Uranium Mineralogy and Flow Sheet Development

A Comparison of Acid and Alkaline Leaching

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Abstract

The uranium industry has entered a new phase of development and renewed market interest has prompted the revival of major and particularly junior exploration, mining and metallurgical development focused on deriving efficient and cost effective production, particularly from lower grade resource.

The occurrence and association of Uranium imposes a very wide range of mineral types and so flowsheet design tends to be specific to each resource, a “cookie cutter” approach will not work in uranium process design. Economically viable extraction necessitates detailed study in the selection of acidic or alkaline leaching, in conjunction with an array of concentration methods. This paper discusses common uraniferous mineral types and compares the economics and challenges faced in acid and alkaline leach environments, presenting some broad guidelines for early selection of base case flowsheet and feasibility study development.

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Background

- Why present on this topic?
  - Because uranium ore processing by acid leaching is an established and accepted production method.
  - The question comes up time and time again – Why don’t we just do an acid leach?
  - Uranium flowsheet development is not a simple matter of grade and tonnes. Mineralogy is critical to the optimum economic flowsheet.
  - There are no hard and fast rules, due to the complexity of the uranium and gangue minerals and the environment of each, each flowsheet must be considered on it’s own merits.

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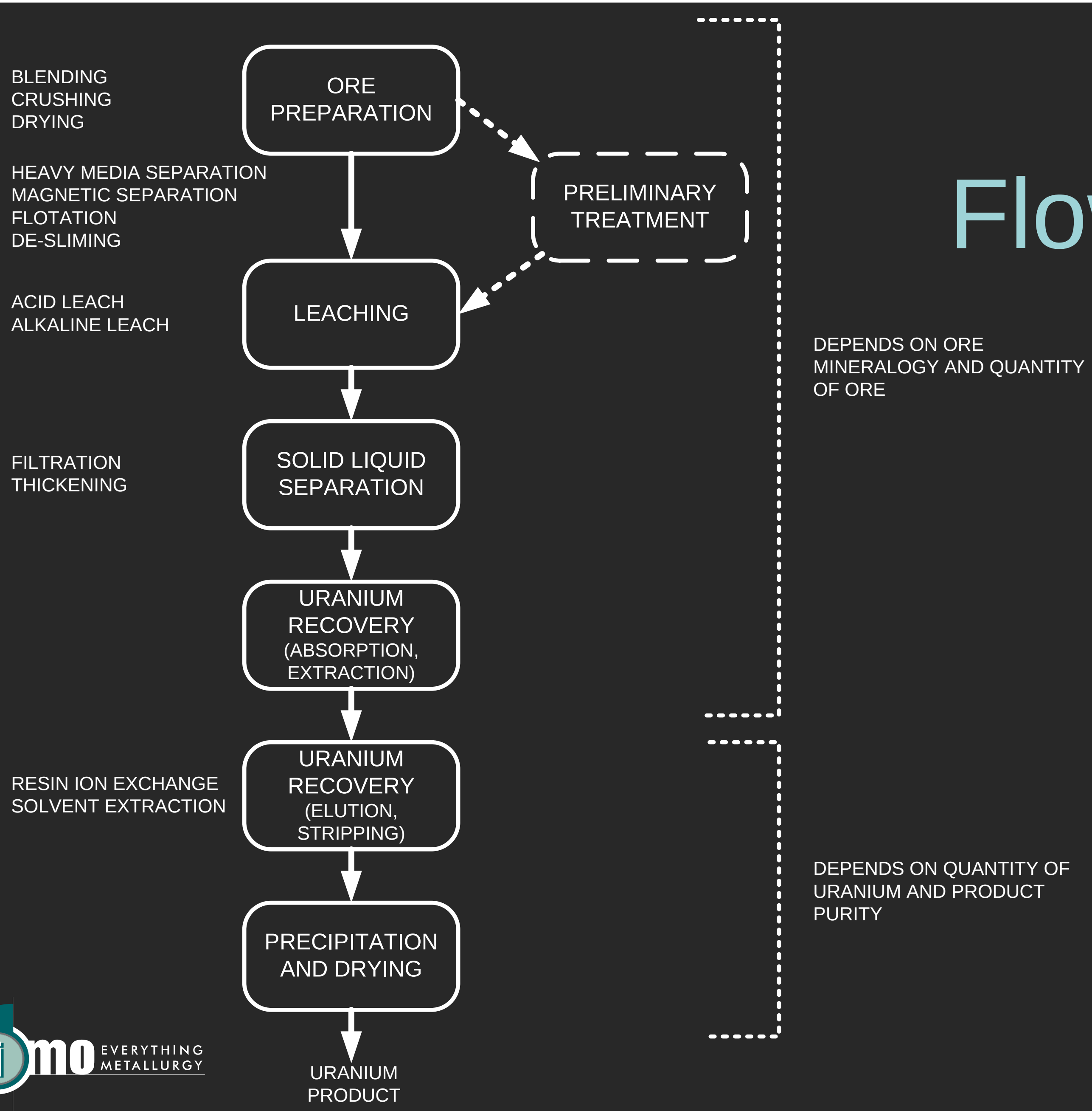
Basic Flowsheet



Reasons why mineralogy affects flowsheet design

- Degree of comminution required to effect uranium liberation
- Potential for separating gangue materials from uranium bearing minerals by physical techniques
- Nature of lixiviant required (acid, alkaline and/or oxidant)
- Probable rheological properties affecting solid - liquid separation potential
- Probable ionic composition and concentration of leach liquor.

Uranium Deposit Types

The International Atomic Energy Agency (IAEA) assigns uranium deposits to 15 main categories of deposit types, according to their geological setting and genesis of mineralization, arranged according to their approximate economic significance.

- Unconformity-related deposits
- Sandstone deposits
- Quartz-pebble conglomerate deposits
- Breccia complex deposits
- Vein deposits
- Intrusive deposits (Alaskites)
- Phosphorite deposits
- Collapse breccia pipe deposits
- Volcanic deposits
- Surficial deposits
- Metasomatite deposits
- Metamorphic deposits
- Lignite
- Black shale deposits
- Other types of deposits

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Main Uranium Minerals

uraninite

davidite

brannerite

- Oxides
  - **Pitchblende/ uraninite**
  - **Davidite**
  - **Brannerite**
  - Betafite
  - Thorianite
  - Thucholite
  - Pyrochlor
  - Microlite
  - Euxenite
  - Gummite
  - Furgusonite
- Silicates
  - Coffinite
  - Uranophane
  - Sklodowskite
  - Kasolite
  - Thorite
  - Zircon/cyrtolite
  - Allanite

coffinite

kasolite

uranophane

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Main Uranium Minerals, cont.


autunite


carnotite


johannite

- Phosphates
  - Xenotime
  - Monazite
  - Autunite
  - Torbernite
  - Saleeite
  - **Carnotite**
  - Sabugalite
- Sulphates
  - Johannite
  - Uranopilite
- Carbonates
  - Liebigite
  - Bastnasite
  - Uraniferous calcite
- Molybdates
  - Muluranite
  - Umohoite


liebigite


bastnasite


umohoite

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Gangue Minerals

- Quartz
- Carbonates
  - Gypsum
- Phosphates
- Silicates
- Iron Oxides
- Sulphides
- Carbonaceous constituents

Potential Physical Concentration Techniques

Due to the nature of uranium ores, that an economic resource has a very low amount of uranium present compared to base metals, and uranium tends to be present in an intergranular matrix and widely dispersed, physical concentration methods tend not to be widely successful to upgrade uranium ores. However, in some circumstances the following techniques can be employed.

- Gravity separation
- Heavy Media Separation - davidite
- Magnetic Separation – gold / uranium in RSA
- Flotation – reverse sulphide , development on others
- De-sliming
- Some of the above combined with ultra-fine grinding

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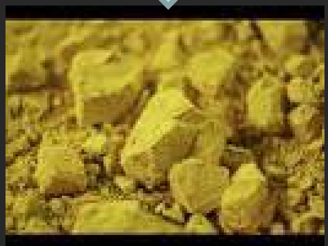
Summary



- First thing to do when looking at a uranium flowsheet – assess the mineralogy.
- Develop high level flowsheet from mineralogical assumptions.
- Can develop first pass process plant capital and operating costs.
- Can estimate uranium recovery.
- Input into project economics to assess viability of project at early level.
- Identify any opportunities for physical beneficiation or process risk areas at an early stage in the project.

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References

- Significance of Mineralogy in the Development of Flowsheets for the Processing of Uranium Ores, International Atomic Energy Agency, Vienna, 1980
- Tailoring Process Selection to Uranium Mineralogy and Ore Type, D Lunt and Z El-Ansary, GRD Minproc, June 2008.
- Wikipedia, sourced May 2010.

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Questions?

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