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Deal with Environmental Challenges in Civil and Energy Engineering Projects Using a New Technology

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Abstract

In many cases, industry has main role in environmental crises especially in civil and energy projects. For example, more than 60 percent of annual greenhouse gas emissions are related to the industrial activities in the world (transportation fuels and distribution 25.3%, power stations 21.3%, industrial process 16.8%). Studding of air, water, and soil pollutions as separately may cause neglect from address to a comprehensive look in industrial pollution issue. In addition, without the exact information about quantity and quality of pollution sources, reduce or eliminate industrial pollutions are not possible. Environmental flow diagram (EFD) is made based on energy reference system (RES) and process flow diagram (PFD) for each industrial company or unit. In this paper, by coding in visual basic program environment, EFD designed for determining sources of pollutants, division sources of pollutants flows based on acceptor environment, and explaining impact of solutions to the energy optimization and reduce environmental pollutants. EFD is an user friendly software that can be used in all of the industrial companies and civil and energy projects for detailed knowledge of pollution level of the area to solution of environmental crises.

Keywords: Environmental crises; Civil engineering; Computer modeling; Energy engineering, Environmental solutions; Pollutant sources identify; Optimization solutions

Introduction

Environmental crises study in industrial units has been aimed at many researches, which some of them will be described in the following.

Allen and Rosselot [1] studied pollution prevention at the macro scale. Banerjee et al. [2] showed application of air pollution dispersion modeling for source-contribution assessment and model performance evaluation at integrated industrial estate-Pantnagar. Chakrabarti and Mitra [3] researched Economic and environmental impacts of pollution control regulation on small industries. The deterioration in water quality has an adverse on human beings as well as aquatic ecosystem directly or indirectly [4-6]. Filibeli et al. [7] controlled pollution in organized industrial districts in Turkey successfully. Valipour et al. [8] applied EFD for health, safety, and environment (HSE) sections successfully. Kakar and Bhatnagar [9] survived ground water pollution due to industrial effluents in Ludhiana, India. Krishna et al. [10] assessed heavy metal pollution in water using multivariate statistical techniques in an industrial area in India. This study indicated the necessity and usefulness of multivariate statistical techniques for evaluation and interpretation of the data with a view to get better information about the water quality and designs some remedial techniques to prevent the pollution caused by hazardous toxic elements in future. Li et al. [11] studied on estimating unit loads of pollutants from industrial wastewater discharges. The results showed that all of the estimation models for the unit loads of pollutants have been generated for each industry, with 95% confidence levels for the validity test. Ma [12] analyzed the distribution of industrial pollution sources in U.S. and China. The study found that race and income-the two common lenses used in many U.S. studies played different roles in the Chinese context and rural residents and especially rural migrants were disproportionately exposed to industrial pollution. Magiera et al. [13] used soil magnetometry for mapping particulate pollution loads in urban forests in the Upper Silesia Industrial Region, Poland. They said that very low soil pH usually favored the release of heavy metals and other toxic elements into the soil environment, and through the soil, directly into the forest ground flora and underground water system. Nelson-Smith [14] researched the problem of oil pollution of the sea. Ntengwe [15] reviewed industrial wastewater treatment and analysis as means of preventing pollution of surface and underground water bodies in Zambia. Oketola and Osibanjo [16] estimated sectoral pollution load in Lagos by Industrial Pollution Projection System (IPPS). The degradation of surface and groundwater quality due to industrial and urban waste has been recognized for a long time [17]. The untreated or partially treated effluent on entering a water body either gets dissolved or lie suspended on river bed, thereby causing the pollution of water body [18]. Pearce and Kingham [19] studied environmental inequalities in New Zealand. Pen-Mouratov et al. [20] introduced soil free-living nematodes as indicators of both industrial pollution and livestock activity in Central Asia. This study confirmed that the grazing in accompaniment to industrial pollution, intensify a negative effect on soil nematode communities. Ramzan et al. [21] evaluated and improved environmental performance of HC's recovery system. Rathore [22] studied on pollution load induced by dyeing and printing units in River Bandi at Pali, Rajasthan, India.

In all previous researches, pollution acceptor sources (air, water, and soil) have been studied as separately, but these three sources are inseparable. Generally, in environment field and related science, the most of previous studies have been done about forecasting or management (increasing efficiency, etc.) using classical methods [23-45] and researches about deal with challenges and using of new technologies is poorly. In addition, in previous studies only the ways to deal with industrial pollution have been investigated. However without

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the exact information about quantity and quality of pollution sources, reduce or eliminate industrial pollutions are not possible. In this article, using environmental flow diagram pollutants of industrial units were identified and decisions about environmental pollution were as simple as possible.

Materials and Methods

Design basis for environmental flow diagram was the reference energy system. The difference was that the units that have not been considered in terms of environmental, have been removed and units that were not in the process, but in terms of environmental concern have been added to it. RES indicates all energy levels include extraction, collection, primary and final processing, separation, conversion, storage, transmission, distribution, loading, and end-users of energy carriers. In RES diagram, each line shows energy flow but EFD uses to detect and identify sources of pollutant and each line shows pollutant flow. In this diagram, all the units are in the specified energy levels and pollutants flow are enumerated according to the environmental source (air, water, soil) of pollution acceptor. In this diagram, the source of production, transmission and conversion processes, and the recipient environmental sources of these pollutants are specified. Generally, the guideline of EFD preparation includes these steps:

Investigating all of the energy levels in RES and PFD of processing units to identify sources of pollutant, pollutant flows division based on pollution acceptor source (water, air, and soil), determining a level for produced pollution as the final pollution in the end of diagram and divides it based on pollution acceptor source, removal of non-related terms to environmental pollutions, and finally adding other sources of pollution which non-related to energy levels such as industrial wastewater.

Indicators of pollution that are examined in EFD includes greenhouse gases (CO_2, CH_4, and N_2O) and air pollutants (CO, SO_2, NO_x, and THC) in atmosphere section and BOD, COD, heavy metals, oil & grease, and total hardness in water and soil sections.

Methods of air pollution estimation in EFD include sampling of emission sources, emission factors available in international resources, engineering calculations, and process simulation. In addition, mode of evaluating water and wastewater in EFD include sampling of industrial wastewater in operational area, comparison with national and international standards, and detecting pollutants that are above environmental standards.

All of the necessary states to designing of EFD have been done in visual basic program environment.

Results and Discussion

According to the minimum information as input data, environmental flow diagram is user friendly software that can be used in all of the industrial companies to deal with environmental crises. Figure 1 shows information related to a oil heater (OH) in EFD. All of the data for it gathered as auditing. One warning is visible in Figure 1 because of amount of CO emission more than environmental standard. Figure 2 shows a table and graph related to the WWT unit. Since a part of output of this unit, was dispel to surface waters and rest of it was used for irrigation of fruit trees, values of elements in WWT was compared with both river and irrigation standards. For example, value of NO_3 was in warning status for irrigation and no problem for dispel to the river.

According to the Figure 2, high values of coliforms in WWT have been caused which other pollutant was not visible in graph. Figure 3 shows values of atmosphere pollutants in original status and if implementation of scenarios related to the optimization of energy consumption (optimized) and reduction of air pollutions (integrated). Nature of pollutants estimation for CO, SO_2, and NO_x was based on emission factor and for greenhouse gases (CO_2 and CH_4) was calculated. If implementation of optimized scenario (optimization as short term), values of pollutants increased but in integrated scenario (deal with pollutants as long term) values of pollutants decreased than original status. Atmosphere problems in Figure 3 include:

1. Emission of air pollutants and greenhouse gases from LPG dehydration unit
2. Short height of cold vent in LPG dehydration unit
3. Emitted gases from evaporation pound
4. Crude oil (in cases of problem in the operation unit) and oil waste burning in burn pit
5. Dissolved gas vent in oil to atmosphere from oil storage tank for reservoir pressure control
6. Possibility of leakage from transmission equipment available in the region according to the smell of gas during the audit visit
7. Soot formation by flares
8. Emission of methane, volatile organic compound (VOC), and hazardous air pollutant (HAP) to atmosphere
9. Emission of combustion gases to the atmosphere by combustion equipment include:

Gases turbines in compressor units CS600 and CS700

De-methane boilers liquid gas compressors in NGL1500

Oil extraction turbo pumps

Figure 4 shows 12 strategies in two sections for optimization and environmental pollutants reduction include:

A. Strategies related to the optimization of energy consumption:

1. Optimization of NGL unit and heat recycling from combustion gases in gas injection station
2. Use of chillers to reduce inlet air temperature to turbine and cooling the buildings
3. Output heat recovery from flues
4. Adjusting of the air fuel ratio in the NGL boiler and turbopumps
5. Use of heat-cycle in the steam turbines

B. Environmental strategies:

1. Ethylene glycol discharge regulating in the liquid gas dehydration unit
2. Install separator flash tank on liquid gas dehydration unit
3. Use of pressurized storage tanks for removal of emission from oil storage tanks
4. Burning of oil vapors in microturbogenerators after collection and compress it
5. Oil vapor collection by installing of vapor recovery unit (VRU)
6. Leaks eliminate from combustion equipment

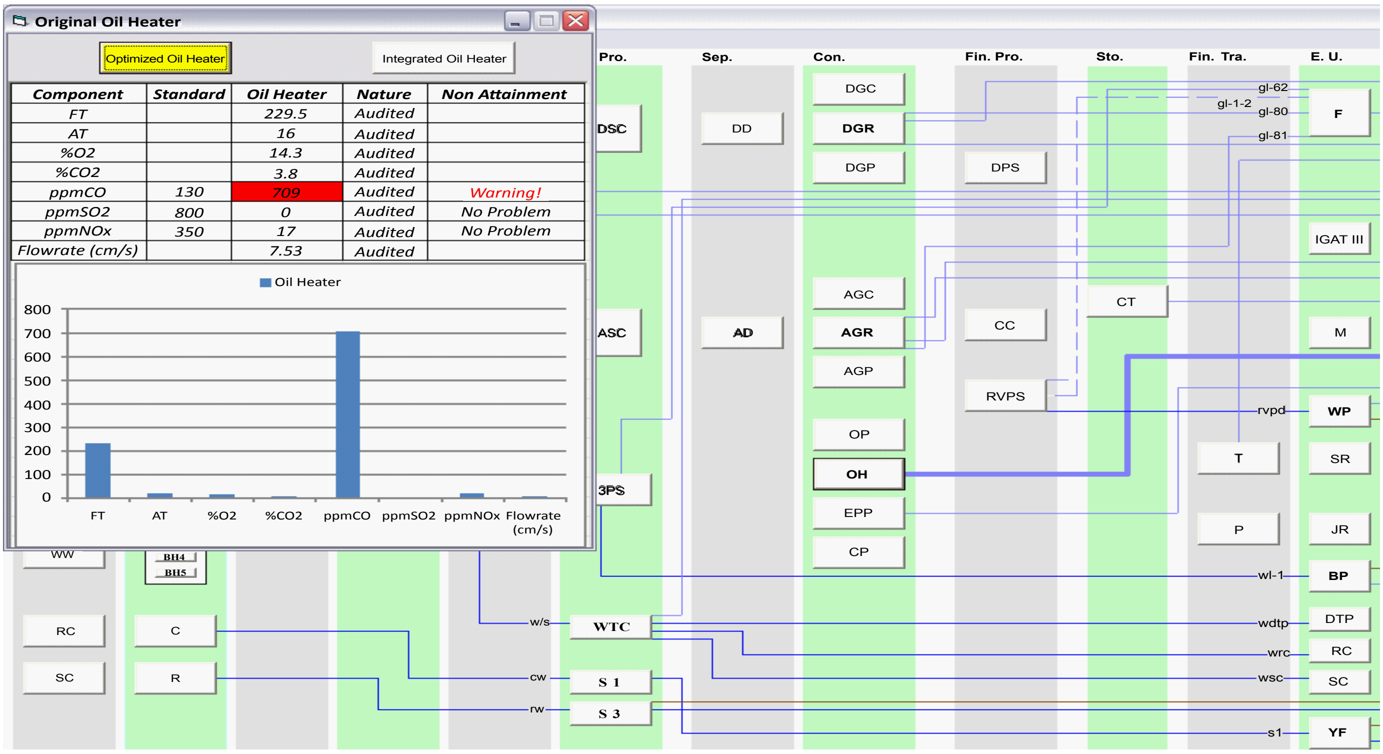

Figure 1: Table and graph related to the a atmosphere pollutant, oil heater (OH), by clicking on it in EFD environment.

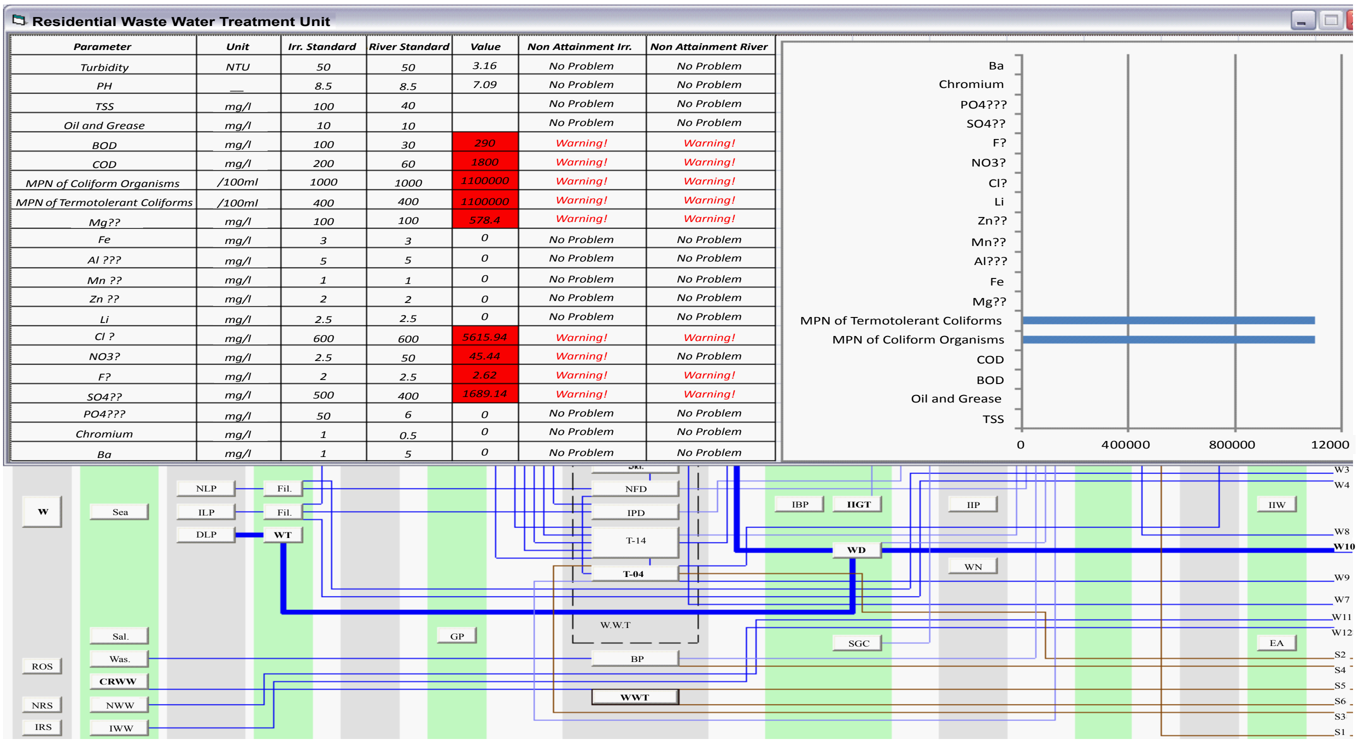

Figure 2: Table and graph related to the water pollutant, residential waste water treatment (WWT), by clicking on it in EFD environment.

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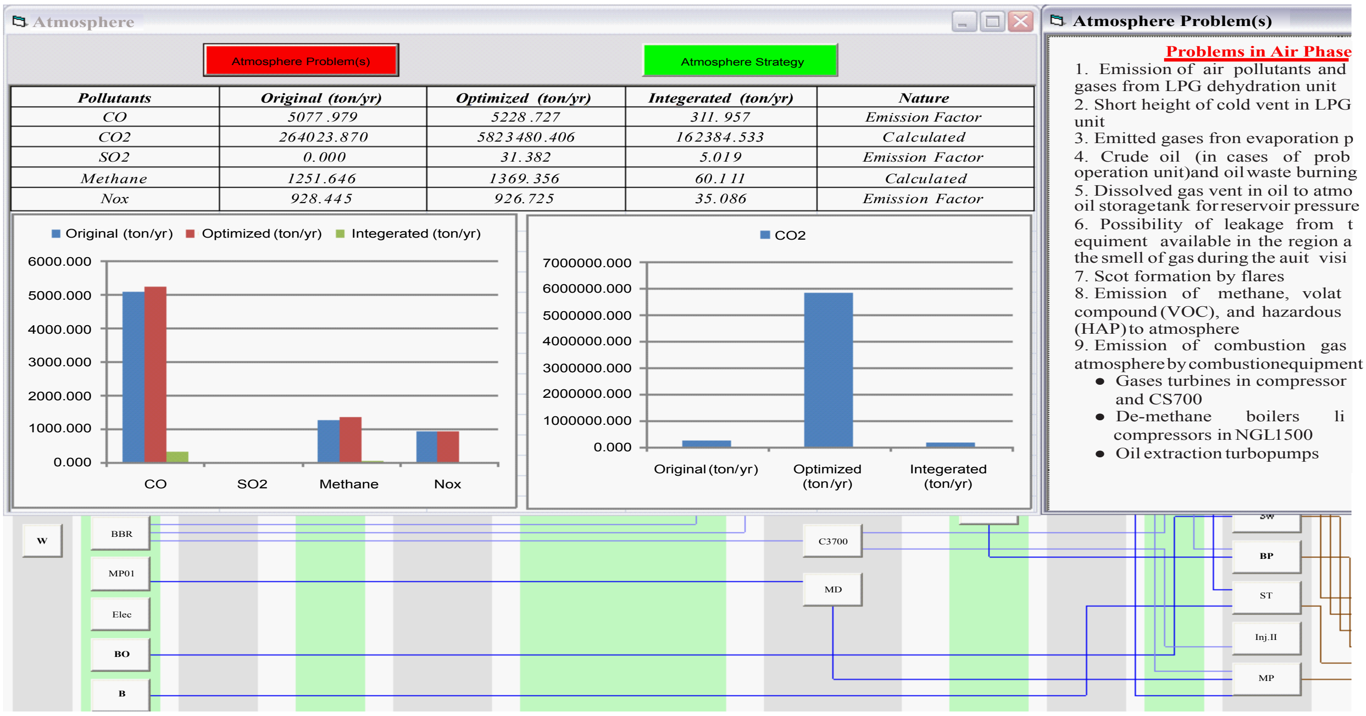

Figure 3: Final pollution in air section with its problems.

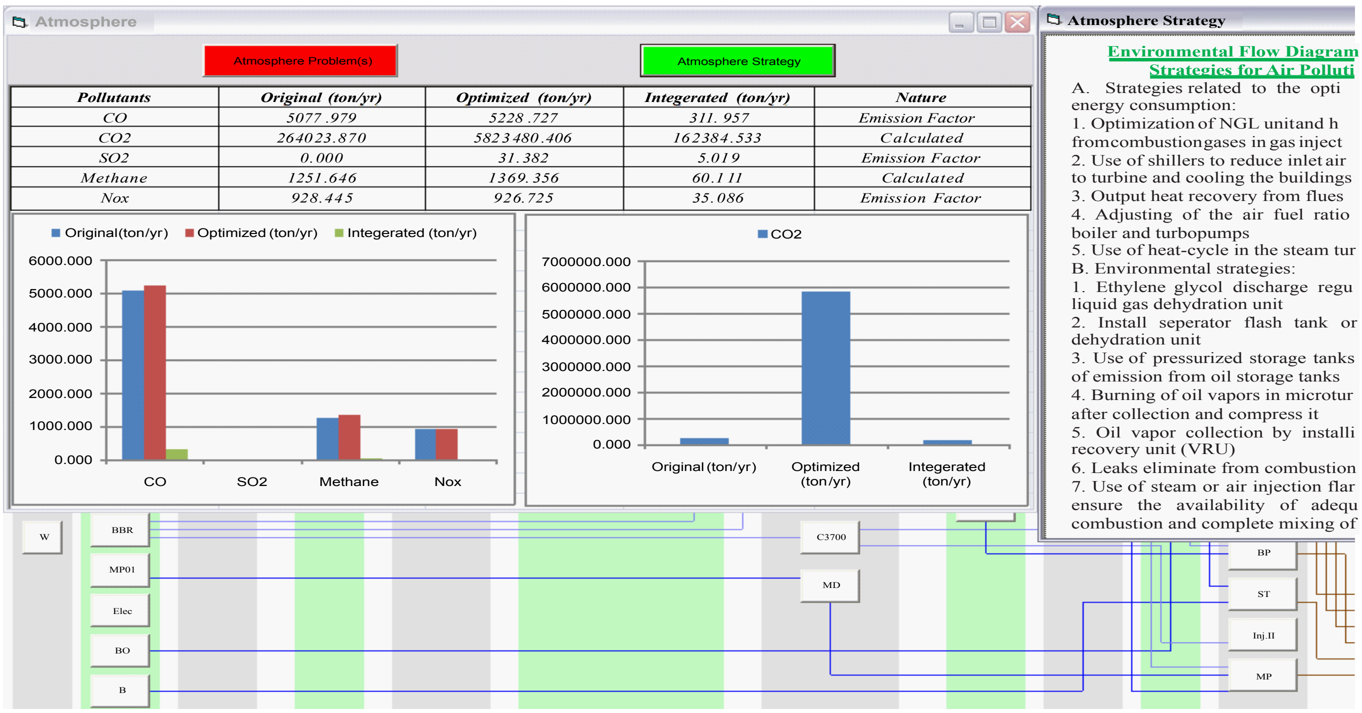

Figure 4: Final pollution in air section with suggested strategies for reducing or removing pollution problems in this section.

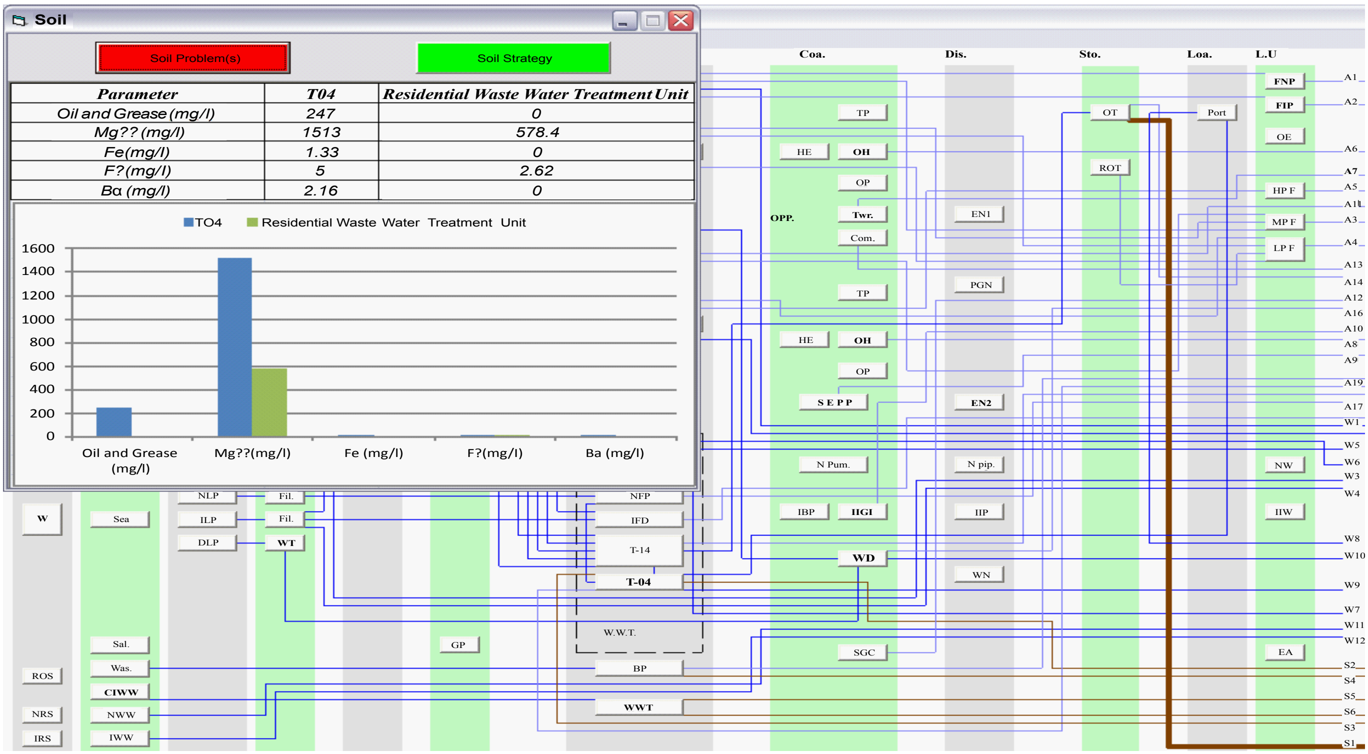

Figure 5: Final pollution in soil section.

7. Use of steam or air injection flares tip and to ensure the availability of adequate air for combustion and complete mixing of air.

Figure 5 shows main sources of environmental pollution in soil phase. Also on the “Options” menu, by clicking on the “Pollutant Point(s)” a window for determining year will be displayed. If selecting desired year, EFD software starts to calculate all of the pollution points and after end of the calculations, shows these points as red color. Thus, all points that amount of pollution in them excess of the environmental standards are specified.

According to the mentioned cases, EFD can be used in all of the industrial companies and civil and energy projects for detailed knowledge of pollution level of the area and solution of environmental crises.

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