

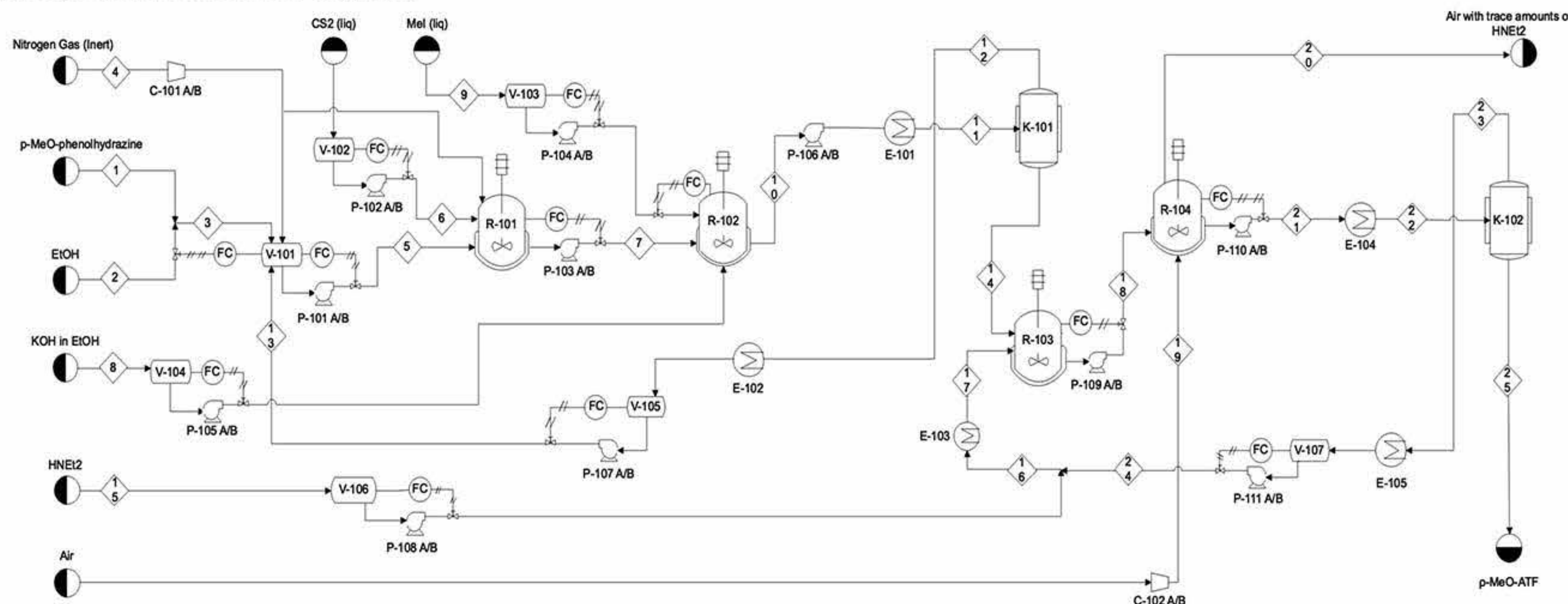
Intro

Nearly all gold mining operations use cyanide to oxidize and extract gold from ore through a process called heap leaching. Cyanide is relatively cheap and freely soluble in water, leading to its frequent use in heap leaching. Unfortunately, cyanide is also very toxic and hazardous to the environment. This has led many governments to ban the use of cyanide in heap leaching, creating a need for alternatives.

Para-methoxy-arylazothioformamide (p-MeO-ATF) has been identified as a possible alternative to cyanide for gold extraction. This project assesses the viability of p-MeO-ATF by experimentally determining its rate of gold extraction, its water solubility, and designing and performing a profitability analysis on a preliminary production and extraction operation.

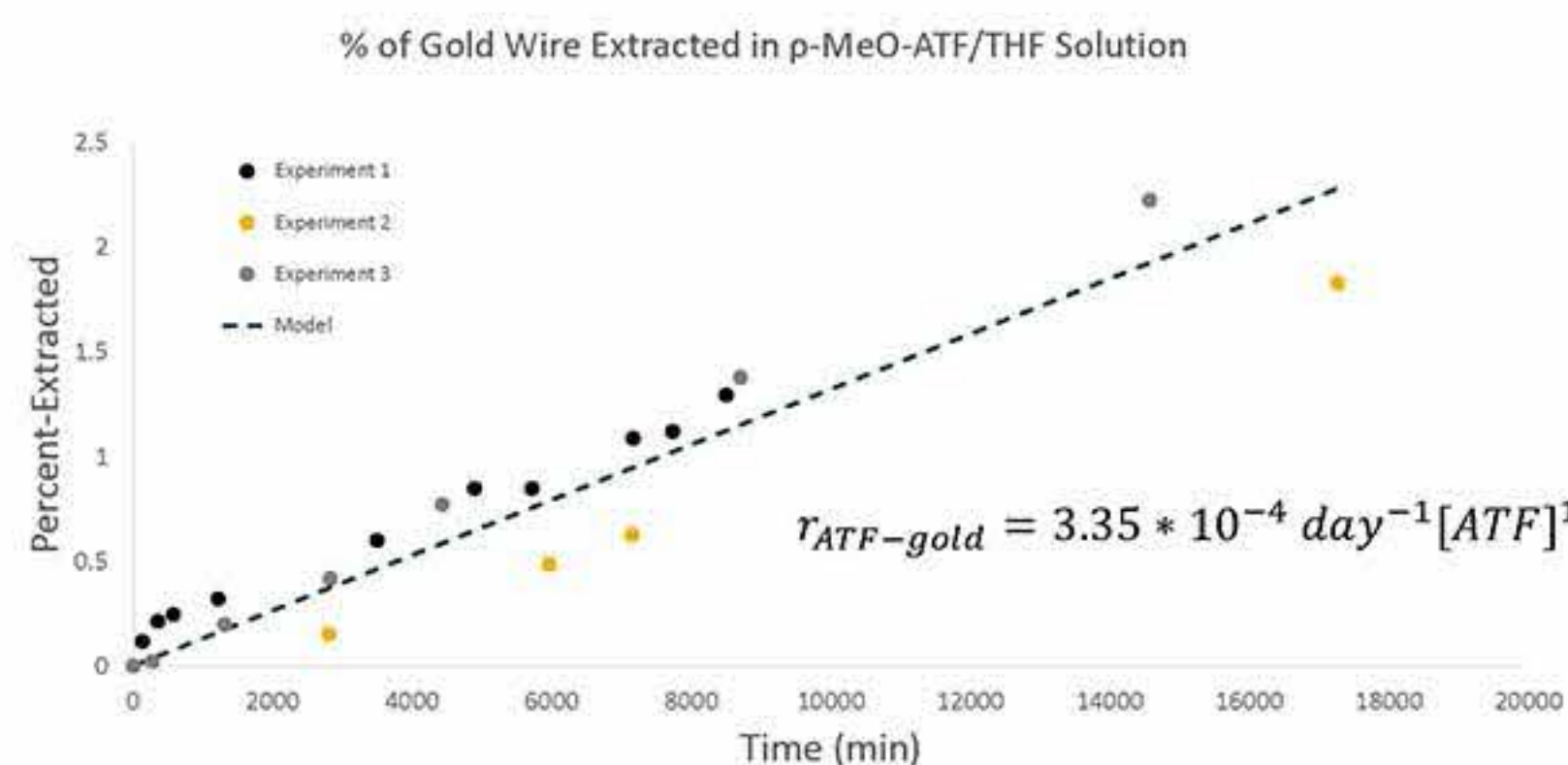
ATF Synthesis

The continuous p-MeO-ATF production was adapted from a small batch production method developed by Dr. Waynant. It was experientially determined that the crude p-MeO-ATF product could be utilized in the heap process, removing the need for complex purification steps for the product. Vaporizers were utilized instead of distillations columns due to the lack of multicomponent mixtures with similar boiling points. The solvent related to any synthesis step is removed before a new solvent is added, which provides greater simplicity in separations steps. Below is the of the continuous p-MeO-ATF production process flow diagram.

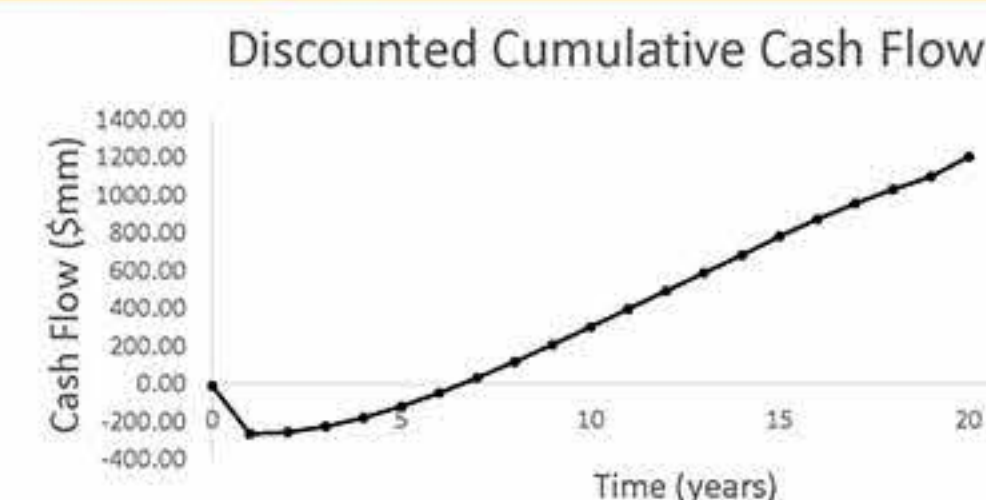


Results

The solubility of p-MeO-ATF in water was determined to be 12 ppm. The kinetics of p-MeO-ATF were evaluated in tetrahydrofuran (THF), acetone, diglyme, and ethanol. Only THF yielded appreciable gold recovery, so THF is utilized in the scaled-up heap.



Economic Analysis



Discounted Payback Period (yrs)	Net Present Value (\$mm)	Present Value Ratio	Discounted Cash Flow Rate of Return (%)
1.11	1203	5.54	32.73

Key Assumptions:

- Not considering costs associated with mining
- 16 years for p-MeO-ATF plant to produce enough product to operate at max capacity
- p-MeO-ATF selective only for Au, Ag, and Cu
- Plant processes 600 tons of ore per hour
- Average of 0.25 oz Au per ton of ore
- 70% of gold in heap extracted with 95% recyclability of p-MeO-ATF

Conclusion

- The rate of p-MeO-ATF gold extraction is significantly slower than cyanide gold extraction.
- p-MeO-ATF has a low water solubility which suggests waste would be easier to contain than cyanide waste.
- Without accounting for upstream mining costs, onsite production of and extraction with p-MeO-ATF is profitable.

Future Work

Further research should be done to confirm assumptions made for the following topics:

- Recovery and Recovery of p-MeO-ATF using electrowinning
- Toxicity information of p-MeO-ATF
- Selectivity of p-MeO-ATF for gold in an ore sample

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