THESIS

ON
RECOVERY OF URANIUM FROM EL-ERADIYA ORE CENTERAL EASTERN DESERT, EGYPT

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RECOVERY OF URANIUM FROM EL-EREDIYA ORE,

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SUMMARY

RECOVERY OF URANIUM FROM EL-ERADIYA ORE CENTERAL EASTERN DESERT, EGYPT.

The subject of the present research is to study the best conditions to leach and recover uranium economically from a technological sample obtained from El-Eradiya at the Centeral Eastern Desert of Egypt. Various factors which affect the percent efficiency of uranium leaching and recovery from this ore have been studied.

This thesis is divided into three chapters. Chapter I includes the introduction, in which a survey on the distribution of the most important sources of uranium(which is the primary uranium mineral Pitchblende, UO_2) is given. Also a note on the chemical composition of the secondary uranium minerals e.g Uranophane is included. A detailed discraption of uranium ore material , subject of this research is also given and a summary of the chemistry of uranium is reviewed.

Complete chemical and mineralogical analyses were carried out to determine both uranium

and the gangue matrix. The exact amount of uranium in the ore beside the major and minor elements is a prequisite for the recovery of uranium from the ore. Results of the experimental studies of the constituents of the ore reveal that it consists of light and heavy fractions. The light fraction, which is a mixture of minerals, is examined by infrared spectroscopy. The results indicate that it consists of Kaolinite, $Al_4Si_4O_{14}(OH)_8$, and Jasper, SiO_2, whereas, the heavy fraction, containing the radioactive minerals, is found to contain Pitchblende, UO_2 and Uranophane, $Ca(H_3O)_2(UO_2)_2(SiO_4)_2.2H_2O$. A number of analytical methods have been adopted in order to obtain the complete chemical analysis for the major, minor and the trace element constituents of the studied ore sample. Most of the constituents were determined spectrophotometrically, while Na_2O and K_2O were analyzed by flame photometry. In addition, x-ray analysis was used for the determination of a number of trace elements Such as Th, Pb , As, Mo Cu, Nb, Zn and Ba. Uranium content in the ore has been determined fluorimetrically.

Chapter II includes the study of two principal leaching techiques , namely acid curing and agitation leaching. Agitation leaching has been fully studied during the present work. A leach process depends mainly on a number of factors which have been carefully studied in order to obtain the best uranium leaching efficiency that matches at the same time with economic considerations. These factors are acid concentration, effect of different acids, temperature, different types of oxidants, effect of concentrations of potassium chlorate, leaching time and effect of solid/liquid ratio. From the experimental results obtained, the optimum leaching conditions to obtain complete uranium dissolution were found to be 72.12 Kg/t ore of sulphuric acid, 1 Kg/t ore of potassium chlorate as oxidant, solid/liquid ratio 1:10, agitation time is two hours and the suitable temperature is 100°C. Under such conditions the uranium concentration in the leached liquor was found to be 0.3209%, i.e the uranium leaching efficiency is 100%.

Chapter III involves the recovery of uranium by solvent extraction which was carried out in four steps. The first step was achieved by the extraction of an inorganic compound into an organic solvent such as bis(2-ethyl hexyl) phosphoric acid, D_2EHPA, or tri-octyl phosphine oxide, TOPO, in carbon tetrachloride as diluent. The extraction process depends, in principle, on the formation of neutral complex which dissolves in the orgnic layer more than in the aqueous layer. In the present work, the different factors that affect the efficiency of the extraction of uranium into D_2EHPA and TOPO in CCl_4 were studied in order to deduce the optimum conditions necessary for the most economical extraction. These factors include the aqueous/organic phase ratio, effect of different concentrations of D_2EHPA, different pH values, effect of different concentrations of TOPO, effect of D_2EHPA/TOPO molar ratio (synergistic effect), effect of different diluents, effect of temperature, effect of shaking time and solvent saturation. From the results obtained it is concluded that maximum uranium extraction from the studied leached liquor can be achieved at pH 1.7, using 0.01M D_2EHPA/TOPO at a molar ratio of 7:3 in carbon tetrachloride as diluent. The optimum organic to aqueous phase ratio was found to be 1:1 (v/v), shaking time was found to be 5 minutes while settling time was found to be 2 seconds. Extraction was best obtained at room temperature and four stages were found sufficient for solvent saturation. The nature of the extracted species has been identified by plotting log [D_2EHPA] against log D and log[TOPO] against log D, where D is the distribution ratio. The results indicate that uranium is di-solvated with respect to D_2EHPA and monosolvated with respect to TOPO. Hence the formula of the extracting system can be represented as $UO_2^{2+}[D_2EHPA]_2TOPO$. The value of ΔH -7.9 Kcal/mole was obtained from the results of studing the effect of temperature on the extraction coefficient of U(VI). It is obvious that the present value is reasonably close to the values reported in the literature[124]. The concentration of uranium from the extraction process was found to be 1.2836%.

The second step " scrubbing" was carried out by washing the organic phase containing uranium for several times with a small quantity of deionized water.