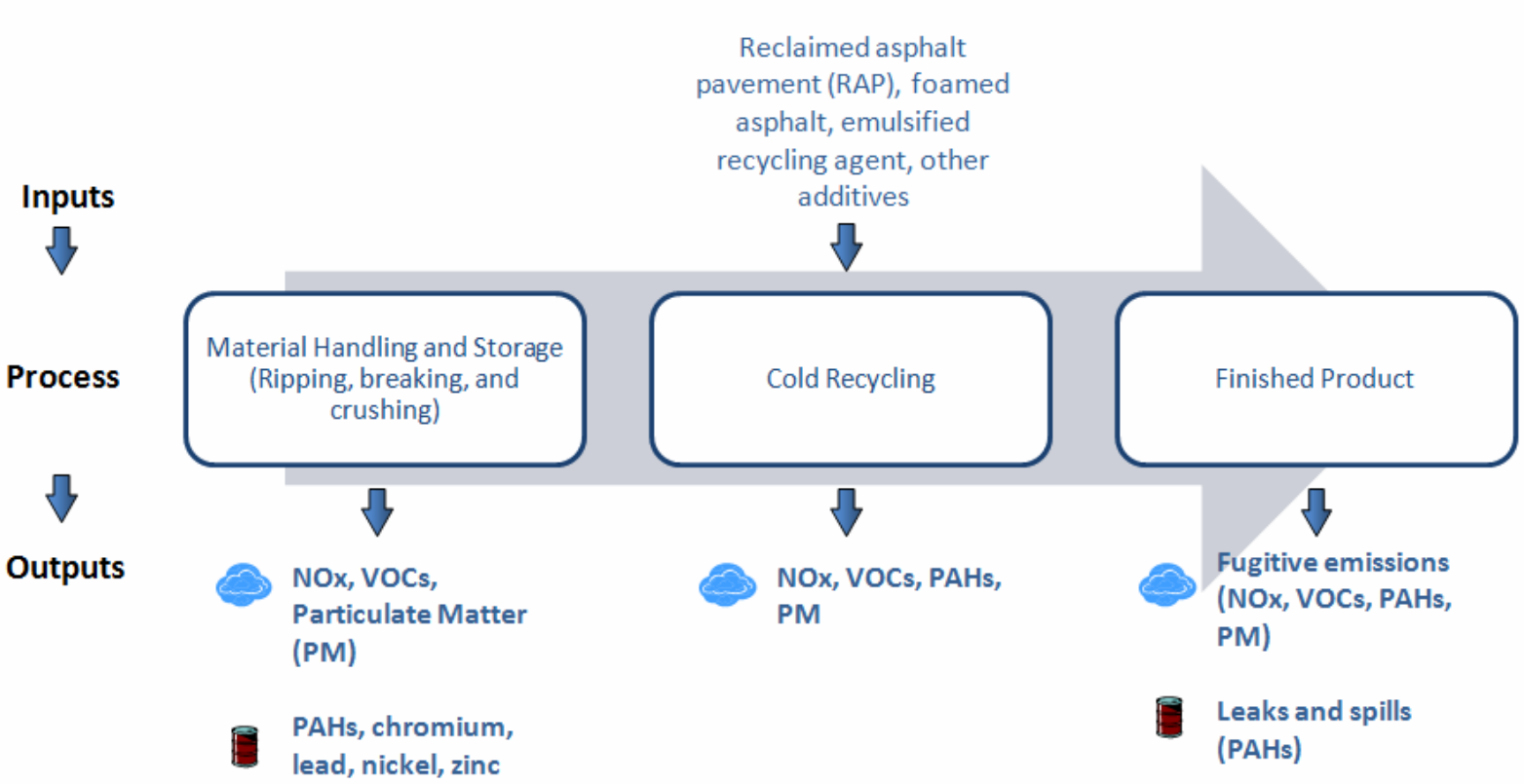
Asphalt Recycling

Figure 5: Hot Recycling Process



Symbols used in the flow diagram

Figure 6: Cold Central Plant Recycling Process



Symbols used in the flow diagram

Pollution Prevention Steps You Can Take

This resource identifies steps you can take to reduce or eliminate your use of the priority substances and other chemicals that may have a health and/or an environmental impact, and to prevent pollution in petroleum and coal products manufacturing.

> The pollution prevention measures identified in this information sheet can reduce costs and/or increase profits. 

Pollution Prevention Assessments – A Good First Step

Before you go too far with any given measure, you may want to do a Pollution Prevention Assessment of your business. You may need an outside expert to help. A typical Pollution Prevention Assessment will include mapping process flows, reviewing equipment uses, evaluating the way you use and store chemicals, evaluating the way you use energy, as well as reviewing waste handling practices and discharges. This assessment helps you to identify many pollution prevention opportunities (and any regulatory compliance issues) and decide which steps to take first.

Pollution Prevention - A Key to Good Management

Good management of your chemical purchases, chemical use and waste disposal is very important. You can improve your environmental performance through pollution prevention by:

- identifying how you are using the priority substances and other chemicals of concern that may have a health and/or an environmental impact
- figuring out how much you are using of each chemical and estimating the related emissions (see the earlier description for more information on how to estimate chemical use and emissions)
- discussing the options to reduce or to eliminate these chemicals and, where feasible, taking action. Actions could include:
    - using a different product
    - changing how you apply or clean up the chemical product/waste
    - training staff on how best to apply and clean up the chemical product/waste, or
    - installing new technology
    - maintaining equipment to ensure that leaks and general efficiencies are managed
- tracking the amount of chemicals you use and see if it goes down over time, and
- reviewing progress and identifying whether or not you need to make changes to the company's practices and procedures.

Changes you could make in your facility

The following table lists many options to help you reduce or stop using the priority substances and other chemicals of concern in your facility. Some measures will cost more than others, and some will be easier to implement than others. Operators can implement certain measures by making minor shifts in their day-to-day approaches; while others will require management to invest in new technologies.

The table provides a quick and simple way to take stock of what measures your business has already put into place and those measures that your business could apply. In completing the table, you are encouraged to prioritize the actions you would take. While it is not exhaustive, the table identifies many pollution prevention opportunities for the Petroleum and Coal Products Manufacturing sector. When assessing the options, please consider your facility-specific conditions and how each option might affect pollution releases to the air, land and water.

The table identifies three general types of options and distinguishes each with a symbol:

Low-cost, good operating procedures – These measures involve operational and managerial changes that can reduce chemical use. They include simple changes to normal practices, process improvements, as well as training and good housekeeping opportunities. This measure does not need new technology purchases.

Choosing an alternative chemical – These measures involve replacing traditional products (such as solvents and cleaning products) with products that have less harmful properties. The ease and cost of these measures depends on the product and the process used.

New technology or system – These measures involve the installation of a new system, machine or process. The cost varies depending on the technology / system.

See **More Resources** for a list of helpful resources related to pollution prevention in the petroleum and coal products manufacturing industry.

Pollution Prevention Opportunities	Type of Activity	Is the opportunity in place? Yes	No	N/A	If 'No', indicate the level of priority for action (High, Medium or Low)		
Receiving and Storing Chemicals and Raw Materials							
Regularly inspect storage and conveyance systems to prevent and control releases of liquids.		☐	☐	☐	H	M	L
Reduce Volatile Organic Compound (VOC) emissions by removing unnecessary storage tanks from service.		☐	☐	☐	H	M	L
Place secondary seals on storage tanks.		☐	☐	☐	H	M	L
Apply in-house procedures for the safe receipt and handling of crude oil containers.		☐	☐	☐	H	M	L
Use bulk storage instead of individual drums to minimize the chances of leaks and spills.		☐	☐	☐	H	M	L
Use wastewater and hazardous materials storage containment basins with water proof surfaces to prevent infiltration of contaminated water to soil and groundwater.		☐	☐	☐	H	M	L
Process and Equipment Modification							
Reduce the generation of oily water in tank bottoms through careful separation of oil and water using filters and centrifuges.		☐	☐	☐	H	M	L
Replace chromate-containing sludges from cooling tower and heat exchangers with less toxic alternatives, such as phosphates.		☐	☐	☐	H	M	L
Replace ceramic catalyst supports with recyclable activated alumina supports.		☐	☐	☐	H	M	L
Minimize the amount of solids leaving the desalter by: • Using a low shear mixing device to mix desalter wash water and crude oil. • Using low pressure water in the desalter to avoid turbulence. • Replacing the water jets with mud rakes to reduce turbulence when removing settled solids.	  	☐	☐	☐	H	M	L
Install screens over drains that are near heat exchanger bundles to prevent cleaning solids from entering the water system.		☐	☐	☐	H	M	L
Use thermal treatment for applicable sludges to separate hydrocarbon and water for recycling.		☐	☐	☐	H	M	L

 Low-cost, good operating procedures	 Choosing an alternative chemical	 New technology or system

Resource for Greening Petroleum and Coal Products Manufacturers. Toronto Public Health. December 2010.

Pollution Prevention Opportunities	Type of Activity	Is the opportunity in place? Yes	No	N/A	If 'No', indicate the level of priority for action (High, Medium or Low)		
Reduce VOC emissions by eliminating the use of open ponds for settling solids and storing process water. An alternative to open ponds is closed storage tanks.		☐	☐	☐	H	M	L
Install rupture disks and plugs on pressure valves and open ended valves to reduce fugitive emissions.		☐	☐	☐	H	M	L
Replace old boilers to reduce NOx, SOx and particulate matter emissions.		☐	☐	☐	H	M	L
Refurbish or eliminate underground piping to avoid releases to the soil and groundwater.		☐	☐	☐	H	M	L
Ensure the use of correct pressures, temperatures and mixing ratios for optimum recovery of product and reduction in waste produced.		☐	☐	☐	H	M	L
Use water softeners in cooling water systems to extend useful cycling time of the water.		☐	☐	☐	H	M	L
Install secondary seals on floating roof tanks. Where economically and technologically feasible, replace floating with fixed roofs. This can eliminate the collection of rainwater and the subsequent contamination of crude oil or finished products.		☐	☐	☐	H	M	L
Replace clay filtration with hydrotreating.		☐	☐	☐	H	M	L
Substitute air coolers or electric heaters with water heat exchangers to reduce the production of sludge.		☐	☐	☐	H	M	L
Install tank agitators to prevent solids from settling out.		☐	☐	☐	H	M	L
Use vent gas scrubbers to remove oil and other oxidation products from overhead vapours.		☐	☐	☐	H	M	L
Minimize emissions by ensuring complete incineration of flue gas by incinerating at high temperatures (approximately 800 °C).		☐	☐	☐	H	M	L
Minimize SOx emissions through desulphurization of fuels.		☐	☐	☐	H	M	L
Install mist precipitators to remove sulphuric acid mist.		☐	☐	☐	H	M	L
Install scrubbers with caustic soda solution to treat flue gases from the alkylation unit absorption towers.		☐	☐	☐	H	M	L

 Low-cost, good operating procedures	 Choosing an alternative chemical	 New technology or system

Pollution Prevention Opportunities	Type of Activity	Is the opportunity in place? Yes	No	N/A	If 'No', indicate the level of priority for action (High, Medium or Low)		
Reduce particulate matter emissions by installing: • Cyclones • Electrostatic precipitators • Bag filters • Wet scrubbers		☐	☐	☐	H	M	L
Reduce particulate matter emissions during the coking process by: • Storing coke in bulk, under enclosed shelters • Keeping coke constantly wet • Cutting coke in a crusher and convey it to an intermediate storage silo • Spraying the coke with fine layer of oil, to stick the dust fines to the coke • Using covered conveyer belts with extraction systems to maintain negative pressure • Using aspiration systems to extract and collect coke dust • Pneumatically conveying the fine particulates collected from the cyclones into a silo fitted with exit air filters, and recycle the collected fines to storage	 	☐	☐	☐	H	M	L
Ensure excessive cracking does not occur. This prevents the production of unstable fuel oil, thereby preventing increased sludge and sediment formation during storage.		☐	☐	☐	H	M	L
Waste Disposal, Segregation and Separation							
Segregate process waste streams from rainwater runoff to reduce the quantity of oily sludges. This increases the potential for oil recovery.		☐	☐	☐	H	M	L
Improve the recovery of oils from oily sludges by: • Belt filter presses • Recessed chamber pressure filters • Rotary vacuum filters • Scroll centrifuges • Disc centrifuges • Shakers • Thermal driers • Centrifuge-drier combinations		☐	☐	☐	H	M	L
Identify benzene sources and install upstream water treatment to more effectively treat benzene-contaminated water.	 	☐	☐	☐	H	M	L
Concentrate similar wastewater streams through a common dewatering system.		☐	☐	☐	H	M	L
If your facility has a direct sewage discharge, apply an appropriate pre-treatment method (e.g., solids/oil/water separator or Dissolved Air Flotation (DAF) unit). Ensure compliance with the City of Toronto's **Sewer Use Bylaw,** if applicable.		☐	☐	☐	H	M	L

 Low-cost, good operating procedures	 Choosing an alternative chemical	 New technology or system

Pollution Prevention Opportunities	Type of Activity	Is the opportunity in place? Yes	No	N/A	If 'No', indicate the level of priority for action (High, Medium or Low)		
Regularly check operation of these pre-treatment units and remove collected contaminants. Dispose collected contaminants at an approved waste management facility.		☐	☐	☐	H	M	L
Recycling Opportunities							
Recycle and regenerate spent caustics.		☐	☐	☐	H	M	L
Use oily sludges as feedstock in coking operations.		☐	☐	☐	H	M	L
Collect and reuse coke fines through dry sweeping or by placing vacuum ducts in dusty areas, which run to a baghouse for collection.		☐	☐	☐	H	M	L
Recycle lab samples.		☐	☐	☐	H	M	L
Recycle used oil.		☐	☐	☐	H	M	L
Use phenols and caustics produced in the refining operations as chemical feeds in other applications.		☐	☐	☐	H	M	L
Regenerate catalysts and recover valuable metals from spent catalysts.		☐	☐	☐	H	M	L
Regenerate filtrations clay by: • Washing clay with naphtha • Drying by steam heating • Feeding into burning kiln		☐	☐	☐	H	M	L
Maximize slop oil recovery by agitating sludge with air and steam to recover residual oils.		☐	☐	☐	H	M	L
Asphalt Recycling							
Install a new blower burner or controls for drying operations.		☐	☐	☐	H	M	L
Ensure the proper amount of air is provided to the burner. Too much excess air wastes fuel and is inefficient.		☐	☐	☐	H	M	L
Reintroduce exhaust gases into the burner to combust harmful emissions (VOCs and PAHs).		☐	☐	☐	H	M	L
Install a baghouse exhaust treatment system to collect particulates.		☐	☐	☐	H	M	L

 Low-cost, good operating procedures	 Choosing an alternative chemical	 New technology or system

Pollution Prevention Opportunities	Type of Activity	Is the opportunity in place? Yes	No	N/A	If 'No', indicate the level of priority for action (High, Medium or Low)		
Use tarpaulins when transporting or storing material		☐	☐	☐	H	M	L
House reclaimed asphalt pavement in an enclosed area (protect from precipitation, etc.) or silos		☐	☐	☐	H	M	L
Upgrade existing exhaust filters		☐	☐	☐	H	M	L
Maintenance, Management and Good Housekeeping							
Regularly check boiler combustion to ensure highest efficiency and lowest consumption of energy.		☐	☐	☐	H	M	L
Place secondary seals on storage tanks.		☐	☐	☐	H	M	L
Establish a leak detection and repair program to inspect leaks from hoses, pipes, valves, pumps and seals.		☐	☐	☐	H	M	L
Establish an employee training program to: • Train workers to reduce solids sent to sewers • Educate personnel on how to avoid leaks and spills		☐	☐	☐	H	M	L
Use non-hazardous degreasers.		☐	☐	☐	H	M	L
Employ sweeping or vacuuming of paved process areas to reduce solids sent to the sewers.		☐	☐	☐	H	M	L
Pave runoff areas to reduce transfer of solids to waste systems.		☐	☐	☐	H	M	L
Replace chlorinated solvent vapour degreasers with high-pressure power washers.		☐	☐	☐	H	M	L
Store chemicals according to manufacturer's recommendations and keep chemical storage away from drains.		☐	☐	☐	H	M	L
Provide appropriate spill containment in chemical storage and transfer areas.		☐	☐	☐	H	M	L
Keep an accurate inventory of products used (including chemical name, manufacturer, and MSDS sheet).		☐	☐	☐	H	M	L

 Low-cost, good operating procedures	 Choosing an alternative chemical	 New technology or system

Resource for Greening Petroleum and Coal Products Manufacturers. Toronto Public Health. December 2010.

Pollution Prevention Opportunities	Type of Activity	Is the opportunity in place? Yes	No	N/A	If 'No', indicate the level of priority for action (High, Medium or Low)		
Store chemicals according to need, with minimum inventory kept on hand.		☐	☐	☐	H	M	L
Keep lids on containers at all times when not in use to prevent loss of chemicals through evaporation and spills.		☐	☐	☐	H	M	L
Date containers when opened to ensure you use them before they expire to reduce waste from expired products.		☐	☐	☐	H	M	L
Use spigots and pumps when dispensing new materials and funnels when transferring wastes to storage containers to reduce spillage.		☐	☐	☐	H	M	L
For facility cleaning, substitute less harmful products, such as water-based biodegradable cleaners (no-VOC or low-VOC) or use recyclable solvents.		☐	☐	☐	H	M	L
Mark all containers to identify the contents to avoid improper handling or disposal.		☐	☐	☐	H	M	L
Develop and post a spill response plan so that it is available for all employees.		☐	☐	☐	H	M	L
Make spill kits available at the chemical storage rooms or racks for easy access.		☐	☐	☐	H	M	L
Ask employees for pollution prevention suggestions.		☐	☐	☐	H	M	L

Contact us to provide your feedback on this resource or to suggest any additional pollution prevention resources (email chemtrac@toronto.ca or call 416-338-7600).

 Low-cost, good operating procedures	 Choosing an alternative chemical	 New technology or system

More Resources

Asphalt Recycling and Reclaiming Association. 2001. Basic Asphalt Recycling Manual.
http://www.pavementpreservation.org/toolbox/links/1-124-BARM1.pdf

- A manual discussing the multiple types of asphalt recycling processes available in the United States and the related advantages of each type. Processes include:
    - Hot Recycling
    - Cold Central Plant Recycling (CCPR)
    - Cold In-Place Recycling
    - Full Depth Reclamation

Berkeley National Laboratory. 2005. Energy Efficiency Improvement and Cost Saving Opportunities for Petroleum Refineries: An ENERGY STAR Guide for Energy and Plant Managers.
http://www.energystar.gov/ia/business/industry/ES_Petroleum_Energy_Guide.pdf

- A thorough guide that introduces energy efficiency opportunities to petroleum refineries. This document provides industrial process descriptions and related energy efficiency measures from petroleum refineries worldwide. Some of these opportunities include:
    - Process optimization
    - Efficiency improvements for utilities, heaters and heat exchangers
    - Flare gas recovery
    - Energy management systems (EMS) and programs

Center for Hazardous Materials Research (CHMR). Fact Sheet: Pollution Prevention: Strategies for Petroleum Refining.
http://www.p2pays.org/ref/11/10483.htm

- A website that provides pollution prevention opportunities for selected industries. The strategies presented are specific to the petroleum refining industry and have been implemented by existing refining facilities. Pollution prevention strategies include:
    - Segregating process waste streams from rainwater runoff
    - Using the correct pressures, temperatures and mixing ratios
    - Using oily waste sludges as feedstock for coking operations
    - Installing secondary seals for floating roof tanks

Environment Canada. Petroleum Refining.
http://www.ec.gc.ca/energie-energy/default.asp?lang=En&n=1467336C-1

- This Environment Canada website offers refinement process descriptions and identifies pollutants that result from the refining process. Examples of such pollutants are:
    - Nitrogen Oxides (NOx)
    - Volatile Organic Compounds (VOCs)
    - Particulate Matter ($PM_{2.5}$)
    - Benzene

Environment Canada. 1996. Technical Pollution Prevention Guide for Asphalt Preparation Operations in the Lower Fraser Basin.
http://www.p2pays.org/ref/04/03995.pdf

- A document created specifically to offer pollution prevention opportunities for asphalt plants in B.C. This guide provides a brief description of the processes involved in asphalt manufacturing, recycling and pollution prevention measures, such as:
    - High efficiency blower burners
    - Installation of a baghouse to capture particulate emissions
    - Recycling priority substances into the burner for complete combustion

International Finance Corporation (IFC). 2007. Environmental, Health, and Safety Guidelines for Petroleum Refining.
http://www.ifc.org/ifcext/sustainability.nsf/AttachmentsByTitle/gui_EHSGuidelines2007_PetroleumRefining/$FILE/Final+-+Petroleum+Refining.pdf

- Part of IFC's technical reference documents, this report outlines the Good International Industry Practice. The EHS guidelines provide pollution prevention options for companies in the petroleum refinering industry. Among others, options include:
  - Use of vent gas scrubbers
  - Use of particulate matter reduction technology
  - Segregation of wastewater streams
  - Use of long life catalysts and regeneration

Townsend, T. 1998. Leaching Characteristics of Asphalt Road Waste. University of Florida.
http://www.beyondroads.com/visual_assets/RAP_Leachability_Study.PDF

- An academic study on the leaching of road waste from several sites. Potential sources of leaching are from stockpiling the RAP before recycling.

U.S. EPA. 1995. Profile of the Petroleum Refining Industry.
http://www.epa.gov/compliance/resources/publications/assistance/sectors/notebooks/petrefsn.pdf

- A comprehensive and detailed report that outlines petroleum refinery processes, associated waste and pollution prevention opportunities. Examples of the types of pollution prevention opportunities include:
  - Eliminating filtration clay from refinery filters
  - Replacing ceramic catalyst support with recyclable activated alumina supports
  - Recycling and regenerating spent caustics
  - Establishing a leak detection program

U.S. EPA. 1995. Compilation of Air Pollutant Emission Factors: Chapter 5.1: Petroleum Refining.
http://www.epa.gov/ttn/chief/ap42/ch05/final/c05s01.pdf

- This document offers a description of the petroleum refining industry and the process emission sources and control technology available. Emission sources include:
  - Boilers and process heaters
  - Catalytic cracking units
  - Vacuum distillation units
  - Sulphur recovery

U.S. Department of Energy. 2007. Energy and Environmental Profile of the U.S. Petroleum Refining Industry.
http://www1.eere.energy.gov/industry/petroleum_refining/pdfs/profile.pdf

- A complete report documenting the industrial processes involved in petroleum refining and the associated emissions and effluents concerning each process. Some of the pollutants include:
  - Nitrogen oxides
  - Chromium
  - Particulate Matter ($PM_{2.5}$)
  - Ammonia
  - Hydrogen sulphide