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Aqueous Phase Extraction of Liquid Potash from Spentwash Incinerator Fly Ash along with Sulfur/Silica/Magnesium and Bio-char Containing Soil Manure

Mohan K. Dongare[1]* and Vijay Kumar Goel[2]
[1]Scientist (Rtd) National Chemical Laboratory, Pune-411008; Malati Fine Chemicals, Pune-411008
[2]Dhampur Bio Organics Ltd, New Delhi – 110 020

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ABSTRACT

Liquid potash fertilizer has been extracted from spent wash incinerator fly ash by simple aqueous extraction process. The fly ash from spent wash incinerator is treated with hot water to extract potash in aqueous phase and the resulting slurry is subjected to clarification processes where the solids are removed from the slurry to obtain potassium in aqueous phase. The liquid potash thus obtained is used as fertilizer for foliar spray applications in agriculture which showed very promising results demonstrating application of spent wash incineration fly ash derived potash for agriculture application. The solid residue obtained from clarifier containing unrecovered potassium, sulphur, silica, magnesium and bagasse ash (as bio-char) is also used as soil fertilizer with encouraging results. A simple aqueous phase extraction process with minimum processing steps can give both potassium as well as sulphur, silica, magnesium and bio-char containing soil fertilizer. This simple process has been already implemented by Dhampur Bio Organics in Asmoli sugar unit (UP) and both liquid potash and soil manure are being supplied to local farmers currently and the results are very encouraging showing positive impactof these products as good fertilizer.

Keywords: Potash, aly ash, muriate of potash, sulphate of potash, fertilizer.

Introduction

In agriculture,the term potash refers to potassic fertilizers, mainly potassium chloride (KCl), sulphate of potash (SOP), and potassium magnesium sulphate (SOPM) or langbeinite. Muriate of potash (MOP) is an agriculturally acceptable mix of KCl (95% pure or greater) and sodium chloride for fertilizer use. Potash is essential for plant growth and quality. Owing to unfavourable weather conditions, farmers across the globe need to use fertilizers to improve the productivity of the crops. All these factors, coupled with surging investments, are expected to influence the global MOP market. India imports total potassium that is required for our agricultural sector (about 25 to 40 lakh tons/ year). Potash prices continue to increase because of global demand as well as recent Ukraine war making it difficult for the export of MOP from Belarus and nearby countries to India.

Spentwash incinerator fly ash

The sugar industry in India has contributed immensely to improve the economy as well as employment in rural India. These sugar industries generate large quantity of molasses as by-product which is raw material for manufacturing ethanol, an important biofuel. The bio-ethanol production generates large quantity of dark brown coloured spentwash as waste (~10-12 ltrs of spentwash for 1 lit ethanol). Sugarcane molasses based distillery spent wash is one of the highly organically loaded material, with characteristic obnoxious smell, dark brown colour and low pH which makes it extremely difficult to treat for its disposal in the environment.

As per CPCB guidelines, most of the sugar industry associated distilleries in India (about 500) are planning to install spentwash concentration and its incineration for the safe disposal of distillery effluent and will generate

*Corresponding Author email: dongare.mohan@gmail.com

large quantity of fly Ash. The existing incinerators (about 100) generate about 50 to 100 tons of fly ash per day per distillery and this fly ash is getting accumulated in distillery premises. It has sporadically been used as PDM or directly as a soil mixture. It is well known that, sugar spentwash incinerator fly ash contains about 30 to 40% potassium. However there are no efforts taken so far for the recovery of this potassium from fly ash. At present about 7000 tons/ day fly ash is generated in India which will be a good source of potassium for its use in Indian agriculture if recovered. The present paper details a better scheme for usage of this fly ash.

At present spentwash incinerator fly ash containing potassium is being granulated using bentonite and other binders to make "Potassium derived from molasses (PDM)" containing 14.5% K_2O and is used as potassium fertilizer which is also supported by Government of India as indigenous potash source. However due to non-availability of 14.5% K_2O in the PDM, the technical and commercial feasibility is being reviewed for its future suitability. The ash has also been directly mixed with soil but with indifferent results as potash in the ash cannot be easily extracted by the plants. To make the plants utilise the potash two methods are simultaneously used, which makes it easy for the plants to utilise the potash. The methods are easy and very beneficial. This paper deals with these two methods.

MATERIALS AND METHOD

Aqueous phase extraction of potassium from spentwash incinerator fly ash

Chemical analysis of fly ash

The chemical analysis of the fly ash collected from Godavari Biorefinery, Karnataka was carried out using SEM/EDAX process and the results are as follows showing the presence of potassium chloride / potassium sulphate / silica, magnesium and other metals in fly ash (Figure 1).

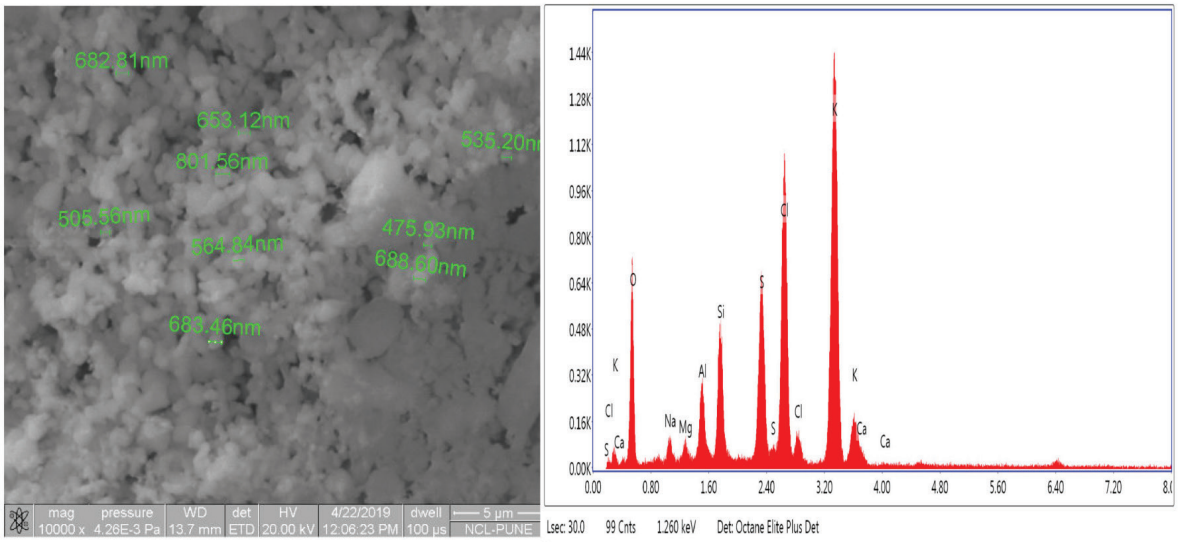

Figure 1 : SEM photograph of fly ash EDAX of fly ash

RESULTS AND DISCUSSION

Our Innovative Process

We have developed a process (patent filed) for the recovery of potassium from spentwash incinerator fly ash. The recovered potash has been analyzed using standard analytical techniques and the results matched very well with Muriate of Potash (MOP) for its structural (XRD) and chemical characteristics. The pictures of initial fly ash and recovered potassium as well as its XRD pattern).

The process parameters have been optimized on laboratory scale. However, one production unit has already been set up for the manufacture of muriate of potash at Asmoli Sugar of Dhampur Bio Organics

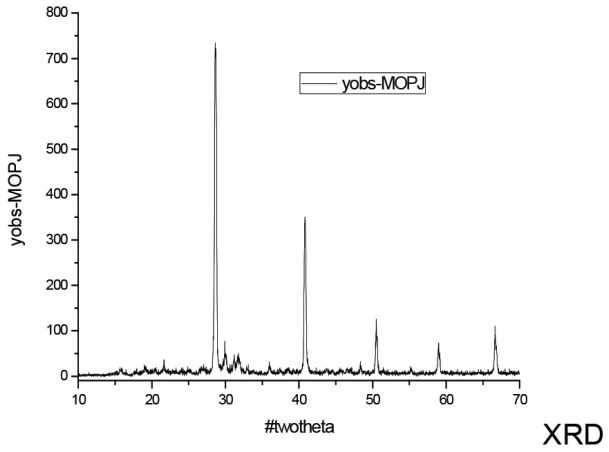

Figure 2 : XRD pattern of potassium chloride obtained from fly ash

and the solid crystalline product has been supplied to the farmers of the surrounding area.

The above mentioned product contains mixture of potassium chloride (Muriate of Potash, MOP) and potassium sulphate (Sulphate of Potash) and this being a new product, needs inclusion in Fertilizer Control Order (FCO) for marketing this product in the Indian market to our farmers as indigenous MOP/ SOP. The inclusion of this new product in FCO is under process.

Liquid potash

Recently there has been a keen interest in liquid fertilizers which can be sprayed as foliar spray for better utilization and liquid potassium fertilizer is being used in agriculture. In USA and Europe liquid MOP is being used for foliar spray as 0-0-62 product.

Bhavishya et. al., have tried to make nano potash as liquid fertilizer (Nano-potassium intercalated composted coir pith: A slow-release fertilizer suitable for laterite soils of humid tropics of India) bio-catalysis and agricultural biotechnology 57 (2024) 103054.

Hence we have tried to change our process and now we are working on liquid potash as well as silica/magnesium/bio-char containing organic manure using following simple aqueous phase extraction process (Figure 3).

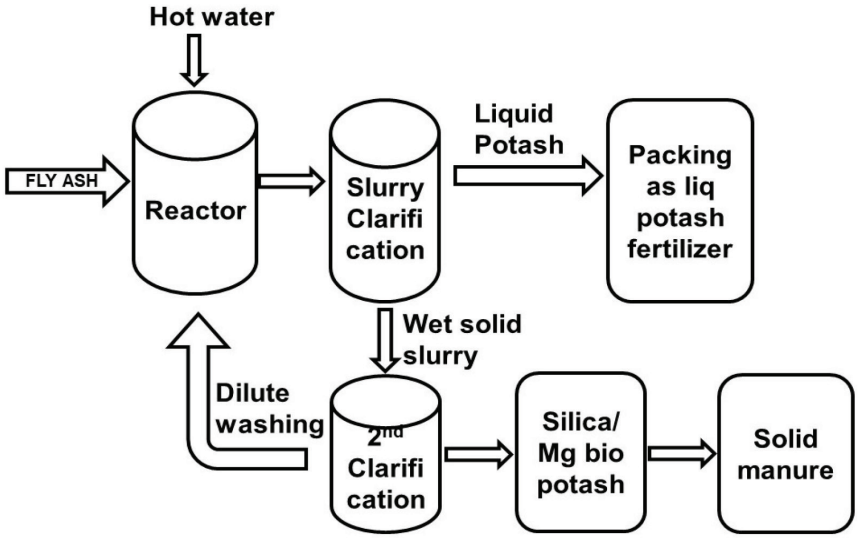

Figure 3 : Aqueous phase extraction process

Analytical results of liquid potash

The liquid potash obtained using our modified process has been tested and showed following results.

Concentration of solid in liquid potash: 11%.

1. EDAX (Energy dispersive X-Ray) analysis – for elemental analysis - The EDAX analysis is as follows (Table 1)

Table 1 : EDAX analysis

EDAX analysis		
Element	**Weight %**	**Atomic %**
O K	28.08	47.17
MgK	0.54	0.60
AlK	0.47	0.47
SiK	0.58	0.55
S K	10.05	8.42
ClK	19.14	14.51
K K	41.14	28.27

Table 2 : Estimation of composition with and without water of crystallization of dried sample

Composition Estimated Based on the EDAX Data	
KCl	14.5%
K_2SO_4	16.84 %
$MgCl_2$	0.6 %
SiO_2	0.55 %
$Al2O_3$	0.24 %
H_2O of crystallization	40 %

Composition Normalized without Water of Crystallisation	
KCl	44.32 %
$K2SO_4$	51.36 %
$MgCl_2$	1.83 %
SiO_2	1.68 %
Al_2O_3	0.73 %
Purity of potash	**95.68%**

The liquid potash is being supplied by Dhampur Bio Organics at their Asmoli sugar unit and the results are very interesting indicating the efficient use of liquid potash in agriculture.

Table 3 : Estimation of total potash and equivalent K_2O in solid and original liquid sample

Potash	Composition in solid after drying without water of crystallization	Equivalent K_2O	Composition in original liquid	Equivalent K_2O
KCl	44.32 %	27.92 %	4.83 %	3.04 %
K_2SO_4	51.36 %	27.73 %	5.6 %	3.03 %
	Total K_2O in solid after drying	**55.65%**	**Total K_2O in original liquid sample**	**6.07%**

Sulfur/silica/magnesium/bio-char containing soil manure

The solid ration obtained from slurry clarifier contains unrecovered potash (about 5%), sulfur, nano silica, magnesium carbonate / and bio-char. The chemical analysis of the residue has been carried out using SEM/EDAX analytical technique and the results are as follows (Figure 4).

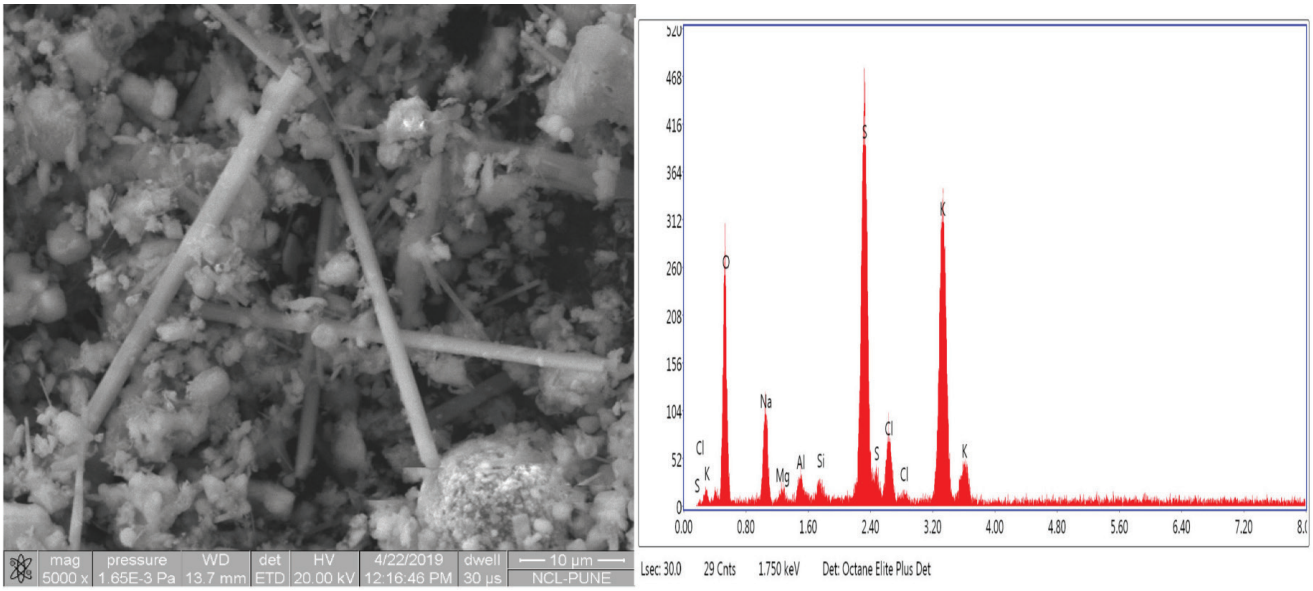

Figure 4 : The SEM photograph and EDAX analysis of the residue of fly ash after aqueous phase extraction

The SEM photograph and EDAX (Figure 4) shows unrecovered potassium crystals as well as sulfur, Silica/ magnesium and bio-char which is mixed with the pressmud available with the sugar industry to obtain soil manure. The soil manure is being distributed to the farmers in the surrounding area of Asmoli and the results are very encouraging showing utility of the soil manure obtained from fly ash.

For vermi composting, pressmud available from sugar mill was mixed with both ash and the cake from which some potash had been extracted. This mixture after some trials has proved very benefiical for vermi composting. There was no necessity to mix cow dung. Of course, this required some trials with various earthworms and different temperatures. But in the end we could find the right solution for producing a good, healthy vermi compost. Now the further trials are being done to see whether a continuous process of vermi composting can also be developed.

CONCLUSION

From the study carried out it is quite clear that the liquid potash can be recovered from spentwash incinerator fly ash using simple aqueous phase extraction /clarification process as well as the solid residue obtained containing potassium, nano silica/magnesium and bio-char can be used as soil manure.

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