Pergamon

Radiat. Phys. Chem. Vol. 46, No. 4–6, pp. 1133–1136, 1995
Copyright © 1995 Elsevier Science Ltd
Printed in Great Britain. All rights reserved
0969-806X/95 $9.50 + 0.00

0969-806X(95)00343-6

PRESENT STATE OF EB REMOVAL OF SO_2 AND NO_x FROM COMBUSTION FLUE GASES IN BRAZIL

POLI, D.C.R.; OSSO JR, J.A.; RIVELLI,V.*; VIEIRA, J.M.; LUGÃO,A.B.

INSTITUTO DE PESQUISAS ENERGÉTICAS E NUCLEARES - IPEN-CNEN / SP
Cidade Universitária - Travessa R, 400 - CEP-05508-900 - São Paulo - BRAZIL
*COMPANHIA DE TECNOLOGIA DE SANEAMENTO AMBIENTAL

ABSTRACT

Environmental problems caused by the increased world energy demands are becoming of growing importance and Brazil is now starting to set limits to the emission of toxic gases. The development of technologies for removal of these gases are therefore necessary and this work shows the present state of the technology of SO_2 and NO_x removal by electron beam irradiation in Brazil. Data concerning the increasing energy demand in Brazil and the environmental governmental measures are presented, along with the design and implementation of a laboratory pilot plant for the electron beam flue gases removal process located at IPEN-CNEN/SP.

KEYWORDS

High energy electron beam, accelerators, flue gases, toxic gases treatment.

INTRODUCTION

The release of toxic gases into the atmosphere, mainly because of the acid rain has been object of many discussions in all the world resulting in international programs of research for the development of efficient flue gas removal techniques (mainly SO_2 and NO_x) and in setting more and more limits of emission.

In the past few years, the use of fossil fuels with a high sulfur content in Brazilian industrial installations has grown. In addition, estimates indicate such growing will be continuous. Due to the environmental regulations enacted, the development of a technique able to remove toxic gases has become essential.

Among the flue gas treatment methods, the process of electron beam irradiation has shown to be promising. Under irradiation, those gases are simultaneously removed from the combustion gases. In the presence of ammonia, the by-product of the process is ammonium sulfate and ammonium nitrate that after filtration can be used as fertilizers. This process has been investigated in Japan (DOI,T. et alli,1993), Germany (PAUR,H.R. et alli, 1993), USA (EBARA, 1988) and Poland (CHMIELEWSKI, A.G. et alli, 1992).

Pilot plants until 50 000Nm3/h have been built in those countries and the results of the researches have shown that the process presents many advantages (IAEA TEC-DOC 428, 1987); (1) simultaneous removal of SO_2 and NO_x, (2) dry process without waste water, (3) by-product can be used as fertilizer, (4) no need of catalyst, (5) low capital and operating costs. This process can be used for treatment of flue gases from oil or coal fired power stations (CHMIELEWSKI,A.G. et alli, 1992), municipal solid waste incinerators (DOI,T. et alli, 1993), industrial boilers, furnaces and for automobile tunnels(PAUR,H.R. et alli, 1993).

A feasibility study of the process in Brazil was initiated under IAEA support what has lead to the construction of a laboratory pilot plant.

AIR QUALITY CONTROL - NATIONAL PROGRAM IN BRAZIL

In 1989, The National Environmental Council (CONAMA) stablished the National Program for Air Quality Control (PROVAR). The CONAMA Resolution N. 008 dated December, 06, 1990 fixed standards (maximum level of air pollutants emission) in pollution fixed sources, once it was considered the major contingent of atmospheric pollution.

The resolution affects new coal or oil fuel burning fixed sources of pollution, carried out in boilers, furnaces, stoves and dryers for generation and use of thermal energy, incinerators etc. The stablished emission standards are presented in Table1.

Table 1. Maximum levels of air pollutants in pollution fixed sources according to CONAMA N.008, Dec./06/1990 expressed in weight of pollutants by caloric power (g/Gcal).

TYPE OF FACILITY	TYPE OF POLLUTANTS	CLASS OF AREA	
		I	II / III
NOMINAL POWER	PARTICLES	120	350 OIL / 1500 COAL
<70MW	SO_2	2000	5000 NOMINAL
NOMINAL POWER	PARTICLES	----	120 OIL / 800 COAL
>70MW	SO_2	----	2000

Any economic activity producing air pollution is forbidden on first class areas which have to be atmospherically preserved. In areas to be preserved (leisure, watering, hydromineral and hydrothermal places) new fixed sources with nominal power over 70MW are not allowed to be installed.

PROGRESS IN THERMAL POWER PRODUCTION INDUSTRY IN BRAZIL

Energy consumption in Brazil was 233.9TWh in 1990 and is expected to reach 321.0, 420.7, 539.1 and 668.6TWh in the years 1995, 2000, 2005 and 2010, respectively. Table 2 shows the contribution (%) of each type of electrical generation according to the 1990/2010 Plan (MINISTÉRIO DE MINAS E ENERGIA, 1987) where constant progress will be continued with average annual growth rate of 6% .

Table 2. Contribution (%)

TYPE	1986	1990	1995	2000	2005	2010
HYDRO	90,2	91,3	91,0	90,0	89,4	88,6
THERMIC	9,8	8,7	9,0	9,4	10,6	11,4
COAL	1,6	2,2	2,3	2,9	3,5	4,1
NUCLEAR	1,4	1,0	2,3	3,0	4,3	5,1
OTHER ONES	6,8	5,5	4,4	3,5	2,3	2,2
TOTAL	100,0	100,0	100,0	100,0	100,0	100,0

There are in Brazil at present a series of difficulies preventing the building up of new hydroelectric power plants, thermoelectrical facilities using coal or heavy oil have become thus an alternative solution. In the southern region of Brazil (Rio Grande do Sul and Santa Catarina states) there are coal resources that can be used to produce electrical energy (46800MW in total, 8000 MW in surface mines and 38800MW in subsoil), since a suitable gas treatment method is used in order to obey existing laws.

Besides electrical energy generation, there are several sources of pollution, mainly in São Paulo city, such as automobiles, industrial oil burners and town incinerators.

LABORATORY PILOT PLANT

A laboratory pilot plant has been built at IPEN-CNEN/SP, and it is shown in Figure 1. The electron beam accelerator, from Radiation Dynamics Inc., has 1.5MeV power and 25mA current.

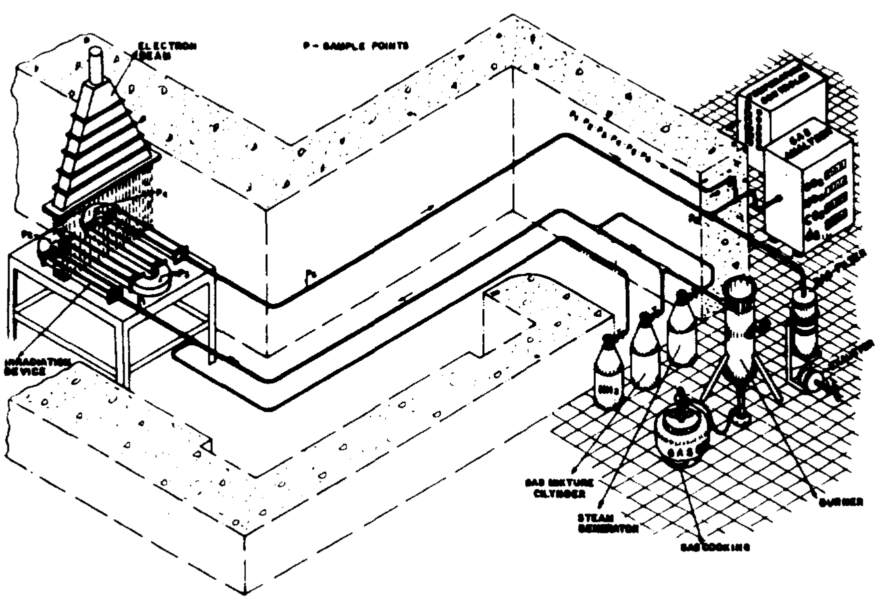

Figure 1 - Laboratory pilot plant for gas treatment by electron beam irradiation

The irradiation device allows a four-turn irradiation, and it was already used for dosimetric studies (CAMPOS,C.A. et alli,1994). The gas flow rate will be 1200m3/h, and a synthetic mixture of SO2 and NOx will be used in preliminary studies. The carrier gas will be normal cooking gas, that is burned at a proper burner. NH3 will also be injected, and the fertilizer will be collected at a bag filter. Several sample points will allow the measurement and control of gas flow rate, temperature and humidity and also the analyses of the gases to calculate the efficiency of their removal.

REFERENCE

CAMPOS, C.A.; PÈREZ, H.E.B.; VIEIRA, J.M.; POLI, D.C.R.,; SOMESSARI, S.L.; BRUZINGA, W.; ALBANO, G.D.C. (1994). Desenvolvimento de um sistema calorimétrico para dosimetria de gases, em fluxo contínuo, irradiados com feixe de elétrons. Anais do V Congresso Geral de Energia Nuclear, 2, 659-661. Rio de Janeiro-Br.

CHMIELEWSKI, A.G.; ILLER, E. ZIMEK, Z.A.; LICKI, J. (1992). laboratorium and industrial research installation for electron beam flue gas treatment. Proceedings of an International Symposium on Application of Isotopes and Radiation in Conservation of the Environment, Karlsruhe, 9-13 March, 81-92

DOI, T.; OSADA,Y.; MORISHIGE, A.; TOLUNAGA, O.; MIYATA, T.; HIROTA, K.; NAKAJIMA, M.; KOMIYA, M.; MIYAJIMA, K.; BABA, S. (1993). Pilot-plant for NOx, SO2 and HCl removal from flue gas of municipal waste incinerator by electron beam irradiation. Radiat. Phys.Chem., 42, 679-682.

EBARA ENVIRONMENTAL CORPORATION. (1988). Final report for testing conduced on the Ebara flue gas treatment system process demonstration unit at Indianapolis, Indiana, Greensburg, PA.

INTERNATIONAL ATOMIC ENERGY AGENCY. (1987). Electron beam processing of combustion flue gases. Vienna. IAEA-TECDOC-428.

MINISTÉRIO DE MINAS E ENERGIA. CENTRAIS ELÉTRICAS BRASILEIRAS S.A. ELETROBRAS. (1987). Plano Nacional de Energia Elétrica 1987/2010. Rio de Janeiro, Br.

PAUR, H.R. MAETZING, H. (1993). Electron beam induced purification of dilute off gases from industrial process and automobile tunnels. Radiat.Phys.Chem., 42, 719-722.

RESOLUÇÃO CONAMA N. 008, Dec. 06. (1990). Secretaria do Meio Ambiente da Presidência da República, Brasil.