OAK RIDGE National Laboratory

Fluoride volatility processing of used nuclear fuels

Guillermo Daniel Del Cul

Jason M. Richards

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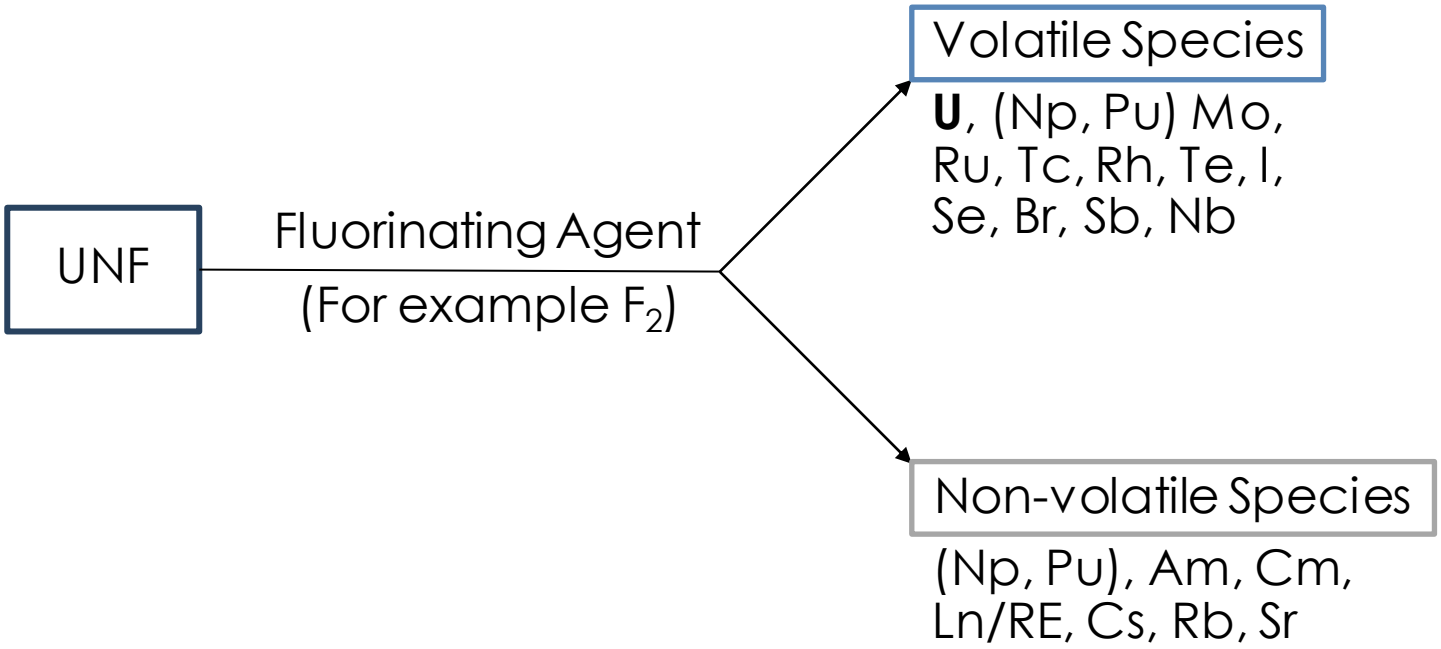
Fluoride Volatility Processing of UNF

Chemical conversion of UNF to recover and purify valuable components as volatile fluorides

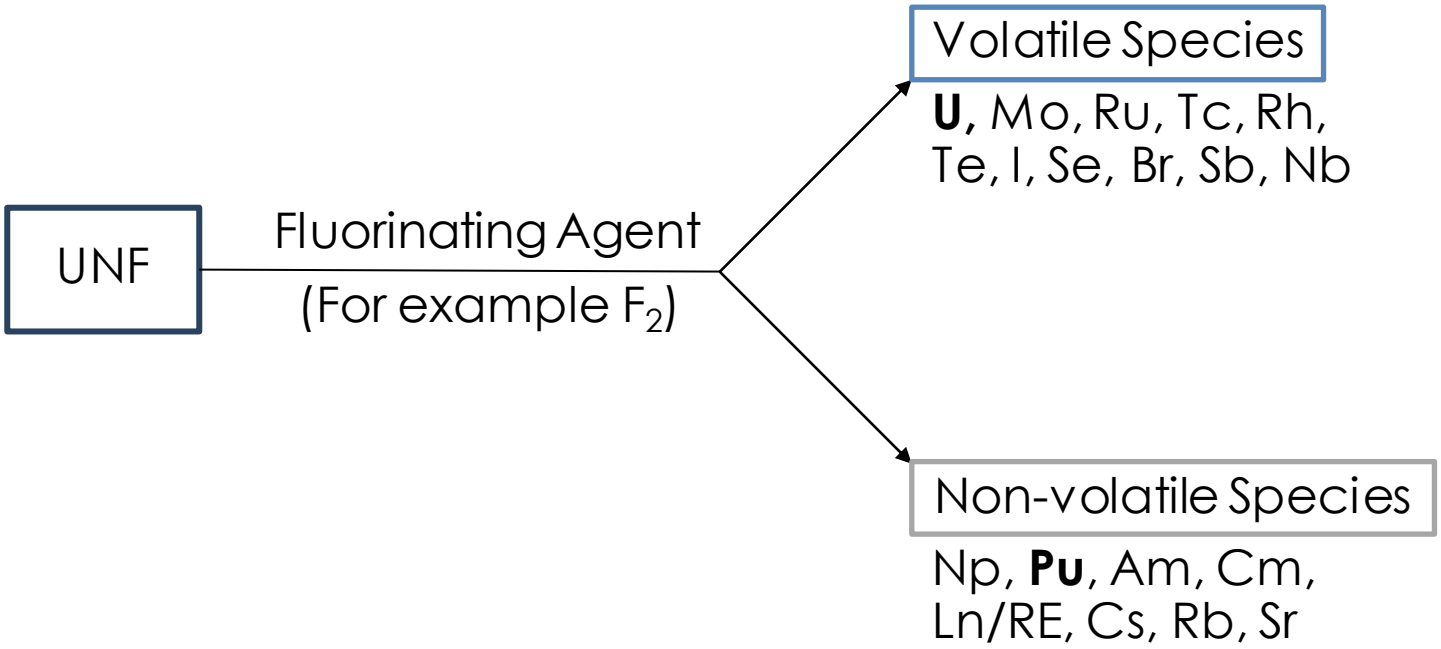


*Process conditions dictate Pu, Np behavior

Fluoride Volatility Processing of UNF

The process must be:

Effective | Safe | Secure



Fluoride Volatility Processing of UNF

The process must be:

Effective

- More than 100,000 MT of uranium from non-commercial USA reactors have been recovered through fluoride volatility.

High TRL

- Commercial nuclear fuel is often enriched in the form of UF_6 at a rate of about 60000 MT of UF_6 per year.

Compatible with current processes

- Fluorination equipment, such as flame tower fluorinators, have been, and are currently, produced on a variety of scales.

Scalable

- Fluoride volatility processing can accommodate a variety of UNF types and the product is easily converted into various forms such as oxide, metal, UF_4, etc.

Versatile

Fluoride Volatility Processing of UNF

The process must be:

Safe

- The volatile fluoride fraction (>90% of the fuel) does not contain the high-dose fission products. Bulk uranium is separated from high-dose components early in the process.

Reduced FP handling

- The non-volatile fluoride fraction (<10% of the fuel) is not diluted in the process, resulting in a compact waste form.

Low-volume waste

- Only the fluorinator and non-volatile fluoride fraction require hot cells reducing worker dose and cost.

Small footprint

Fluoride Volatility Processing of UNF

The process must be:

Secure

- Selection of the process conditions and the fluorinating agents can be used to tune the removal of Pu and Np from nearly zero to a very high degree.

Control over Pu partitioning

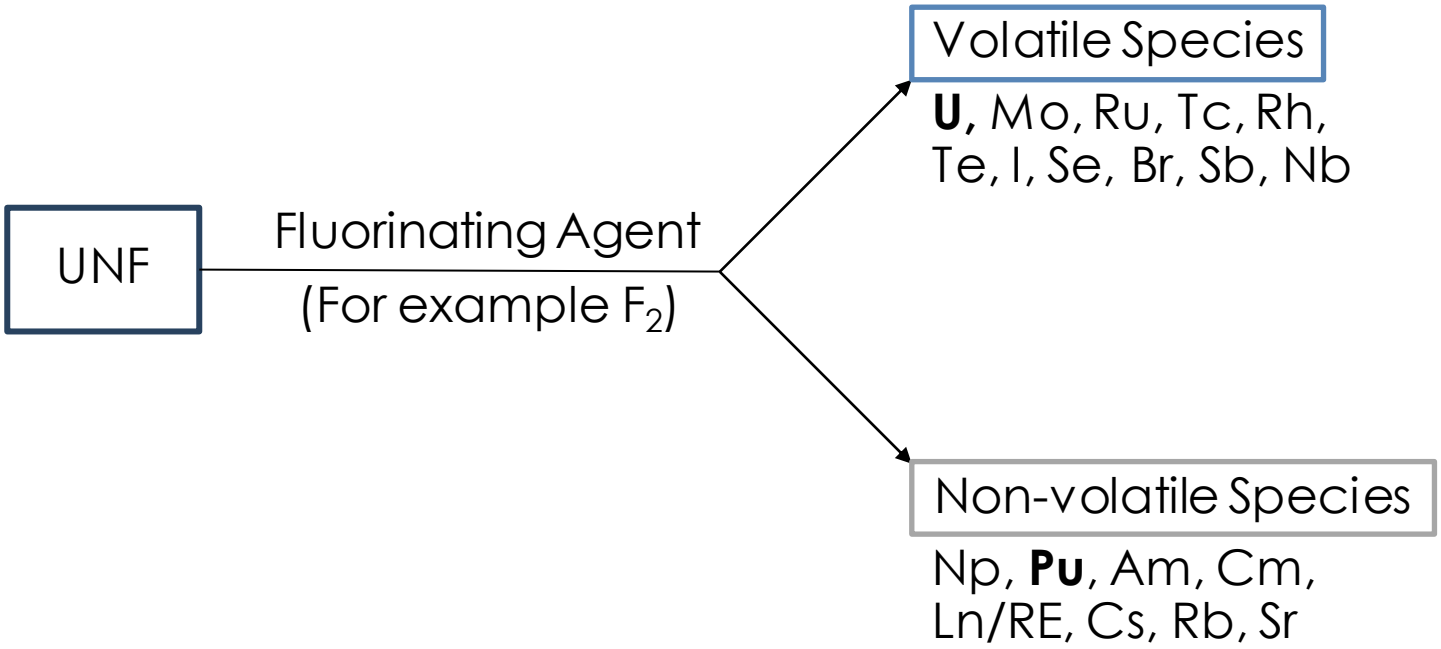
- Process conditions, such as reaction temperature and fluorinating agent, are easy to observe and difficult to change. Pu fate is easily controlled and verified.

Simplified Safeguards

Fluoride Volatility Processing of UNF

The process must be:

Effective | Safe | Secure | Improved



Fluoride Volatility Processing of UNF

The process must be:

Improved

- Research is needed to determine the head end of the process (Decladding, grinding, voloxidation, etc.).

UNF

- Fluorine generation is an energy intensive process, but it is currently employed in conversion facilities and other industries.

Fluorinating Agent
(For example F_2)

- Research would be needed to optimize treatment of the volatile fraction to meet U or U/Pu (Np) product or waste form specifications.

Volatile Species

U, Mo, Ru, Tc, Rh, Te, I, Se, Br, Sb, Nb

- Fate of the non-volatile fraction would need to be decided.

Non-volatile Species

Np, **Pu**, Am, Cm, Ln/RE, Cs, Rb, Sr

Summary

Fluoride volatility benefits:

Effective

- The process provides clean recovery of valuable materials with a chemical conversion.
- The technology is high TRL, scalable, can handle a variety of fuel inputs, and integrates well into future processing.

Safe

- The head end and flame fluorinators are the only components to be located inside a hot-cell.
- The non-volatile fraction contains the high-dose FP and remains undiluted in the process, minimizing waste volume.

Secure

- Pu partitioning is determined by process conditions.
- Process conditions are easy to observe and difficult to change once implemented.
- It is easy to avoid a pure Pu stream.

Specific needs must be addressed as desired inputs and outputs are decided.