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Novel Technique for Purification of Fertilizer Phosphoric acid with Simultaneous Uranium Extraction

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Abstract

A process codenamed PHOSPURIN is described for the purification of Fert Phosphoric acid with simultaneous extraction of Uranium compounds from acid. This includes maintaining the acid stream at different redox potentials for the necessary extraction of all the metals & rare earths using Solvent Extraction technique. Details are also provided on the extraction behavior of various cations and rare earths from fert acid media employing redeveloped Phosphate reagent (codenamed KROPHOS-18) in kerosene system.

The effects of various parameters, such as the concentration of acid, metal ion and extractant, nature of the diluents etc., on the extraction of various cations have been investigated. Based on the extraction data, most of the cations like Fe (II) & (III), Al, Mg, Ca, Mn, Na, K, heavy metals like Arsenic / Cadmium, rare earths including Uranium etc., are all being extracted with high to very high separation factors from all molar fertilizer phosphoric acids.

The practical utility of the extractant & the process has been demonstrated by tests on commercial fert phosphoric acid. It has been conclusively found that KROPHOS-18 has good properties, such as high distribution coefficient, good stability, acceptable kinetics, good phase separation etc.

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Keywords: Wet process phosphoric acid; Purification; Solvent extraction; Uranium Extraction.

1. Introduction

1.1. General

Water Soluble fertilizers (WSF) are gaining popularity by the day for their high purity and water-solubility making them an ideal fertilizer for fertigation and for foliar application. Technically pure Phosphoric acid is a primary raw material for producing such WSF products as well as various other downstream technical grade phosphates. Purification of acid also eliminates the transfer of harmful metals like Arsenic, Cadmium & Uranium to downstream products & processes.

To meet the growing requirement of high purity phosphoric acid, solvent extraction technique and novel phosphorus based KROPHOS-18 extractant developed indigenously have been successfully tested.

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This author therefore has taken a lead & initiative on the development of this twin novel approach to establish both purification of Fert Phosphoric acid while also simultaneously recovering Uranium in a separate stream. The process has been codenamed PHOSPURIN.

With constant rise in demand of energy, it is apparent that the world cannot rely on hydroelectric, gas / oil, coal, wind and biomass only for energy. In comparison, Nuclear power provides the lowest cost, safest and cleanest source of energy.

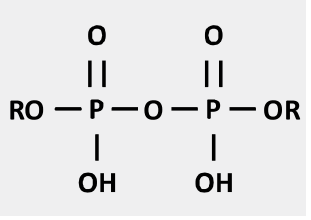
Despite Fukushima's negative impacts, there are numerous reasons for the growth of global nuclear power, including a world hungry for all forms of energy and increased concerns over the greenhouse gas emissions. This has also once again revived the interest of fertilizer manufacturers worldwide to develop facilities for the extraction of uranium from fert acid.

1.2. Background of Invention

Solvent Extraction is an attractive alternative for the recovery of metal ions from various solutions. In case of fert phosphoric acid, it is used to extract most of the polluting cations from the acid. Various Phosphorus extractants such as DEHPA7, 9, 15, TBP3, OPPA1, 12, DBBP18, APPA4, 10, TOPO7, 9, 15 etc., have been studied to purify green acid / extract Uranium since 1950's. Amongst these, currently TBP has been utilized commercially for acid purification. Though enormous information is available on metal extraction parameters with above reagents in other mineral acid systems, relatively less information exists on extraction characteristics of Pyro phosphoric acids on purification of phosphoric acid.

Alkyl Pyro Phosphoric acid came into prominence as extractant in the late fifties and the sixties for the extraction of uranium and other rare earths from fertilizer acid. During such U+ extraction, simultaneous acid purification was ignored, priority being Uranium. Though this process was used commercially in some plants for some period in Florida, USA, the operations were later discontinued due to the unstable nature of Pyro Phosphoric acid & low uranium price. During the last four decades, Alkyl Pyro Phosphoric acids have been avoided due to their unstable nature & availability of better reagents.
Section headings

Pyro Phosphoric acids are represented by the general formula –



Its distribution coefficient measures 30 – 40 for Uranium in fert phosphoric acid. A coefficient of this magnitude has a number of advantages, some of which include –

a) Smaller amount of reagent required
b) Fewer extraction stages
c) Smaller equipment and thus CAPEX savings
d) Extraction of metal in concentrated form
e) Lower (OPEX) production cost etc

KROPHOS-18 has been stabilized by a unique method of synthesis by the author himself. The reagent which is well known to have one of the highest coefficients of extraction amongst all the current phosphate reagents can hold metal ions stoichiometrically equivalent of its molar concentration. KROPHOS-18 samples were used for the current tests.

1.3. Phos acid & Solvent Extraction

Phosphoric acid manufactured from elemental phosphorus route dominated the technical grade acid supply scenario in the early 1960's & 70's. There were no any such major commercial processes developed on industrial scale to purify fertilizer acid during that period. It was only the after the increase in the energy prices during 70's that the elemental