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A New Approach Towards Environmental Monitoring Plan in Steam Power Plants

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ABSTRACT: Production of electricity for promotion of people's welfares is inevitable.There are about 54000 MW of various power plants in Iran. The type of power plants includes gas, steam, combined, hydro and a very minute amount of wind mills. The per capita electricity production is about 2200 Kwh. Power plants can impose adverse environmental impacts during construction and utilization phases. Environmental monitoring plan (EMP) can continuously examine the effects of power plants on the surrounding environment. In the present investigation, we have carefully examined the steam power plants of the country to develop appropriate EMP for the utilization phase. Results of study show that while emissions from stack need continuous monitoring, the other part of power plants can be monitored on monthly, seasonally or even yearly basis. Further, preparation of appropriate log sheets to record the results of EMP for the necessary action plans by authorities can lead to environmental monitoring program.The comparison amongst log sheets of various years may eventually provide environmental monitoring performance.

Key words: Environment, Monitoring, Plan, Program, Performance, Power Plant, Steam

INTRODUCTION

Reduction of environmental costs of energy production is one of the main challenges of the scientists. Utilization of renewable energies can greatly reduce the adverse environmental effects of power plants. However, such practices in oil producing countries due to plentiful availability of fossil energy cannot be adapted (karbassi *et al.,* 2008a). Perhaps energy saving measures can be more beneficial for Iran and other oil producing countries (Tehrani *et al.,* 2009; Karbassi *et al.*, 2008b; karbassi *et al.*, 2007; Shafipour & Farsiabi, 2007; Abbaspour *et al.*, 2006;). In general, energy efficiency practices and environment conservation are of high importance researches (Barros and Assaf, 2009; Zare and Chen, 2009). In the recent years, some attention has been paid to the energy efficiency measures in Iran. For instance, adaptation of simple measures in mill section of cement factories of the country that can lead to electricity saving of 720 million Kwh/yr (karbassi, *et al.*, 2010) has been subjected to careful examination. Environmental monitoring with respect to human exposure to contaminants has studied by Van Emon & Gerlach (1998). Sheppard et al. (2007) describes the application of the chemistry of total suspended particulates, lichens/mosses, and surface dust for assessing spatial patterns of airborne tungsten and other metals. The emission of dust from open mine activities around coal field was monitored by Ghose (2005). A new framework to conduct an EIA, emphasizing that it should be part of the environmental management of the area or region was proposed by Vizayakumar and Mohapatra (1991). The aim of present investigation is to know about the source of pollution in steam power plants of Iran and subsequently to provide a unique format for monitoring of contaminants. It should be pointed out that the present format is mainly concerned with steam power plant and with little modifications can be adapted to the gas and combined cycle power plants too.

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MATERIALS & METHODS

Various methods such as desk reviews, field surveys, workshops, policy dialogues, and consultations are used to obtain the necessary data. One of the steam power plants of the country named as Tarasht

(Alstom) was chosen to check out the accuracy of data. Relevant regulations, baseline data, and reports on operational activities of steam power plants were collected. It should be pointed out that the main fuel of steam power plants in the country is natural gas but during winter time fuel oil is also used. In general, 80 percent of fuel consumption is supplied by natural gas and other 20 percent by fuel oil. Table 1 and 2 show the general information of Tarasht steam power plant and air pollutants, respectively.

The average efficiency of Iranian power plants is about 37% in 2006 which is worse than previous year by -0.2%. The efficiency of gas, combined and steam power plants in 2006 are 27.6, 46 and 36.8% respectively (Karbassi *et al.*, 2007). The chemistry of wastewaters from Iranian power plants has been subjected to quantitative and qualitative analysis (Saeedi & Amini, 2007; Amini *et al.*, 2008).

RESULTS & DISCUSSION

The results of analysis show that steam power plants using natural gas a fuel do not contribute to the emission of SOx. However, these power plants emit considerable amounts of NOx since they are not equipped with Low NOx Burners (LNB). Table 3 summarizes the emission of NOx and SOx from Tarasht steam power plant.

Other steam power plants of the country were subjected to similar analysis. Table 4 shows the average emission rate of various air pollutants from 23 steam power plants in the country. It should be pointed out that the emission rates of pollutants vary considerably due to the type of fuel as well as due to the technology and the year of establishment of each power plant. In general, most of the studied power plants have higher NOx emission when compared with the standards announced by Environmental Protection Agency (EPA). Though the major fuel (80%) of the power plants is natural gas, but the emission of SOx is also higher than EPA's standards when they operate on fuel oil during winter time. The CO emission in most of steam power plants are in accordance with EPA's standard though some of them due to improper ignition system have higher CO emissions.Table 4 clearly shows that highest emission rates of CO2 belongs to heavy fuel oil. However, the highest emission rates of

Table 1. General characteristics of Tarasht power plant

Name	No. of Units	Establishment year	Turbine, Generator & Power Plant Manufacturer	Capacity (MW)
Tarasht	4	1959	Alstom	50

Table 2. Air pollutants from Tarasht power plant

Fuel Type	Stack Diameter (m)	Stack Height (m)	Flue Gas Temperature (o^C)	Flue Gas Velocity (m/sec)	SO_2 Emission (g/s)	NO_x Emission (g/s)
Gas	3	22	205	5	0	8.55

Table 3. Maximum NOx and SOx emission from Tarasht steam power plant

Season	Maximum NOx (µg/m³)	Maximum SOx (µg/m³)
Spring	0.511	0.00
Summer	0.354	0.00
Autumn	0.330	0.00
Winter	0.162	0.00
Yearly average	0.336	0.00

NOx are related with fuel gas (specially, the power plants that are not equipped with LNB). While the emission rates of SOx stands nil for fuel gas, the heavy fuel oil and gasoil have emission rates of 15.28 and 4.53 respectively. It should be noted that the lowest emission rate of CO belongs to gasoil and the highest one to the heavy fuel oil.

Steam power plants use treated water in their cooling system and subsequently produces various amounts of wastewater along with considerable amounts of solid wastes. The average waste production of steam power plants is given in Table 5.

Based on the above mentioned data, we have tried to develop an appropriate format to monitor the pollution from steam power plants.These formats are given in Table 6, 7 and 8. Since any environmental monitoring plan should be as simple as possible with minimum cost of measurements, we have tried to reduce the number of indicators. Also the period of measurement has been selected according to the sensitivity of pollutants as well as national regulations. For instance, according to role and regulations whenever BOD is supposed to be subjected to measurement, the period should not be more than 7 days. On the other hand, some pollutants such as SOx, NOx, SPM and CO are directly and continuously impact the health of people within the effective zone of power plant. Therefore, the measurement of such pollutants must be carried out on continuous basis while measurement of noise pollution can be done at monthly or seasonal intervals. Based on the various sources of pollution within steam power plants and also the quantitative and qualitative of pollutants, the formats have been prepared. These formats have been checked for its validity in Tarasht power plant. The simplicity of format has been agreed by steam power plant's authorities from different provinces of Iran. Actually, there are 17 regional electricity networks that are connected national wide. Therefore, the proposed format can be used for all 23 steam power plants nationwide. These power plants are operating under different climatic conditions and hence one or two parameters mentioned in the environmental monitoring plan may be more or less sensitive to when compared to other climatic conditions.

There are many diverse methods to measure the parameters mentioned in Tables 5 to 7. However, we propose that all power plants within the country use a unique method so that the results of monitoring from various power plants can be compared with each other. The series of EPA methods are useful for such unique and uniform measurements.

CONCLUSION

Monitoring techniques are very diverse. In the present investigation we propose a format that covers all parts of steam power plants for environmental monitoring plan. Also, there is a need for another format to monitor the effect of pollutants within the vicinity of power plant. This includes effects on surface and ground waters, plants, animals, ambient air quality along with social and economic conditions of the area of study. The data generated through environmental monitoring plan should be reported on a yearly basis to the concerned authorities within unique log sheets. The log sheets can be used to check out for environ-

Table 4 . Average emission rates of air pollutants from steam power plants of Iran

Fuel Type	CO_2 (kg/kWh)	NOx(g/kWhr)	SO_2(g/kWhr)	CO(g/kWhr)
Natural Gas	0.63	2.7	0	1.1
Heavy Fuel Oil	1.03	2.5	15.28	2.8
Gasoil	0.86	2.0	4.53	0.52

Table 5. Production of various waste by steam power plants of the country

Number of steam Power Plants	Power Generation (MWh)	Average operation (hr/yr)	Wastewater (m^3/hr)	Toxic Wastes (ton/year)	Carbonate Wastes (ton/year)
23	90000000	7280	5850	1450	21599

Table 6. Environmental monitoring plan for oil tanks, clarifiers, sand filters, RO & ion exchange resins in steam power plants

Period of Monitoring	Parameter for Monitoring	Place of Monitoring		Activity	Source of Pollution
		Point of Discharge to Environment	Outlet		
After Every Wash	TPH	✓	Within Discharge Channel	Washing	Oil Tanks
After Every Discharge		✓		Discharge of Water	
After Accident		✓		Spill and Accidents	
After Each Discharge or Wash	pH, Fe*, Al*, EC, TOC, TDS, TSS	✓	Within Discharge Channel	Discharge of Remains	Clarifiers
				Back Washing	Sand Filters
				Utilization	Reverse Osmosis Systems
				Acid and Soda Ash Recharge	Ion Exchange Resins

Table 7. Environmental monitoring plan for polishing plant, cooling towers, heat convertors & wastewater system in steam power plants

Period of Monitoring	Parameter for Monitoring	Place of Monitoring		Activity	Source of Pollution
		Point of Discharge to Environment	Outlet		
Every Month	pH, EC, Fe, TDS, TSS, Cl, P	✓	Within Discharge Channel & Blow down	Acid and Soda Ash Recharge	Water Clarifiers (Polishing plant)
Every Month	pH, EC, Fe, TDS	✓	Within Discharge Channel & Blow down	Addition of Chemicals	Cooling Towers
After Each Washing	EC, pH, COD, TDS, TSS, Ni, Cu, SO_4, NO_3 P,Fe	✓	Within Channel	Chemical and Non Chemical Washings	Heat Convertors & Feed water Heaters
Weekly	BOD, COD, EC, pH, TDS, TSS, Ni, V, Cu, Zn, P, Fe,NO_3, Cr	✓	Treatment System Outlet	Normal Utilization	Wastewater Treatment System

Table 8. Environmental monitoring plan for power plant's stack

Period of Monitoring	Parameter for Monitoring	Place of Monitoring	Activity	Source of Pollution
Continuous (On-Line)	NOx, SOx, CO, SPM, O_2	Inside Stack	Ignition of Gas and Liquid Fuels	Boiler's Furnace

mental performance of power plants as well as drawing necessary action plans to reduce the adverse effects. In other words an environmental management plan should consider plan, program and performance. The expenditures associated with implementation of an environmental management plan should be as low as possible. In this way, execution of envrionmental monitoring plan would be welcomed by power plants' authorities. The results of present investigation shows that measurements of parameterscited in Tables 6 and 7 will roughly costs around US$ 4500 per year. However, monitoing of air pollution from stack needs an initial investment of US$ 90000 for the purchase of equipment to measure pollutants continuously. We suggest an extra environmental monitoring plan to be designed and carried out to evaluate effects of pollutants in the vicinity of power plant (approximately 10 km radius) on a five year basis. This should include social and economical aspects too.

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