HATCH™

Project Memo

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# Arkein Capital
# KNEW Pilot Plant

## Process Review

## 1. Introduction

Acid mine drainage (AMD) and other acid water mining effluents are a global environmental and processing challenge. A low cost technology for the effective treatment thereof will have far reaching impact, especially if saleable value products are produced.

Arkein Capital (Arkein) is considering investing in the erection of a pilot plant for evaluation of the KNEW process (proprietary process supplied by Trailblazer Technologies) for commercial application on AMD and other related feed solutions, to produce commercially viable salts, including ammonium sulphate [$(NH_4)_2SO_4$] and potassium nitrate [$KNO_3$].

Arkein requested Hatch to conduct an informal review of the process and provide high level commentary on its technical viability. This memorandum provides said commentary, as well as some concerns and considerations for future phases of the project.

## 2. Process

The proposed KNEW process is a combination of three separate ion exchange (IX) steps, incorporating a sulphate precipitation step via addition of recycled methanol (top-up required) as well as neutralisation with alkali compounds (caustic and sodium carbonate or palm ash). Other notable reagents and consumables are anhydrous ammonia ($NH_3$), nitric acid ($HNO_3$), potassium chloride (KCl), coal as fuel for burners and electricity for mechanical equipment and boilers.

Eluates are spray dried to produce the separate salt products, whilst the raffinate constitutes the treated (and therefore clean) water discharge. Products include mixed heavy metal nitrates, $KNO_3$, dolomite, NaCl, $(NH_4)_2SO_4$ and product water. The only waste indicated on the flowsheets is silt that is filtered from the feed solution. The heavy metal nitrates produced will probably end up being a waste stream as well, and may contain radioactive elements, rendering it a costly waste to dispose of.

IX processes are common and well known, with a wide variety of IX resins available with varying specificity for select elements. These processes are typically effective for the removal of targeted elements, up to certain limits and depend on the selectivity of the resins employed.

Neutralisation and spray drying do not pose high technical risk either, as these are employed in a range of industries as well.

## 3. Concerns and Considerations

- The finances as per the presentation seem borderline – as a "green" project for a current operation with environmental concerns regarding their tails / drainage / liquid effluent it may be viable, but for a 3rd party investor it may not be attractive enough.
- Sensitivity analyses are required to indicate minimum levels of specific elements in liquid effluent to make the process financially feasible.
- Robustness and control requirements for variability of feed are vague. This may result in an overly conservative design for a 'worst case scenario', resulting in inflated capital expenditure and additional operational concerns with larger than required resin inventories.
- Concern about the 'clean' water effluent – environmental legislation may prevent this from being reintroduced to natural water sources, resulting in a large volume of problematic effluent. Input on current and expected future environmental legislation in this regard should be solicited.
- Heavy metal nitrates composition and disposal/sale to be confirmed.
- Market for products (in commercial scale quantities) to be analysed, especially since these salt markets may be restrictive.

## 4. Conclusion

The proposed process is considered technically viable, due to its implementation of known IX technology and supported by common unit operations.

The process is probably best suited to AMD from coal mining operations containing significant levels of sodium and calcium, and will likely not make economic sense for AMD from gold mining operations due to low contained sodium levels.

While the process will benefit any producer of mine acid water in terms of negating their environmental legacy, it will not necessarily pose a positive business case, and therefore the basis for investment and business strategy should be considered carefully.

A positive business case may be further diminished or overturned by increases in reagent costs, whilst product selling prices are expected to remain constant or even reduce due to the additional supply.

It is recommended that a thorough characterisation of targeted feed solution is done for each application, as these will dictate the finances.

The normal project progression should also be followed (concept through feasibility) in order to establish the business case for the intended project on a commercial scale.

Finally, if the water produced is allowed to be sold for agricultural use as indicated during the presentation, methods for reticulation, monitoring and effecting payment have to be identified, evaluated and confirmed.

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