# An Interview with Dr. Jochen Petersen: New Frontiers in Hydrometallurgy

**Ahmet Deniz Bas (ADB): You have been leading one of the world's most renowned hydrometallurgy group and working at the University of Cape Town. What would you like to say briefly about your work and academic life? How did you choose to start a career in hydrometallurgy? What was the main reason behind that?**

**- Jochen Petersen (JP):** Fate? During my undergraduate studies in chemical engineering at the University of Witwatersrand I had the option to take a course on Hydrometallurgy with Frank Crundwell. I wasn't all that interested and only chose the option because there was a time table clash on another course I wanted to take. I still have Frank's course notes to this day… Also as part of the course there was an excursion to Anglo American's Rustenburg Base Metal Refinery, which was the first time a saw a comprehensive hydrometallurgical process plant with every single hydrometallurgical unit operation imaginable. That wowed me immensely.

For my PhD in the 1990s I wanted to 'something to do with the environment', I ended up at the University of Cape Town with my supervisor, Jim Petrie, who was pioneering concepts such as Life Cycle Assessment and Cleaner Production in South Africa. In that context I got into leaching of metals from wastes, partly to recover them, partly to assess the long-term hazard potential of a particular solid waste material in a dump. That created my entry into heap leaching, which is a very similar process to leaching from a mineral rock dump, and in trying to model a heap/waste dump like a reactor, I used a lot of the foundations laid by Dave Dixon in his PhD work. Dave examined my thesis and as a result invited me to join him for a post-doc at the University of British Columbia (UBC). This is of course one of the work-leading institutions in the area of Hydrometallurgy, and my time there opened my eyes to, and piqued my interest in, the field properly.

Jochen Petersen of UCT

I returned to Cape Town for family reasons and found my way back to UCT to work with Geoff Hansford and Sue Harrison on bioleaching, and started research on heap (bio)leaching there, which was very topical at the time and goes on to this day. I participated in some fairly large international industrial projects in the area of heap bioleaching, which gave me much exposure to the hydrometallurgy industry internationally, especially some of the big players.

But my passion was not on the biological side, and I wanted to do research on all aspects of hydrometallurgy. As it happened, just after my return to UCT a biannual Masters Course in Hydrometallurgical Engineering was started, led by Mike Nicol, in which I assisted, especially in seeing through many of the students (who were all industrial participants) through their dissertation work. This gave me fairly extensive exposure to many hydrometallurgical processes and the industry in South Africa and helped deepen my knowledge immensely, and I started to publish more frequently on my research, especially in Hydrometallurgy. I'm not sure whose attention I caught there, but I was invited to the Editorial Board of the Journal in 2008, joined the Editor team in 2011 and eventually became Editor-in-Chief in 2013.

My academic career was quite separate from my career in hydrometallurgy – I am now a Professor in chemical engineering and teach courses in chemical engineering science, but actually very little hydrometallurgy at the undergraduate level, and I am also the only one amongst my colleagues who is focussed on hydrometallurgy in their research. That is perhaps a good thing as it keeps my perspectives wide to the chemical process industry as a whole, and not be too focussed on mining and metallurgy.

**ADB: What are your thoughts about the recent developments in hydrometallurgy in the world and in South Africa?**

**- JP:** Hydrometallurgy seems to have always had a bit of niche existence in the broader field of extractive metallurgy. I see it very much as a 20th-century technology still trying to establish itself alongside the more 19th-century pyrometallurgy. While there is a place for both, I think the 21st-century imperatives of energy efficiency and cleaner production will give hydrometallurgical processes more prominence and opportunities, and even further the strife for establishing a Circular Economy, where metal resources are at least partially re-covered from consumer goods rather than freshly mined entirely. The need for 'new' commodities in 21st-century technology, such as rare earth metals, Li and PGMs, have spawned much novel process development, most of which is using hydrometallurgy.

These aspects frame where recent developments in the field have been moving. The strife for energy efficiceny fosters a move away from energy intensive concentration of increasingly lower grade minerals to means of direct leaching, and (rightly or wrongly) away from high-temperature pyrometallurgical processes to pressure or atmospheric leaching. The desire to avoid toxic gaseous emissions, especially sulphur and arsenic compounds, has equally forstered hydrometallurgical processes that can contain these better.

The concept of Circular Economy and associated business opportunites have seen much development in technology to recovery valuables using hydrometallurgy, such as leaching of waste batteries to recover Ni, Cd, Co, Zn, or Li, the recovery of REEs from lamp phosphors, recovery of PGMs from spent catalysts or the leaching of Cu, Au from electronic circuit boards. These developments are international and are progressing in South Africa as much as elsewhere in the world. A significant portion of modern hydrometallurgy orignates from South Africa, and it was perhaps in the fore-front of the discipline in the 1980s and 1990s, and some solid work, especially in the PGM sector, continues to this day. The focus on recovery from secondary resources is, however, only just emerging in South Africa, a consequence perhaps of being a major primary resource producing country.

**ADB: How do you see the future of hydrometallurgy in the world and in South Africa?**

**- JP:** Following on from the previous question I would say extraction of metals from secondary resources will be a major application of hydrometallurgy, especially in terms of the separation of specific metals from multi-metal leach liquors and overall cost-efficient processes. The development of selective separation techniques, especially in the area of ion exchange and selective precipitation methods, to achieve this efficiently, and at a relatively small scale, will be critical in this regard.

Extraction of metals from low-grade ores is the other area of continued development – and I see this as a good opportunity for hydrometallurgical technology. However, the primary resource industry has become quite risk-averse – in my opinion not only because of low commodity prices, but also due to the tendency of large corporations to become more short-term focussed – and hence is shying away from investing in new technology routes. This is why I think development in the secondary resource industry, which consists mostly of SMEs, will be more rapid and innovative.

**ADB: Which countries or processes would be the dominant in hydrometallurgy in the future?**

**- JP:** The primary resource industry will remain significant for many decades to come, but the reliance on it will gradually decline as more and more efficient secondary resource recovery will emerge. As mentioned above, I think that this recovery will more heavily rely on hydrometallurgy, especially in the area of separations techniques.

In the primary resource sector, the dominant countries will be those that hold the corresponding deposits, be they the classic base metals or more current resources of REEs, Li, etc. The secondary resource industry will concentrate in those countries that produce the most waste resources. However, the scale-ability of hydrometallurgical recovery processes may result in small-scale recovery taking place in every country. Dominance in that sense may perhaps be by those countries that provide the technologies, rather than the resources.

Also, I have noticed that where there is strong state-subsidised research focus on resource recovery (like there definitely is in China and in the EU today) through universities and science councils, there appears to be a stronger open innovation activity than I notice in countries where this is left to the private sector. That is not to say that industry doesn't innovate, but the research is mostly kept secret, and so much valuable learning is never brought into the public domain. Thus countries where there is a lack of state sponsored innovation in the extractive technologies are likely to fall behind, even if they are resource-rich.

**ADB: What would you like to advise to the students wishing to do graduate studies in hydrometallurgy?**

**- JP:** Make sure you enjoy what you are doing and don't lose sight of the bigger picture – how does your work improve the world we live in? If you don't feel the passion, then choose another project (that goes for any graduate studies, of course).

**ADB: I know that you are travelling very often, attending conferences, giving courses, etc. It seems very exhausting. How do you manage your agenda?**

**- JP:** ☺ I often wonder about that myself. Apart from what you list, I also have quite a heavy teaching load at UCT, quite a number of graduate students and a family…
My key philosophy is that it all needs to still be fun, so while doing a little bit of everything, nothing should dominate. I do work quite hard, but if I'm enjoying myself, it's not really a burden, and I think I am managing fine. It is also the beauty of being an academic – I have a lot of freedom to set my own agenda, and that is invaluable.

**ADB: How do the projects and subjects in hydrometallurgy change from one country to the other one? What would you like to say from your experience?**

**- JP:** The primary driver is what commodities are available in each country and what the interest in these are at any given time. Also, hydrometallurgy certainly goes through fashions – for example bio-hydrometallurgy was all the rage in the 1990s, but it sort of found its (quite small) niche now and the excitement waned once people started to see the weaknesses behind a particular application, and those often are economic drivers and not immediately obvious from the basic concepts. For example, a common misunderstanding about hydrometallurgy is that it is much more energy efficient than pyrometallurgy – because it operates at lower temperatures. A frequently overlooked key fact here is that pyrometallurgy can rely on the sulfur content of the feed material as a fuel for the thermal heating to produce a metallic product. In hydrometallurgy much less heating is required, but the metal needs to be recovered by electrowinning – itself an energy intensive process relying on an external energy source. By the same token the current excitement about using hydrometallurgical methods for recovery of valuables from wastes may not be sustained if suitable and cost-efficient separation techniques cannot be developed.

**ADB: If I ask you, please rank your three favourite topics/subjects that you like much in your field/area?**

- JP: 1. Heap leaching – I think it's formidably challenging and still believe it has the potential for efficient resource recovery from low-grade ores if applied correctly.
2. – Ion exchange – still a new field for me, but one I believe holds the key to cost-efficient metal separation and recovery.
3. – Techno-economic (-environmental) process studies – ultimately the success or failure of any technology hinges on socio-economic factors as much as technical ones, and so there is immense learning one can derive from studying the two in conjunction.

**ADB: Would you like to add anything else?**

**- JP:** Yes, perhaps in hydrometallurgy as much as in any other metallurgical discipline we cannot go on with a narrow technical focus – I think it is critical that we all understand and critically assess the environmental and social implications of our activities. Much of the world's pollution is a legacy of metallurgical activity from long ago, and somehow mining still holds the lore of immense riches to those who push for it (surprising given how marginal most mining companies actually are). I think hydrometallurgy can play an important role in responsible extractive technology, but it must built on a sound understanding of the consequences of technology choices, and any self-respecting hydrometallurgist needs to keep this in mind.

**ADB**: Thank you so much for kindly accepting my invitation and for this enjoyable and impressive interview.