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Comparison of Iran Power Plants Air Pollutants before and After Shifting to Natural Gas

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ABSTRACT

In a three years period, 24 fossil fueled thermal power plants located in different parts of the country were extensively examined for discharge of pollutants into the environment and their potential effects on surrounding. During this investigation emission to air, discharge to receiving waters and land as well as electromagnetic fields were measured using relevant standard methods. This paper will focus on air pollution emissions and recent reinvestigation that was done after shifting the fuel from residual oil to natural gas. In our first studies that most of the plants were consuming residual oil, high level of SO_2 emission in some areas was the main cause of losses to vegetations and fruit gardens. It was concluded that a serious problem threats the environment and health of people living near these areas. Based on the results some mitigation plans were recommended to the authorities, and after some times they started to shift to natural gas consumption. Our recent investigation that was after this action, showed a good improvement of air pollution reduction. This was almost 100% for SO_2 and from 32 to 73% for NO_x.

Keywords: *Air pollution, Power plant, Natural gas*

INTRODUCTION

Environment can be defined as our surroundings which consist of the atmosphere, the hydrosphere and the lithosphere in which the life sustaining resources of the earth are contained. The life sustaining resources are food, water, air, energy and etc, which are withdrawn from the biosphere and used by human beings, as well as their waste which is produced and discharged into the environment (Peavy and Row, 1985). The power plants are using resources like fuel and water to provide electricity that is one of the essential needs for sustainable development and life. This activity produces and discharges all different kinds of pollutants such as, gaseous, liquid, electromagnetic fields, and noise which endanger our lives and environments. The amounts of pollutants discharged by power plants, especially air pollution are more than assimilation capacity of nature because now it is clear that sustaining and assimilative capacity of the biosphere though tremendous, is after all infinite. The system has begun to show the signs of stress because of the impacts of human upon the environment (World Bank, 1992). Something has to be done. The first step is to understand the magnitude of emissions from each source. This investigation was at first targeted for evaluation of air pollutant discharges by power plants. Then recommending mitigation measures and finally assessing the effects of actions that were taken for some of the plants.

MATERIALS AND METHODS

Some 24 power plants with operating capacity from 100 to 1000 Megawatts (MG) distributed all over the country having different climates and environments, were selected for our first study. The fuel consumption for some of them was residual oil contain 2.3-3.5% sulphur (s)

and others natural gas or combination of both, either simultaneously or alternatively according to availability of gas.

Stack gas was sampled and analyzed by Testo 350 XL stack analyzer which was factory calibrated for electro chemicals sensors. Dispersion of pollutants was estimated using gaussien model programmed in screen software. The same method was used for recent reinvestigations (ASTM 1994).

RESULTS

SO_2, NO_x and CO is the main pollutants of combustion products. Almost 95% of S from fuel consumption converts to SO_2.

The measurements showed that 6 of uncontrolled plants emitting SO_2 as much as 2 to 1.5 folds of national standards of 800 ppm, in critical metheorological conditions. The dispersion was estimated up to 7000 meters from stack, with concentration almost more than 24 standard recommended by WHO.

The impacts of SO_2 were investigated in plants at different distances from power plants location. The S content of leaves in different species of plants exposed to stack emission was as much as two to three folds higher than unexposed species of the same. The effects of SO_2 on human health exhibit as irritation of respiratory track to DNA reduction and immune deficiency against infections. Hundreds thousands people all over the world are exposed to higher concentration of SO_2 and suffering respiratory disorders caused by air pollution (WHO, 1987; ASTM 1994). Economic effects of SO_2 on agriculture and materials are also documented here and other areas of the world.

Other major pollutant emited from combustion of oil in power plant is NO_x. The concentration of this pollutant was not as high as SO_2, but in some plants up to 375 gr-GJ^{-1} was traced which is somehow more than international standards (Coface, 2003). CO, HC and particulate were usually much lower than emission standards unless the air fuel ratio was not regulated.

Results of measurement in six power plants of first evaluation are given in Table 1 and the comparison between four of them that were shifted to natural gas are given in Table 2.

Table 1: Air pollution measurements in 6 different power plants

No. of plant	Fuel	Power M.W.	Pollutants, ppm		
			SO_2	NO_x	CO
1	R.O	1000	1510	274	2
2	R.O	744	1126	356	<1
3	R.O	545	1506	253	56
4	R.O	749	1237	249	630
5	R.O	1459	1376	193	31
6	RO+NG	620	890	254	<1

Note: RO = Residual Oil
NG = Natural gas

Table 2: Comparing Pollution emission of power plantswhen shifted to NG

No. of plants	Fuel	Pollutants, ppm			%
		SO_2	NO_x	CO	CO_2
1	RO	1510	274	2	22
	NG	0	150	15	2.9
4	RO	1273	249	630	13.2
	NG	0	50	172	4.1
5	RO	1367	195	31	10.8
	RO+N.G	561	143	10	3.2
6	RO+N.G	890	254	<50	11.6
	NG	16	62	11	2.8

DISCUSSION

When our first investigation was accomplished in 1997, we performed a feasibility study for air pollution reduction in Esfehan. Among different methods, wet scrubber, using lime slurry as chemical sorbent was found out to be the best choice. So, a pilot plant was prepared and for finding design parameters, this was done and even it was successfully examined on a by pass of one of Esfehan unit. In the mean time the Ministry of Oil, decided to provide natural gas for power plant. Since this was more economic for the industry, they decided to use it as alternative.

As it can be seen from Table 2, concentration of

SO_2 is reduced by almost 100% and NO_x reduction range from 32 to 75% when gas was replaced instead with heavy oil. The 75% reduction was for the plant that gas and low NO_x burner have been used, in newly installed plants, as stated in World Bank Guidelines (Coface, 2003).

The concentration of SO_2 in Oil burning steam power plants has been 2000 mg/Nm^3 (764 ppm) and in gas burning plants could be neglected. NO_x emission reported 255 and 178 ppm for oil and gas consumption, respectively. This verified our measurements. Predictions made by us Energy Information, (Anonymus, 2001). The allowance prices of SO2 in 2020 will ranges from $ 221 to $ 905 and NO_x from 0-$81 perton. An important result of our measurement that is shown in Table 2 is dramatic reduction of CO_2 as gas was replaced by Oil.

In September 2001 a report issued by us Energy Information Office (Anonymus, 2001). Demonstrated that the power suppliers of the United States, emitted 179 million tons CO_2 above the 1990 base line level allocated by Kyoto protocol this cost $33 to $54/Ton. This means they ought to pay about 10 billion dollars if they could not comply with Protocol. In Iran, actions taken by power plant authorities could provide us for making deal in the world carbon market if the Kyoto protocol is accepted by our government.

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