## Production of ammonium phosphate containing fertilizers from apatite unsuitable for the wet process

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**Abstract**. Methods are described for the production of ammonium phosphate containing fertilizers from apatite unsuitable for the use in the wet process. The studies were carried out with the intention of utilizing the reserve of apatite at Eppawala in Sri Lanka using raw local materials.

## Introduction

The starting material used for the manufacture of most widely used high analysis phosphate fertilizers, i.e., triple superphosphate and ammonium phosphate is orthophosphoric acid [1-3]. Orthophosphoric acid needed for the fertilizer industry is generally made by the wet process. Although the apatite deposits are widely distributed, the quality required for the wet process is limited by high aluminium, iron and chlorine content. Aluminium and iron (Fe<sub>2</sub>O<sub>3</sub> + Al<sub>2</sub>O<sub>3</sub> contamination excess of 8-10% is generally regarded as unsuitable for the wet process) causes severe problems in filtration and purification of the acid [4]. Excessive chlorine leads to corrosion. Furthermore sulphuric acid needed for the wet process is becoming an expensive item in the world market. Because of the reasons given above, it is important to develop methods for the manufacture of high analysis phosphate fertilizers which can utilize low quality ores, preferably avoiding or minimizing use of sulphuric acid. We have conducted experiments on a laboratory scale to develop methods for production of ammonium phosphate containing fertilizers from the low grade rock using any of the mineral acids sulphuric, nitric or hydrochloric.

This study was motivated by the necessity of finding a method for the production of phosphate fertilizers from apatite mined at Eppawala in Sri Lanka adopting raw materials that can be processed locally. The apatite reserve at Eppawala in Sri Lanka is estimated to be 25 000 000 tonnes and at the present demand rate in Sri Lanka the deposit could provide phosphate fertilizers for 3–4 centuries [5–7]. The Eppawala ore is mainly a fluor-

Constituent	Percentage	
CaO	48.1	
$P_2O_5$ (citric acid)	1.2	
$P_2O_5$ (insoluble)	32.0	
SiO <sub>2</sub>	2.0	
$Fe_2O_3$	6.1	
$Al_2O_3$	3.2	
Cl	3.1	
F	2.2	

Table 1. Composition of the ore.

chlorapatite with a little admixture of hydroxyapatite and carbonatoapatite. The exact composition and the impurity levels are variable. In the leached zone, the ore is heavily contaminated with iron and aluminium (Table 1).

## Experimental

In all experiments the ore from the leached zone grounded and sieved through mesh BS 200 was used (composition as given in Table 1). The basis of the method is as follows:

Apatite is treated with sulphuric (75%), hydrochloric (35%) or nitric acid (70%) stoichiometrically sufficient to generate dicalcium phosphate and the product is aged for 2-3 weeks to complete the reactions, i.e.,

$$2\operatorname{Ca}_{5}(\operatorname{PO}_{4})_{3} \cdot X + 2\operatorname{H}_{2}\operatorname{SO}_{4} \rightarrow 3\operatorname{Ca}_{2}(\operatorname{HPO}_{4})_{2} + 4\operatorname{Ca}\operatorname{Cl}_{2} + \mathrm{HX}$$
(1)

$$2\operatorname{Ca}_{5}(\operatorname{PO}_{4})_{3} \cdot X + 8\operatorname{HCl} \rightarrow 3\operatorname{Ca}_{2}(\operatorname{HPO}_{4})_{2} + 4\operatorname{CaCl}_{2} + 2\operatorname{HX}$$
(2)

$$2 \operatorname{CA}_{5}(\operatorname{PO}_{4})_{3} \cdot X + 8 \operatorname{HNO}_{3} \rightarrow 3 \operatorname{Ca}_{2}(\operatorname{HPO}_{4})_{2} + 4 \operatorname{CaNO}_{3} + 2 \operatorname{HX} (3)$$

where X = Cl, F, OH

If the ore contains x% wt. of  $P_2O_5$ , the quantities of different acids required per kg of the ore are given in Table 2. The acidulated product is

Table 2. The quantities of acid required per kg of the ore containing x% by wt. of  $P_2O_5$ .

Acid	Quantity required per kg of apatite	
$H_2SO_4$ (75%)	$1.2x \times 10^{-2}$	
HCl (35%)	$1.97x \times 10^{-2}$	
HNO <sub>3</sub> (70%)	$1.7x \times 10^{-2}$	