Selective deposition of Platinum Group Metals (PGM)

The low concentrations of PGMs in mineral deposits and the effort required to separate and purify them from the significantly higher concentrations of the Cu and Ni host ores accounts for their high commercial value, considering the demand for their unique properties in a wide range of markets. The availability, therefore, of a process technique that could selectively and rapidly recover PGMs from mining/refining operations or the recovery and recycling of PGMs from manufactured products (such as pharmaceutical, industrial or automobile catalysts) would be of real economic benefit.

The strengths and weaknesses, opportunities and threats (SWOT) of potential process options are shown in the table below. As can be seen here, Electrochemical Processes have as yet unrealised potential – with significant advantages of waste minimisation and speed of operation.

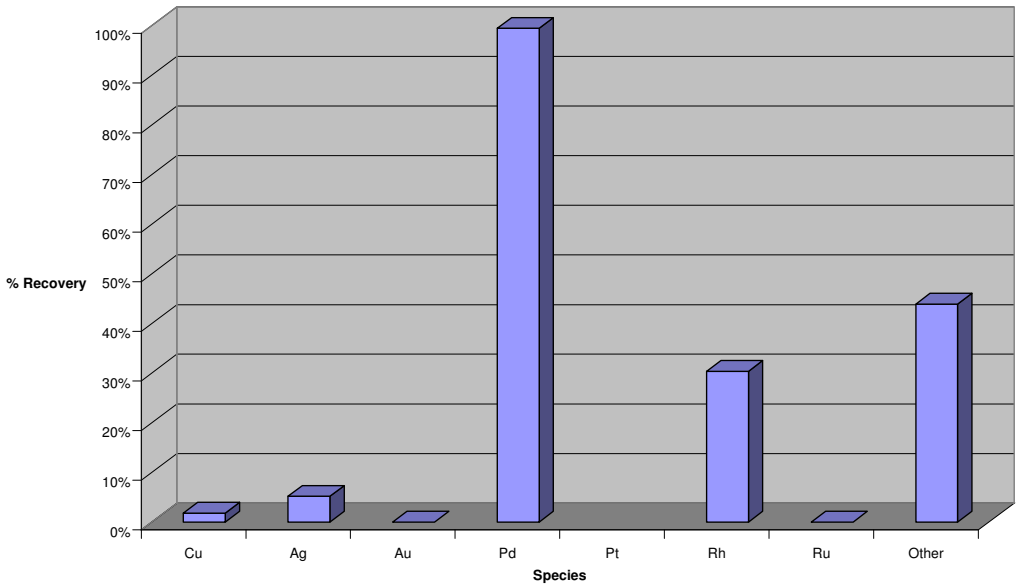
Process	Strength	Weakness	Opportunities	Threats
Chemical precipitation	Well known and used in the industry. Relatively simple plant.	Creates significant chemical wastes – especially containing NH_3. Incomplete recovery in single stage – leading to protracted multiple-step processing.	Standard "low risk" process as current base-line standard	Alternative technologies could displace the base-line by demonstrating reduced waste generation and more rapid PGM "turn-around"
Solvent extraction	Enhanced specificity for extraction of single metal	Solvents expensive, significant multistage plant investment, complex plant operation in control of two liquid phases.	Applications where low volumetric through-put separation is the key goal make this more attractive	Solvent loss, issues of toxicity may make this less attractive.
Selective Ion-exchange	Enhanced specificity for extraction of single metal.	Less specific than solvent extraction process. Unlike solvent cannot be re-used readily.	Packed bed simple to implement. Compact plant an advantage for retro-fits.	PGM normally recovered by resin combustion – leading to high operational costs

Process	Strength	Weakness	Opportunities	Threats
Electrochemical deposition	Flexible and complete recovery with selectivity through chemical and applied potential control – minimise waste production.	Need for accurate control to ensure required performance. Chemical Engineers less experienced with this technology.	Reduction of waste costs – reduced time and expense in complete PGM separation and recovery. Engineered cells of high standard now available.	Electrochemical cells perceived to be more complex.
Photochemistry	PGMs sensitive to recovery by exposure to light – able to achieve complete recovery	Fouling or deposition on optical surfaces will degrade performance.	Treatment of low concentration streams – possibly as a polishing step.	Optical processes less common. Generation of light us relatively expensive compared to chemical or electrochemical means.
Bio-processes	Electro-bioreactor demonstrated to concentrate PGMs.	At very early stage of development.	Specificity of biological systems for metal recovery.	Vulnerability of biological systems, and difficulties in control and space-time yield.

The Accentus technology has the potential to tackle two of the key disadvantages of the base-line chemical process – selectively recovering different PGMs through reduction of waste generation (by carrying out redox processes by the virtually "massless" electron) in a rapid process, without the disadvantage of high operating costs from solvent losses or adsorber incineration.

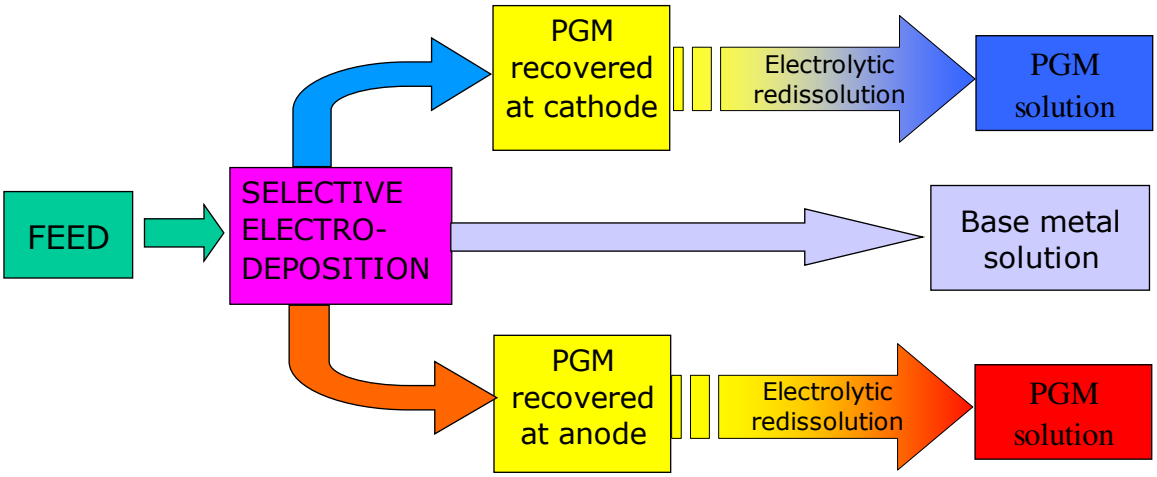
How it works

The patented process involves the recovery of individual precious metals by electrolysis in a divided cell under conditions of controlled pH (<5) and potential, by combined or sequential selective anodic deposition of PGM oxides onto an inert anode, as well as onto the cathode as a metal in such a way that the most noble is deposited first (as defined by standard electrode potential), leaving the base metals in solution. The oxidation-resistant membrane prevents redox shuttles between anode/cathode which otherwise reduces deposition efficiency. Even in an unoptimised system >97% Pd recovery was achieved with a separation factor of >30 from base metals.



Anodic palladium recovery from a refinery stream

After recovery by deposition, reversible electrolytic redissolution into a clean dilute acid solution allows the product to be recovered as a more concentrated, purified solution. Further refining by repetition is possible. If required, inter-stage pH control may be achieved by chemical addition, dilution, or more preferably by acid or base removal by EDSS (Electrodialytic salt splitting).



The overall process can be conducted as either a series of single batches or as a continuous operation in series.

Benefits

The benefits that this technology brings are:-

1. Rapid, virtually quantitative recovery of Platinum Group Metals (PGM).
2. Selective separation from base metals and other PGMs in a form that that can be combined with existing refining streams.
3. Minimises the costs of consumables and chemical usage by simple chemical-free pH control and PGM recovery process.
4. Selective PGM recovery – thus virtually eliminating secondary waste treatment and disposal costs.
5. Flexible and compact plant
   a) modest capital requirement;
   b) modular scale-up, leading to simplicity of plant expansion;
   c) sequential recovery steps possible
   d) low maintenance plant - automatic control
   e) energy efficient (ambient temperature/pressure); low electrical running costs.

Markets

Potential applications span:-

1. PGM production and manufacture;
2. PGM refining,
3. Catalyst recovery (automotive, petroleum refining; chemicals; pharmaceutical)
4. Consumer product recovery

The current status of the patent application is that the initial specification was filed on 4th April 2005, with a priority date of 8th April 2004. In response to the examiner's report of prior art citations, a robust defence was submitted in January 2007 - together with revised claims to clarify the inventiveness and uniqueness of the Accentus patent application that distinguishes it from any prior art. Our patent agent is confident that this will satisfy the concerns raised by the examiner.