

# Strategies Concerning the Management of Environment Diagnosis in Petrochemical Technological Processing

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## Abstract

*For the contemporary society, the environment protection represents a major problem, because de economical development takes place within the environment in which we exist and perform activities. As a fact, the human activity, developing in the environment will interact with it, imposing modifications that, above a certain level, cannot be compensated by spontaneous natural processes (physical, chemical and biological) that take place in the environment, by this causing it irreversible transformations. The environment protection refers to an range of measures that ensure avoiding unbalances by nature conservation, stopping environment pollution, rational management of resources besides ecological reconstruction of partially or integrally destroyed environment.*

**Key words:** *table, emissions, pollution*

## Air Pollution Sources

The specific activities for exploration, treatment, separation, transport, processing and storage developed in the oil industry have a negative impact upon environment, producing air, soil, acoustic pollution. Environment pollution generates high expenses with regenerating the areas.

Further on we shall mention the sources and also the environment pollution agents produced in the oil industry, for each environment factor.

The emission of air pollution agents in refineries comes mainly from the following sources: combustion processes, technological installations, flares, tank batteries, cooling towers and separating basins with open surface, dynamic equipment, testing fittings, vents, flanges, pipes, loading-unloading stages, auto transport and railroad networks. The emissions of pollution in atmosphere are of two kinds:

- guided (evacuated by dispersion stacks or metallic tubing, air shafts, ventilation shafts, exhaustion pipes);
- diffuse (non-controllable evacuation recorded at manipulation of substances and products with different volatility, loading-unloading tanks, and non-tightened elements).

In installations working condition, the gas emissions result from combustion processes and technological processes.

In what concerns technological installations some of these emit also continuously or intermittent other pollution agents, even in small quantities compared with gases resulted by combustion.

In table 1 are presented technological installations and pollution agents that are emitted.

**Table 1.** Technological installations and emitted pollution agents.

Technological Installations	Pollution Agents
Air and vacuum distillation	Hydrocarbons, non condensable gases issued by the vacuum system
Hydro fining of distilled fractions and hydro treatment of vacuum distillate	Hydrogen sulphide from purging, inferior aromatics
Catalytically cracking	Gases from regenerator contain pollutants (nitric oxides, sulphur oxides, carbon monoxide, dusts)
Catalytically reformation and extraction of inferior aromatics	Benzene, toluene, xylenes
Alkylation	Hydrofluoric acid
Gas sweetening and sulphur recovering	Hydrogen sulphide and sulphur oxides
Delayed carbon producing	Coke particles, gases in water used for coke cutting
Oil solvation	Furfural from the section for solvents recovery
Oil dewaxing and de-oiling	Ammonia from cooling section, methyl-ethyl ketone, benzene, toluene from filtering section and recovery of solvents
Bitumen oxidation	Evacuated gases from oxidation reactors that contain carbon oxides, sulphur oxides, hydrogen sulphide, hydrocarbons, oxygen compounds
Refining with chemicals	Sulphur oxides, sulphuric acid
Additives	Reaction gases that contain hydrochloric acid and hydrogen sulphide

## Water Pollution Sources

In what concerns the sector for oil exploration and production, the possible pollution sources can appear along the entire flow of technological extraction process of hydrocarbons from underground, which are the following: oil, gas and water injection in reservoir, tank parks and separators (inclusive for treatment); oil storage. Other pollution sources can be: oil collecting centers, batteries of boilers for steam production (especially at purging equipment); water softening stations (from where results used water); oil products collecting system (decanters, sludge boxes, header slots).

The main sources that determine pollution of maritime areas and implicit the beaches are especially ocean liners that transit Romanian territorial waters.

Due to complexity of processing processes, by continuous flux activity and especially due to installations high capacity, the refineries use huge amounts of water fact that results in a great volume of used waters. In most processes, the effluents resulted have a high degree of pollution as result of water contamination with gas liquids and solids. The residual waters evacuated from a refinery are the result of summing used waters provided from the numerous primary processing processes at which crude oil is submitted, to secondary processing processes in the purpose of superior capitalization.

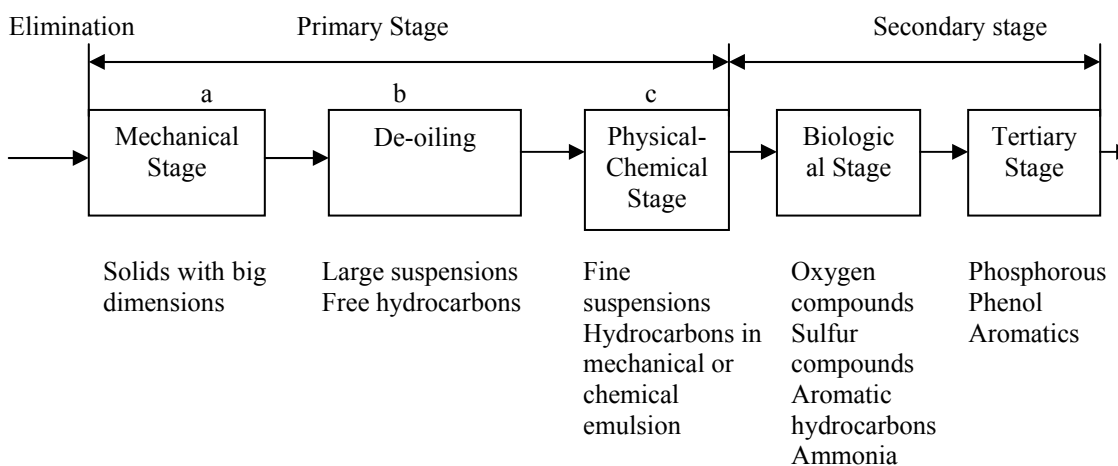
The pollution of waters used in refineries depends on oil quality and its processing method, in the purpose of gaining products with certain characteristics. From high quantities of water used in refineries, (from 3/1 up to 70/1 versus oil), 5-20% are residual polluted waters that must be treated before being discharged in emissaries. The residual waters from refineries and

petrochemical plants practically contain all the range of organic and inorganic residual products, specific for production facilities.

Referring to origin sources, the contaminated waters from refineries can be classified as technological waters, cooling waters, meteoric waters and sewage waters.

Technological waters or of process are impure with petroleum products or compounds originated from reactions that take place in processing installations. From technological processes result used waters as a result of using them as cooling agent or washing agent.

Treatment of water coming from oil refinery installations is performed in usual mode by conventional purification systems, according to diagram presented in Figure 1.



**Fig 1.** Treatment stages for used waters resulted from oil refinery installations

This contains on chronological and technological level:

- the primary stage that has main scope removing substances in suspension and oil products;
- the secondary stage (biological) that assumes removing soluble organic substances in colloidal state by biochemical means;
- the tertiary stage, rarely used until the present but with increasingly higher perspectives to be used in the future, finalizes removal of organic substances and suspensions and in some cases, elimination of nitrogen and phosphorous from secondary effluent.

It is not possible to provide a global solution for purification of wasted waters from refinery.

## Acoustic Pollution Sources

In refineries and petrochemical plants, the installations are built in open spaces for security reasons for avoiding reaching concentration of products within explosion limits. These installations radiate noises without retention barriers from walls, fact that produces inconvenience for working personnel and for those that live nearby the industrial zone.

As known, the noise is defined as a disorderly overlay of sounds with different intensities and frequencies. The acoustic level of noise can be measured with the help of a sonometer that indicates the global level expressed in dB.

For refineries and petrochemical plants, the specialty paperwork recommends a specific level of sound energy on surface unit of  $65 \text{ dB/m}^2$ , as average on perimeter of industrial platforms, while in installations can be accepted  $75 \text{ dB/m}^2$ . In generally the maximum limit admitted for noise at

common working places that require a reduced request for attention is of 90 dB/m<sup>2</sup> (A), acoustic level equivalent continuously, weekly.

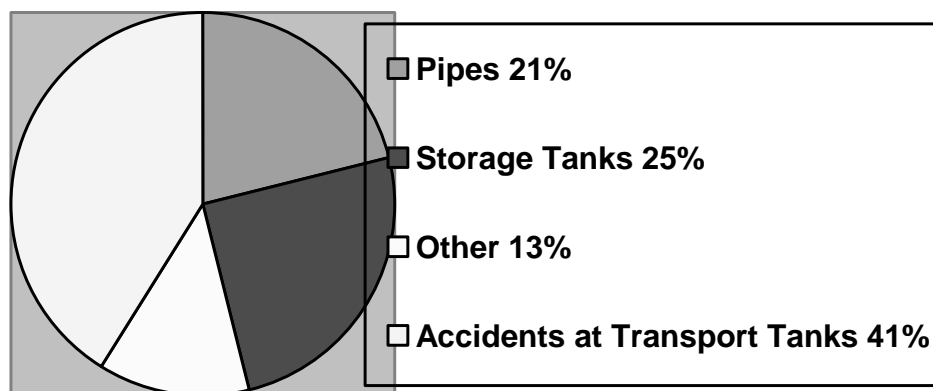
Reducing noise and vibration during functioning of certain equipment constituted and still constitutes a concern for specialists in the field.

## Soil Pollution with Oil Products

In refineries, soil pollution can be direct, caused by slugging of solid or semisolid residues, resulting from the development of technological processes or indirect due to pollution agents released in the atmosphere, carried by wind that deposit on the soil and are washed by precipitations, infiltrating underground.

The potential sources for direct soil and underground pollution can be tank farms, old separators from purification stations, separation basins, skimming pits and tars, underground pipes and sewer networks. The solid residues, improperly stored, that can pollute the soil originate from: solid impurities driven by oil, sludge from purification of wasted water and from treatment of raw water, solid residues originating from maintenance and cleaning operations, ashes from sludge incinerator, coke from the coke installation or de-coke ovens, catalyst fines.

Oil residues that appear near the wells or oil refineries, pipes for oil or petroleum products transport represent an important source of pollution both for the soil and surface or underground water. Buried tanks for oil storage, of certain petroleum products, chemical substances, by degradation of walls and foundation frame present dangerous drains that reach the soil, degrade it and make it improper for other utilization. The oil losses, on global level, are presented in figure 2.



**Fig 2.** Losses of oil or petroleum products from tanks, pipes as result of accidents

Oil or petroleum products tanks have a big surface contact with the soil. At corrosion of tanks bases can appear drainage of petroleum products. The losses in small quantities can not be highlighted and they can result soil impurity. At drainage from the tank, the product overflows in perimeter of recipient park. The spilled product is in generally collected in the drainage system and recuperated at purification of wasted waters but due to fissures in the drainage, they can infiltrate in the soil. If the walls of residues and sludge boxes are not sealed appropriate, the petroleum products can infiltrate in the soil. Earthquakes produce fissures through which petroleum products flow into the soil and underground. Breaking of the pipes leads to draining a part of the product in the soil. In the case of underground pipes, establishing the leaks is more difficult.

Even if they are stripped at exiting the reactor, used catalysts contain traces of petroleum products and when they are stored directly on the soil, they can be washed by meteoric waters, so damaging the soil. Meteoric waters can wash petroleum products that appear accidentally on roads, platforms; loading stages and a part of these waters polluted with petroleum products contaminate soil and underground.

Other sources of pollution are: continuous leakage from transport pipes due to accidental fissures on long distances, exploitability of research wells and exploitation of wells in oil fields, pollution of beaches and river banks by intention or accidental overflow.

## **Air Pollution**

Air pollution is without doubt, the most serious problem, on short and medium term from the health point of view and especially this is why solving this problem head priority for the policy of environment protection. Polluted air is more difficult to avoid than polluted water. Its effects, that penetrate all over, bring damage to health, damages constructions and natural habitat. Air pollution can be natural or human made. Natural pollution can be caused by soil erosion, volcanic eruptions, breathing, biodegradation and others. The man is responsible for pollution by: burning fossil fuels, burning forests, emissions due to motors with internal burning, treatment of residual waters, industry and others. A few billions of tones of different substances are released yearly from the surface of the earth into the atmosphere.

The concentration of these substances in the atmosphere is determined by the rate of emissions and the rate of degradation which these substances support in time. The most important of these substances are measured they originating from different sources. Carbon dioxide emissions, methane and monoxide nitrate are continuously monitored in different countries due to their contribution to heating effect and chlorofluorocarbons due to their effect upon the ozone layer. In the earth's history there were alternative periods of heating and cooling.

The increase of main emissions, started approximately 200 million years ago, with the beginning of industrialization, determined the scientists to forecast an increase of earths temperature with 3-5<sup>0</sup> C. Today we find ourselves in a period of heating that can lead to changes in distribution of precipitations, changes in areas of vegetation and can induce soil damage and decreasing of food sources. The main contribution at heating effect is given by carbon dioxide (approximately 50%), followed by methane (19%) and chlorofluorocarbons (17%). The increase of carbon dioxide emissions is directly connected to increasing energy production and traffic while increase of methane is related to the increasing necessities of mankind for food (animal production).

The oil industry has a major contribution to these emissions. In what concerns oil refining, the main pollution elements are: sulphur dioxide, nitrogen oxide, volatile organic compounds (phenols, hydrocarbons), acids, oil, carbon monoxide, aldehyde, ammonia, dusts. Also, the auto traffic in our country contributes with 45% at total of volatile hydrocarbon emissions and with 30% at lead emissions. So, aromatic compounds from gasoline for automobiles favors the emission of unburned hydrocarbons and products formed from incomplete oxidation in the environment, the benzene from exhaust pipes has cancerous properties, volatile organic compounds pollute the atmosphere, sulphur compounds can produce corrosion and acid rain. When lead concentration in the air overpasses the maximum admitted level, that is 10 grams on square meter, there can be a discussion upon development of lead intoxication. In these cases, the population from affected areas risks diseases of blood, bone spine and liver, appearance of anemia or decrease of life period for red cells, with digestive and cerebral consequences (reduces intelligence coefficient for children). In same measure, there have been discovered disorders in behavior and personality, the most frequent illness caused by lead is neuro psychic syndrome – encephalopathy (characterized by confusion, lack of orientation, visual

hallucinations, delirium, suicide attempts, shaking and convulsions). There are cases in which appear paresis and paralysis, photophobia, strong headaches, renal affections with degenerative damages, allergy illness as bronchia asthma. Being a strong substance at cell level, the lead retained in organism deposits in bones at a 90% level.

Another important consequence of pollution is the presence of acid rain, due especially to nitric oxides, most of them produced from various combustion processes (plants, motors) and in a smaller degree, due to production of nitric acid. Sulphur oxides are also responsible for these acid rains that produce damage to forests and lakes. These result from burning fossil fuels, producing of sulphuric acid from the installations for gas desulphuration.

The presence of sulphur oxides above admitted levels produces affections of breathing system, inflammatory diseases of the liver, affections of the digestive system, malign tumors for nasal fosses and medium ear, toxic encephalopathy and malign tumors, pneumotorax, leukemia and renal insufficiency. A major pollution source represents the emission of volatile organic compounds, as important sources being the following: incomplete burning of motors with internal combustion, storage, gasoline manipulation and vaporizing, production of aromatic intermediaries, the use of solvents for various purposes, refrigerators and so on. Air pollution was always the unwanted side of human activities, with a damaging effect upon health. Unfortunate, the earth can not be divided in clean areas and polluted areas, this because the pollution has no limits.

Pollution emissions can establish a large range of effects, starting with unpleasant smells up to serious damage upon people's health (the London smog in 1952 caused 400 deaths and many other ecological disasters). Besides inhaling the pollutants from the atmosphere, the people ingest them with water and food, these having an effect upon their health. There is not to be neglected the long term effects of inhaling these pollutants. The most affected is the respiratory system, effects being found upon the circulatory system, upon kidneys, the immune system and the nervous one.

The relevant pollutants for the environment medicine are: sulphur dioxide, nitric oxides, ozone, carbon monoxide, dust heavy metals, hydrocarbons and chlorination compounds. Most of them have a high potential of cancer, importance representing: benzene, cadmium, diesel engines emissions, polycyclic aromatics and dioxin. The pollutants effects can be reversible and irreversible. In the case of mentioned substances, with irreversible effects (cancerous), there must be made special efforts for reducing or limiting them.

The pollutants effects are studied with experiments upon animals, in vitro experiments, human case studies, epidemiology studies. A series of person categories present a special sensibility: children, pregnant women, persons with genetic predispositions. They must be treated individually.

The soil is an environment factor that presents the most reduced variable in time, integrating all the consequences of pollution. So, increasing its acidity leads to disorders of its regenerating processes, composition modification, releasing metallic ions, with negative effects upon vegetation and upon underground water. The atmospheric pollutants generated by the oil industry accelerates the degradation processes of construction materials, causing, in the case of construction stone erosion of the surface, dirt, crust shaping. Also, they determine corrosion, , tarnishing, metal punching, discoloration, dirt, peeling, cracking, paint exfoliation and other organic coverings.

Between the effects of mentioned pollutants can be remarked also those upon electrical installations. In this mode, problems appear at electrical networks due to contacts and cables corrosion and favoring the phenomenon of electric discharge and creating of voltage on high voltage insulators.

## Conclusions

1. The emissions of air polluting agents in refineries are generated, in principal, from the following sources: combustion processes, technological installations, flares, tank parks, cooling towers and separating basins with open surface, dynamic equipment, testing fittings, vents, flanges, pipes, loading-unloading stages, auto transport and railroad networks. The air pollution agents produced in refineries can contain: carbon dioxide, sulphur oxides, nitrogen oxides, volatile organic compounds (especially hydrocarbons) and solid particles of various sizes. The installations for filtering emissions in the atmosphere are: dispersion shafts, filters and cyclones.
2. The residual waters evacuated from a refinery are the result of summing used waters provided from the numerous primary processing processes at which crude oil is submitted, to secondary processing processes in the purpose of superior capitalization. The residual waters from refineries and petrochemical plants practically contain all the range of organic and inorganic residual products, specific for production facilities. All these categories of polluted waters originating from refineries must be purified, that means elimination or reduction of all impurities under certain limits, before overflowing them in emissary, so these waters can not damage the receptor in with they are evacuated and not interfere in using its waters.
3. Soil pollution can be direct, caused by slugging of solid or semisolid residues, resulting from the development of technological processes (tank farms – leakage of petroleum products, old separators from purification stations, separation basins, skimming pits and tars, loading-unloading stages); indirect due to pollution agents released in the atmosphere, carried by wind that deposit on the soil and are washed by precipitations, infiltrating underground.

The solid residues, improperly stored, that can pollute the soil originate from: solid impurities driven by oil, sludge from purification of wasted water and from treatment of raw water, solid residues originating from maintenance and cleaning operations, ashes from sludge incinerator.

4. Between acoustic pollution sources in refineries can be mentioned: compressors and turbo compressors, ventilators and turbo blowers, ventilation installations, pipes which vehicle gases at high speeds pumps and electro pumps, thermo electrical facilities, mechanical workshops and ovens.
5. In what concerns oil refinery the main air pollutants are: sulphur dioxide, nitrogen oxides, volatile organic compounds (phenols, hydrocarbons), acids, oil, carbon monoxide, aldehydes, ammonia and dusts. As main pollution sources can be mentioned: incomplete burning of motors with internal combustion, storage, gasoline manipulation and vaporizing, production of aromatic intermediaries, the use of solvents for various purposes, refrigerators and so on. The effects of specific pollutants from oil refinery released in atmosphere can take action upon: humans (serious damages upon health state), vegetation (chlorination and necrosis, reducing photosynthesis and transpiration), water and soil (increasing water acidity, its opacity, affecting aquatic flora and fauna, spontaneous flora and that from culture), constructions (accelerated deterioration of construction materials, corrosion, tarnishing, metal punching), and installations (problems appear at electrical installations due to contacts and cables corrosion).
6. As a result of different human actions, including the activities developed in the oil industry modifications appear, in quantity and quality, the substances that penetrate in water, producing water pollution that leads to unbalancing the environment. The pollution substances present in wasted waters originate from various types of installations from refineries are unpurified with oil, oil fractions, naphtenic acids, phenols, compounds with sulphur, oxygen, azotes, salts. So the overflow from refineries of wasted waters with a high

content of pollutants can affect receptor waters, especially by pH modification, by consumption of dissolved oxygen or by toxicity that affects the receptors water quality, respectively their flora and fauna.

The level of water pollution increased very much in the last decades, especially in those regions on the globe in which the population and industry have developed strong and fast, without taking any measures for water protection.

7. There are numerous pollution products that affect soil and underground, such as: fuels and oils, oxygenated products, hydrocarbons residues, crude oil, other products resulted from exploitation (aliphatic carbons saturated and non-saturated and the monocyclic and polycyclic aromatics). The polluting petroleum products, especially hydrocarbons, present hazard risks, affecting the quality of underground waters that become improper for use long periods of time (drinking water, for irrigations and different industrial uses).

Also it presents human health hazards, for bio environment and for vegetation, the aromatic compounds having a great mutagen and cancer character and not by the last, affects environment safety; presenting risks of explosion and fire, when the petroleum products that floats in the phreatic layer, reach the basement of different constructions. All these risks are related, mainly to the mobility of polluted product. Taking action as an extremely aggressive factor, the pollution affects mainly, the biochemical and chemical processes from plants and soil, followed by the decrease of resistance for individual and collective organisms at illness, pests and other adversities. Furthermore are triggered chained ecological unbalances, with unfavorable consequences upon stability, vitality, regeneration capability and upon the multi functionality of land ecosystems. Once reaching the underground, the petroleum products are submitted to important chemical transformations, the speed of degradation for petroleum products in the soil varies according to level of air in the polluted soil. In this mode, the soil can be submitted to actions that affect all its functions: physical, physical and chemical, chemical, biological and biochemical.

8. The noises from different sources, related to their intensity level, generate different effects of nature and damage upon humans, such as: unwanted physical effects, arterial hypertension, deafness, gastritis or duodenal ulcer. The effects of vibrations and noises take action by relative movements, ligament ruptures and even bleeding or internal organs, related to their energy and action direction. Vibrations can have effect upon certain parts of the human body (hands) and upon equipment (fact that results in the phenomenon of material stress).
9. The environment protection in Romania is regulated by a series of normative documents (laws, government decisions, standards, orders from different ministries, special orders) that create the necessary juridical frame from protection of environment factors, of consumers and respecting the principles of durable development. The main directions for action in the purpose of environment protection are set by the Urgency Order nr. 195/2005 concerning environment protection. On its basis are or shall be issued other special normative acts, to regulate specific domains (Law for Water, Law for Forests and so on).

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## Unele strategii privind managementul diagnozei de mediu în procesări tehnologice petrochimice

### **Rezumat**

*Pentru societatea contemporană, protecția mediului ambiant reprezintă o problemă de importanță majoră, deoarece dezvoltarea economică are loc în cadrul creat de mediul ambiant în care existăm și ne derulăm activitatea. În mod concret, activitatea umană, desfășurându-se în mediul înconjurător, va interacționa cu acesta, impunându-se modificări care, dincolo de un anumit prag, nu mai pot fi compensate de procesele naturale spontane (fizice, chimice și biologice) ce au loc în mediu, determinând astfel transformări ireversibile ale acestuia. Protecția mediului ambiant se referă la un ansamblu de măsuri care să asigure evitarea dezechilibrelor prin conservarea naturii, stoparea poluării mediului, gospodărirea rațională a resurselor, precum și reconstrucția ecologică a mediului distrus parțial sau integral.*