IMPI
for mine water treatment

– By Edith Webster –

IMPI - Integrated Managed Passive Treatment Process technology - has been developed and patented by William Pulles of Pulles Howard & De Lange and Professor Peter Rose of Rhodes University in response to the urgent need for a low-cost, self-sustaining, low-maintenance passive treatment system to address the problems of acidification and salinisation (in terms of sulphate) at operating, defunct and closed mines throughout South Africa.

The IMPI process, says Dr Ralph Heath, a director of Pulles Howard & De Lange, can do this at less than half the capital cost required for an active system, which would use, among other capital-intensive elements, electricity and chemical dosing.

Indeed, IMPI can treat a megalitre per day of mine water at a relatively low capital cost of R3-million to remove one tonne per day of sulphate at an operating cost which translates to 60c per cubic metre. "Operational costs are less than one-tenth of an alternative system," Dr Heath points out.

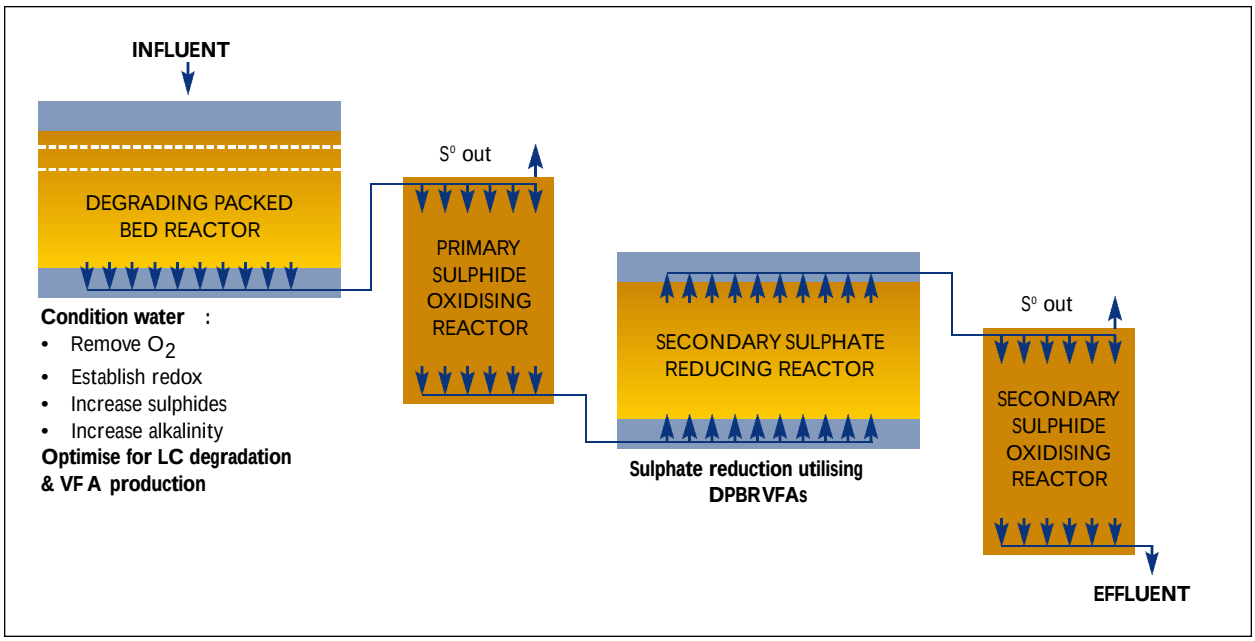
Although it realises significant cost savings,the IMPI is able to do more than any similar passive treatment system has ever been able to do - it can

- sustain high levels of SO_4 reduction;
- remove SO_4 at high efficiencies (100 times higher than it could when research began);
- remove toxic heavy metals very efficiently (87-95%);
- neutralise acid mine drainage;and
- passively and biologically remove elemental sulphur from the process.

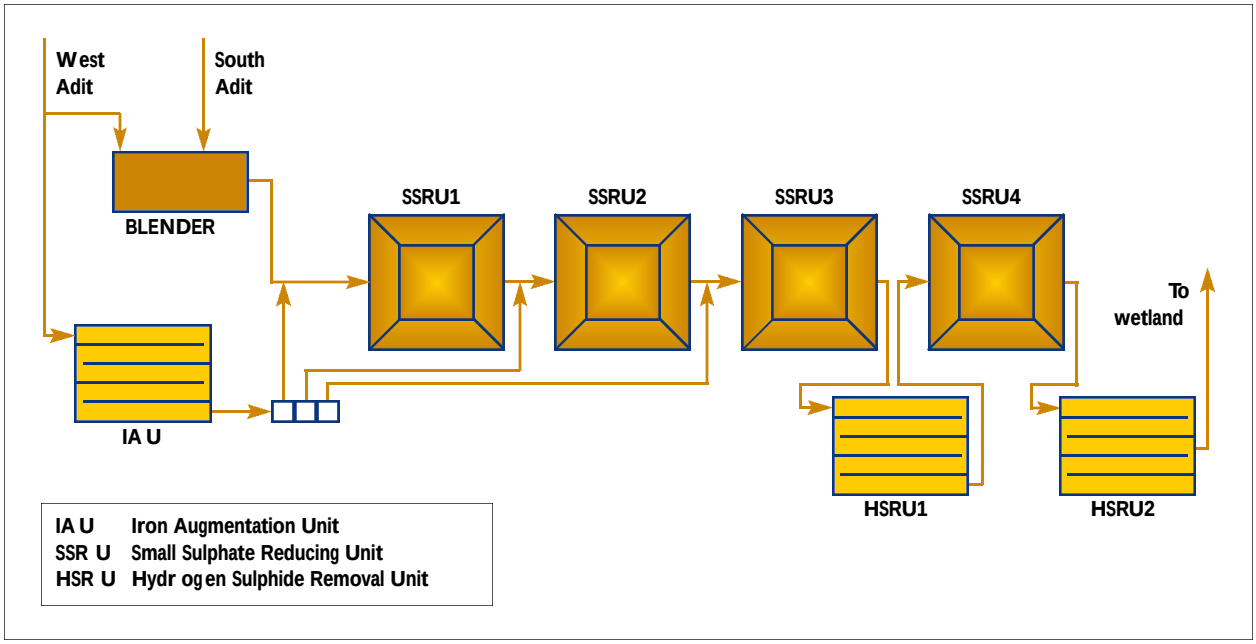
IMPI,explains Dr Heath, is the product of research into "a water treatment system that utilises naturally available energy sources such as topographical gradient, microbial metabolic energy, photosynthesis and chemical energy and requires regular but infrequent maintenance to operate successfully over its design life." The minimum design life of an IMPI treatment plant is 15 years.

THE IMPI PROCESS

Essentially, continues Dr Heath, the IMPI process



Schematic diagram of the IMPI process



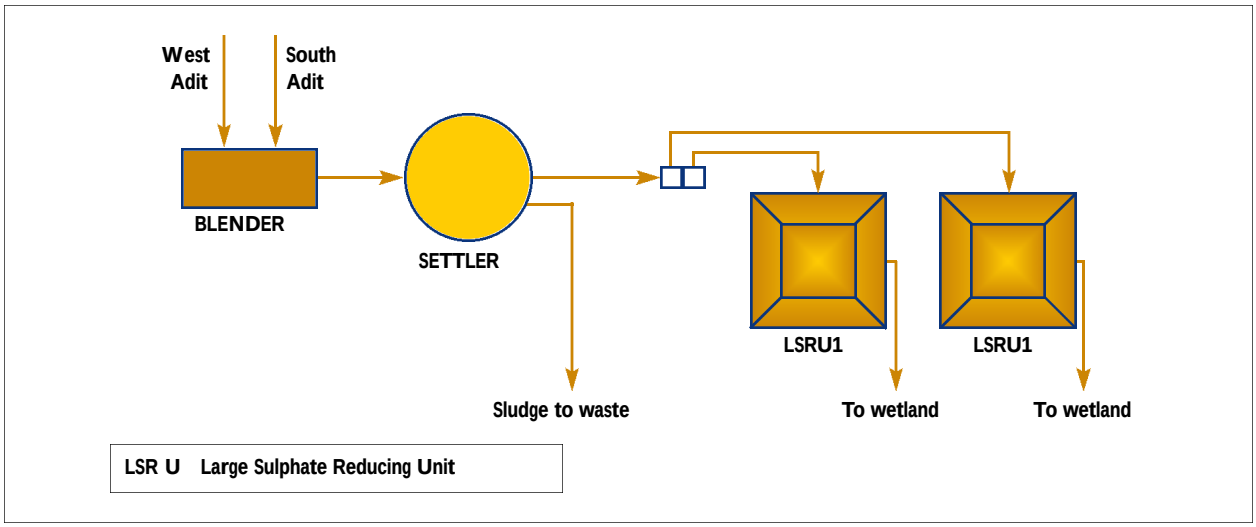
Configuration of small sulphate reducing units

involves the subdivision of the overall mine-water treatment process into individual units, each designed and optimised to perform a key function (see Schematic of the IMPI process).There are four different stages in the IMPI process:

1. Degrading Packed Bed Reactor (DPBR):This reactor is packed with multiple layers of specially selected carbon sources (electron donors) and also receives regular inputs of readily available carbon. Primarily, this unit rapidly conditions the influent by removing dissolved oxygen, establishes the desired redox conditions and produces elevated levels of sulphides and alkalinity in the first portion of the reactor.The remainder of the reactor is devoted to the optimised hydrolysis of lignocellulose material and the production of volatile fatty acids (VFAs). The effluent from this reactor will contain reduced levels of metals and sulphate and elevated levels of sulphides,alkalinity,VFAs and nutrients.

2. Primary Sulphide Oxidising Bioreactor (PSOB):This reactor contains very little carbon source and mainly oxidises sulphides to elemental sulphur for removal from the reactor while minimising changes to the VFAs, nutrients and redox conditions.

3. Secondary Sulphate Reducing Reactor (SSRR):This



Configuration of large sulphate reducing units

reactor contains a specially selected single carbon source rather than a multiple layer, multi-carbon source. It primarily utilises the volatile fatty acids produced in the degrading packed bed reactor and removes additional sulphate down to the required level. The effluent from this reactor contains reduced levels of metals, sulphate, VFAs and nutrients and elevated levels of sulphides and alkalinity.

4. Secondary Sulphide Oxidising Bioreactor (SSOB): This reactor contains very little carbon source and principally oxidises sulphides to elemental sulphur for removal from the reactor.

"If required,a final aerobic polishing stage could be added, primarily to remove residual levels of volatile fatty acids and nutrients.The individual units could be combined in a tapered-up or tapered-down configuration (one DPBR to many SSRRs or vice-versa),depending on the design duty of the reactors," says Dr Heath.

DESIGN

IMPI technology has been designed in three primary configurations:

- IMPISURE for the reduction of sulphates, metals and acidity;
- IMPIMATE for reducing metals and acidity;and
- IMPIPLUME for in-situ remediation of contaminant plumes.

"The technology has been designed so that it can be maintained regularly (every two to four weeks) but infrequently. One of the major reasons previous attempts at passive treatment technology have failed to perform over the long term is the lack of a maintenance programme," Dr Heath points out.

THE PILOT PLANT

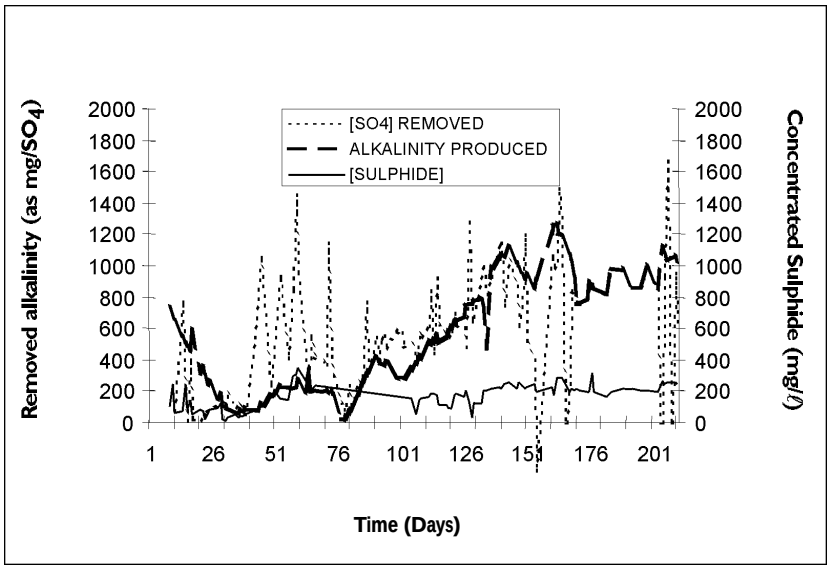
IMPI is now ready to be implemented throughout the mining industry, based on the knowledge gained over seven years from a pilot plant,designed by Pulles Howard & De Lange, at Vryheid Coronation Colliery, with fundamental research funding from the Water Research Commission (WRC), the mining industry and the Department of Arts Culture Science & Technology's Innovation Fund. Dr Heath explains that this plant has been divided into four primary components:

1. Four small sulphate reducing units (SSRUs) arranged in series with additional units intended to remove the sulphides (see Configuration of small sulphate reducing units).
2. Two large sulphate-reducing units (LSRUs) operating in a single step and arranged in parallel (see Configuration of large sulphate reducing units).
3. Six organic substrate testing units (OSTUs) operating at very small scale in parallel.
4. Post treatment units comprising an aerobic wetland and oxidation cascade to address contaminants added or not removed in the sulphate-reducing units.

PERFORMANCE

The performance of IMPI, says Dr Heath, can best be evaluated by studying the effective removal of sulphates, increasing pH and removal of metals (see Typical performance of a DPBR column)."We know that the process is highly effective. Now we just have to refine it, through full scale implementation, to achieve higher rates and more concentrated sulphur," says Dr Heath.

With additional funding from the WRC, the pilot plant at Vryheid Coronation Colliery will continue to operate until March 2004 and the sulphide oxidation process is currently being refined. "The Water Research Commission continues to play an integral role in the development of the IMPI process - without the WRC, we would not have come this far," says Dr Heath.



Typical performance of a degrading packed bed reactor (DPBR) column.