Environmental and Waste Management (ISSN : 0971-9407)
Eds. - A. Bandopadhyay, N.G. Goswami and P.R. Rao
© NML, Jamshedpur - 831 007, 1998, pp. 225-229

A comprehensive pollution control system for the mitigation of fine particulates of lead and SO_X gases from secondary lead smelters

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ABSTRACT

A large number of small scale units making use of scrap, dross and junk automobile storage batteries do not adopt appropriate pollution control measures mostly due to their financial constraints. They emit fine particulates of lead and SO_x gases to the surrounding atmosphere which are injurious to the health of people residing in the neighbouring localities. In view of this, National Metallurgical Laboratory, Jamshedpur has developed a comprehensive pollution control system for control of fine particulates of lead and SO_x gases from secondary lead smelters.

Keywords : Battery scrap, Secondary lead smelter, Emissions, Pollution control system, Particulates of lead.

INTRODUCTION

The storage battery scrap is the chief source of secondary lead production. More than 40% of the total lead [1] consumption goes to the manufacture of batteries and 80% of it reenters the market as secondary lead. Randaccio [2] patented a process by which different types of scraps, viz., powder, filling etc., of various metals containing lead in sufficient amount can be treated to get higher recoveries by smelting. The smelting of battery scrap in an electric furnace without pretreatment for the elimination of sulphur has been claimed in a Japanese patent[3]. Even though the smelting of battery scrap has been practised for a long time, still the recovery of lead is not very good due to the slag matte losses and sulfur fumes. Today secondary processing units have mushroomed in the unorganised sector and they create major pollution problems. Most of these units import lead bearing scrap/dross/used batteries for secondary processing. Many small scale units spread mostly in metropolitan cities as clusters, make use of traditional furnaces to extract lead from old lead acid battery scraps and dross. These small scale units generally do not control process parameters viz., smelting temperature, charge to fuel ratio, leakages in the body etc., and have not adopted appropriate pollution control measures mostly due to their financial constraints. This paper discusses a comprehensive pollution control system developed for secondary lead smelters.

SECONDARY LEAD PROCESSING

The secondary raw materials of lead smelter include a variety of generations from the lead refineries and other processes where lead and lead scrap from different sources are used. These include lead skimmings, lead drosses, discarded lead cable sheathings and above all the spent lead-acid batteries. In fact, the spent lead acid batteries constitute almost 70% of the input for a secondary lead smelter.

The secondary lead smelting and refining is carried out mainly in three types of furnaces such as reverberatory furnace, blast furnace and pot type furnace. The reverberatory box type furnace is generally used when the higher amount of metal is to be recovered and the rotary furnace is often used when the material processed has a lower amount of metal to be recovered. Blast furnaces are used quite extensively in secondary smelting of lead storage batteries and pot type furnaces are used for remelting, alloying and refining processes. Pot type furnaces make use of scrap, dross and junk automobiles. Lead, being a hazardous substance, recycling from wastes/scrap is the best way to protect the environment from lead pollution.

EMISSIONS FROM SECONDARY LEAD SMELTERS

The secondary lead smelter continuously pollute the environment by emissions of lead vapors and sulphur dioxide. The emissions include dust and fumes also. Lead is emitted as air borne particulates along with metallic fumes and sulphur dioxide. The fine particulates of lead with an aerodynamic diameter (i) $>7.5\ \mu m$ range from 12-15 weight percentage, (ii) 7.5 to 2.5 μm range from 20-25 weight percentage and (iii) $<2.5\ \mu m$ range from 60-65 weight percentage. The threshold limit values of lead in emissions and effluents are 10 $\mu g/m^3$ and 0.10 $\mu m/m^3$ respectively while the threshold limit value for SO_2 is 0.50 mg/m^3. The threshold limit values of lead in human blood and general atmosphere are 80 $\mu g/m^3$ and 1.5 $\mu g/m^3$ respectively. The lead levels of 15 to 30 micrograms per decilitre of blood may result in various system abnormalities and behavioural defects. Formation of red blood cell is impaired by intake of lead which leads to anaemia, irreversible brain damage and mortality. Necessary standards for discharge of pollutants from lead industries have been evolved so as to maintain the ecological balance. Various countries have stipulated their emission norms[4], which are becoming tighter and tighter over a period of time. India has also specified the norms for lead emissions, which are very much in line with the international standards [Table 1]. The stringent regulations and the inherent problems in smelting necessitate the evolving of new pollution control systems and their installation to meet these standards.

Table 1 : The control limits of lead emissions in various countries [— men & ** — women]*

Country	Lead in Work Area $\mu g/m^3$	Lead in Blood $\mu g/m^3$	Lead in Emissions $\mu g/m^3$	Lead in Effluents $\mu g/m^3$	Lead in General Atmosphere $\mu g/m^3$
Australia	0.15	70* 30**	10	0.05	1.5
Canada	0.15	70	29	1.5	–
Germany	0.10	70* 30**	5	0.20	2.0
U.K.	0.15	70* 40**	10	Variable	2.0
U.S.A	0.10	50	Variable	Variable	1.5
India	0.15	80	10	0.10	1.5

COMPREHENSIVE POLLUTION CONTROL SYSTEM

The problems in the secondary processing units can be solved if used batteries are given only to such processing units which have requisite pollution control facilities. Hence a cost effective comprehensive pollution control system has been developed which can be exploited by secondary lead smelters for controlling emissions. This system basically consists of three units namely DRY, WET and DRY-cum-WET. It has flexibility for using in either of these three cases depending upon several factors such as (i) the composition and size range of charge materials, (ii) chemically treated or untreated charge materials, (iii) type of furnace employed for secondary smelting and (iv) threshold limit values for emissions prescribed by Central Pollution Control Board from time to time.

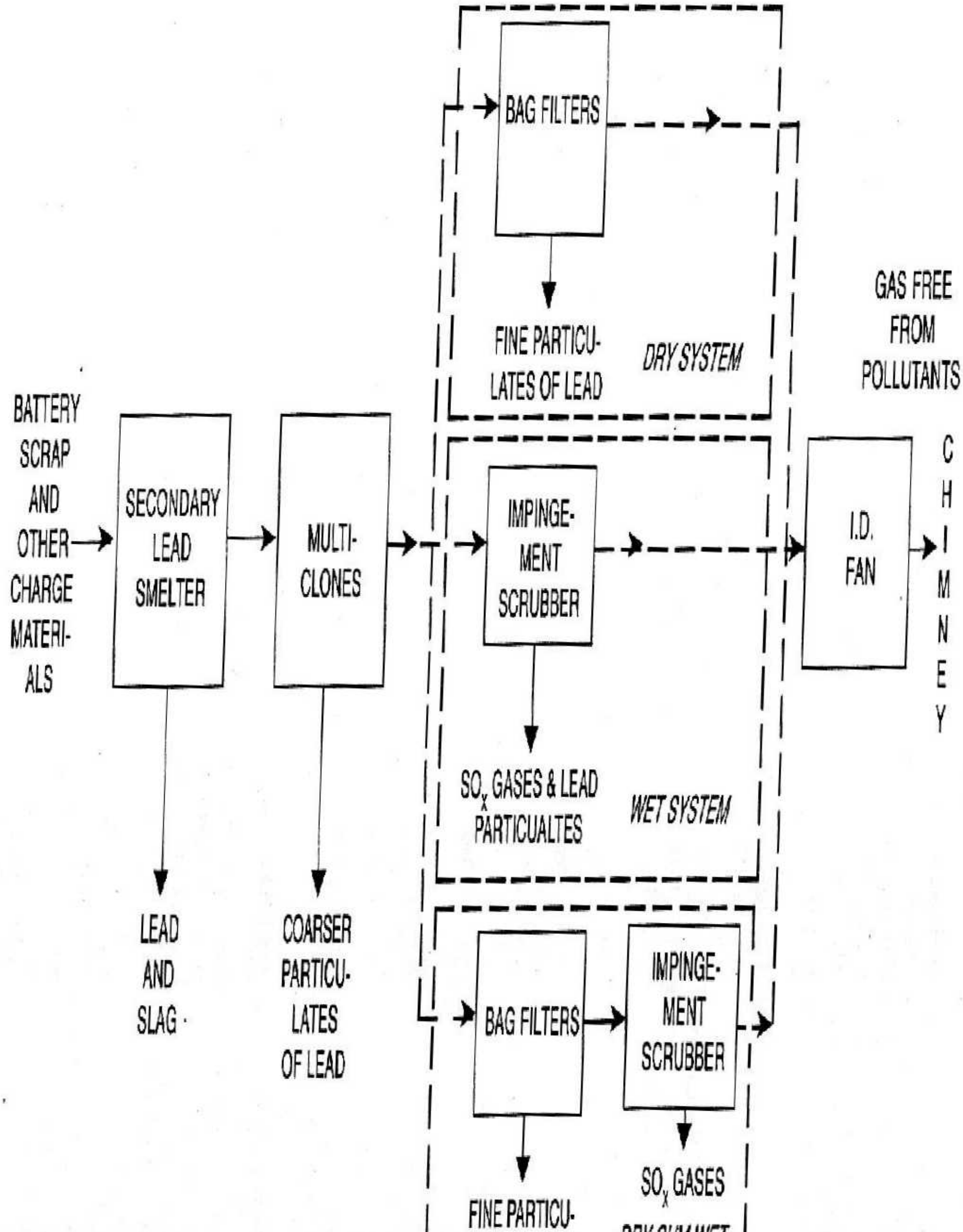

Fig. 1 : Comprehensive pollution control system.

Dry System

The dry system consists of multiclone seprator followed by cost effective unconventional fabric filters [Fig. 1]. The multiclone separator removes major percentage of dust load containing lead particulates over 5 microns in size while the fabric filters arrest the remaining fine particulates (<5 μm) of lead.

Wet System

The wet system consists of multiclone separator followed by the impingement scrubber [Fig. 1]. The impingement scrubber consists of impingement plates where fine lead particulates (<5 microns) are also arrested. The down flowing lime slurry in the scrubber reacts with the counter currently flowing SO_x gases forming calcium sulphate. Thus the exit gas from the impingement scrubber is free from SO_x gases as well as lead particulates.

Dry-cum-Wet System

The dry-cum-wet system consists of fabric filters as well as impingement scrubber apart from multiclone separator [Fig. 1]. The coarser particulates of lead are removed by multiclone separator while the fine particulates by fabric filters. Then the gas, almost free from lead particulates, passes through the impingement scrubber where down flowing lime slurry reacts with the counter-currently flowing SO_x gases forming calcium sulphate. Thus the exit gas from dry-cum-wet system is free from fine particulates of lead as well as SO_x gases.

CONCLUSION

The proposed configuration of pollution control system is extremely flexible in nature and can be adopted partially or fully as per the requirements of an individual secondary lead smelter. This cost effective pollution control system can be easily adopted by all such small scale industries who are otherwise not using appropritate pollution control system due to financial constraints.

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