Thermal Annealing of Neutron Irradiated Ammonium and Potassium Dichromate

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Abstract

A modified solvent extraction study was made to assess the validity of previously published claim that, in neutron irradiated ammonium dichromate heating leads to the generation of a reducing species that cause lowering of the value of retention. Simultaneous investigation of the behavior of both the ammonium and potassium salts showed this claim to be incorrect.

الخلاصة

استعملت تقنيات استخلاص مذيبي معدلة لتقييم صحة ادعاء نشر سابقا بان تسخين ثاني كرومات الامونيوم بالاشعاع النيوتروني يؤدي الى تكوين اصناف مختزلة يسبب بقصان في قيمة الاحتجاز (R) لقد تم اجراء دراسة انية لسلوك كل من املاح ثاني كرومات الامونيوم و ثاني كرومات البوتاسيوم تبين ان هذا الادعاء لم يكن صحيحا.

Introduction

Following thermal neutron capture the compound nucleus is formed in a highly exited state and, as it relaxes, it suffers recoil. The recoiling atom does not cause changes only within the compound to which it is bound but also to molecules of the surroundings, and, as it slows down, it will take part in such chemical processes as addition, displacement, combination and solid state exchange. [1]

The percentage of molecules that retain their initial state or return to it as a result of some physical treatment is called Retention, [2] and was stated to be dependent on solution effects in addition to being modified by temperature and light.

The existence of such species as CrO_3, CrO_2, CrO and Cr^{+6} was proposed for the irradiated potassium chromate, [1], with initial retention of 61%, which was stated, to be independent of pH of the solution in which the sample was dissolved.

Formation of Cr^{+3} in neutron irradiated potassium chromate had also been reported [3].

Harbottle and Sutin in their study of neutron irradiated potassium and ammonium dichromate [4], also attributed the low retention value for the ammonium salt to the reducing behavior of the ammonium ion, while Maddok and Gettoff attributed the lowering of the retention value to photolytic degradation [5], while Haqrbottle, in an investigation on M_2CrO_4 & $M_2Cr_2O_7$ [6&7], found new values for R attributing the changes in R values to solvent effects.

The methods employed for isolating the radioactive species formed in the above reported works included ion exchange, precipitation, paper chromatography and solvent extraction.

Later work carried out at Cambridge indicated the inapplicability of the first three of these methods for this line of work, thus leaving us with solvent extraction as the only viable approach. [8]. Such a procedure was then applied for separation of the radioactive species in neutron irradiated Cr VI compounds hitherto studied whereby the irradiated specimen is added to a homogeeous mixture of the solvent.

And the isolating solvent which was being shaken continuously, thus not allowing time for any solution process to be effective, this we accept as Zero time extraction.

Experimental

Irradiation with thermal neutrons was done using Am (241)/Be source Flux 10^5 n/cm^2, s Counting was made on M PHA type Ortec 6420B with 3*3 Nal(T1) detector Heating in a Baird and tattlock oven Quantity irradiated 10g. Extraction into 10% solution of HDEHP (toluene)(25ml)HDEHP=Bis(2-ethylnexyl) or the phosphoric acid From 3M HNO_3 (25 ml) Specimen used in each extraction (20 mg) Volume used for counting (15 ml)

Results and conclusion

Table A shows results of early work. Tables (B1&B2) show similar trend in values of R for both the potassium and ammonium salts with a decrease in its value with rise of temperature. This is a consequence of the presence of electron rich O & F centers accompanied possibly by thermal decomposition, this invalidates the hypothesis that the ammonium ion decompose and behaves as a reducing species, this similarity in trend is also observed in the isothermal annealing study of these tow compounds. Tables (Cl &C2) and give support to the conclusion that earlier investigation assumed as R- values are in fact the result of solution effects and bear no relation to species actually present in the irradiated solid, a problem that was eliminated through employing Zero time extraction. Therefore the claim of ammonium decomposition is incapable of verification. We therefore conclude that it is incorrect.

Table A

Compound	R%	REF
Ammonium dichromate	31.1 31.9	4 7
Potassium Dichromate	82.1(monoclinic) 89.5(triclinic) 89.9	3 3 7

Table B1 (potassium dichromate)

Heating time (Minute)	Temperature C	R%
0	35	70
60	75	53.5
60	120	57.5

TableB2 (ammonium dichromate)

Heating time	Temperature C	R
0	22	68.9
60	60	61.8
60	120	57.8

Table C1 (potassium dichromate)

Heating time (Minute)	Temperature C	R%
30	70	47.3
60	70	53.5
120	70	56.4

Table C2 (ammonium dichromate)

Heating time (Minute)	Temperature C	R%
30	70	55.3
60	70	55.1
120	70	58.4

References

1- L.szilared and T.A Chalmers, *nature*, 134,462,(**1934**)
2- W.f.Libby j.Amer. *Chem.* Soc.62. 1930(**1940**)
3- J.Green, A.G maddock, *nature* 164,788(**1949**) Sonderdruck aus, Radiochemica Acta, 2.93-96 (1963)
4- G.Harbottle and N.sutin *Advan.Inorg.* Chem.radiochem. 1.267(**1959**)
5- Gettoff and A.Gmaddock, *Radiochem.* Acta,2,90(**1963**)
6- G.Harbottle,j. *Chem.phys.* Vol22, 1083(**1954**)
7- G.Harbottle, j. *phys.chem.* .22. 1083 (**1954**)
8- M.A.H.Al-Abbasi, *Exchange and Recoil Effects in some hexa halo Antimonate (v) Salts* ph.D Thesis, Cambridge University, England **1980**.
9- A.G Maddock and J.I Vergas-*chem effect of nuclear transformation* IAEA, Vienna (**1961**).