Chem Eng and the bigger picture

MechChem Africa talks to Alan Cousins, who has been member of SAIChE for over 30 years and, for the past ten years, the chemical profession's representative on the professional advisory committee (PAC) for ECSA.

Alan Cousins was born and educated in Zimbabwe. "I completed A-Levels in Zimbabwe in 1979 in pure and applied mathematics, physics and chemistry. Then I was in the last call-up for national service and was commissioned into the new Zimbabwean army, where I spent most of my time getting my colleagues released early," he tells *MechChem Africa*.

"After completing national service, I wanted to go overseas to study in the UK, but it was just at that time that Margaret Thatcher pulled the funding plug on overseas students and I couldn't afford it," he continues. "So I applied for and was awarded a Union Corporation bursary to come down to University of Cape Town to study Chemical Engineering.

"I came to South Africa in 1981 and graduated at the end 1984. At about that time, Union Corporation merged with the General Mining and Finance Corporation to become Gencor. On completion of my studies, I joined Gencor as part of my bursary obligation and ended up going to Impala Platinum's precious metal refinery in Springs, where I worked from 1985 to 1987," he reveals.

For a young graduate interested in chemical processes, "this was a good place to be". The options for a young chemical engineer in a mining company at that time were gold or PGMs (platinum group metals) and "I wasn't too impressed with the chemical engineering involved in gold processing," Cousins explains.

"The Springs precious metal refinery was a place with an intense chemical engineering focus at that time. A whole chain of extraction processes was being used to separate out the different metals, including solvent extraction; inorganic leaching; ion exchange; and calcining. The refining processes were much more chemical extraction focused than those used for gold," he explains.

"PGMs are really hard to ionise, but when they do, they form some amazing compounds. Iron has Fe^{2+} and Fe^{3+} ionisation states, but PGM metals can form ions with a charge of 2+, 3+, 4+ or 5+. These all form different complex salts, so the R&D side is fascinating," says Cousins.

"In those days, PGM extraction was fairly primitive, involving Aqua Regia leaching, salt precipitation and the emission of significant amounts of sulphurous and nitrous oxides (SOx and NOx),

Outlining the process used, Cousins says that mined PGM ore is first concentrated by flotation and then converted in furnaces to a form that can be leached. The resulting metal, called matte, consists of a mixture of platinium, palladium, rhodium, ruthenium and iridium (the PGMs) but it also comes with nickel, copper and small quantities of gold.

"At the first stage, a high temperature acid pressure leach process was used to preferentially dissolve the copper and the nickel from the PGM Group metals. This dissolved leach then went for further processing – electro winning – to extract the copper followed by precipitation to recover the nickel.

"The residue from the pressure leach process, a dark grey sludge, was placed into an Aqua Regia leach, a mix of nitric and hydrochloric acid, named because of its ability to dissolve gold. Aqua Regia, which was used to preferentially dissolve out the platinium and palladium, is associated with some very toxic fumes, though," Cousins says.

"From this leach, complex platinum and palladium salts were precipitated, which are particularly allergenic. I only ended up on the platinum side of this process because I survived all the allergy tests during my medical," he notes.

Once the platinum and palladium were pulled out, the remaining PGMs – rhodium, ruthenium and iridium – were extracted, via a combination of ion exchange and solvent extraction principles, "but there were not yet mature markets for these metals," he adds.

All the individually precipitated salts then had to go through calcining furnaces to reduce the metal ions into pure precious metals.

"This process was not sustainable, though, from the environmental side, owing to SOx and NOx fumes and, because the salts were allergenic, many of the employees involved became allergic causing staff turnover to be unsustainably high," Cousins points out.

During his third year at Gencor, Cousins moved into the project environment to address the inadequacies of the Springs extraction processes and doing the front-end design of a new platinum refinery.

"What this gave me was the basis for the rest of my career. The department was run on an EPC basis and the manager, Grenville Dunne, used multi-disciplinary task teams, including all the engineering disciplines, project engineers and process engineers," Cousins recalls.

"I was involved in big-picture development: calculating mass, heat and energy balances; preparing process flow diagrams (PFDs) and piping and instrumentation (P&I) diagrams; and designing process equipment. It was great exposure to a wide range of engineering tasks," he tells *MechChem Africa*.

In 1987, Cousins moved to Fluor in Sandton, Johannesburg, to a join a team involved in the early development of PetroSA's Mossgas refinery.

The EPC years

After becoming engaged in 1987, Cousins moved to Fluor in Sandton, Johannesburg, to a join a team involved in the early development of PetroSA's Mossgas refinery. "I joined Fluor to carry on doing engineering design. I wanted to get into oil and gas – the distillation columns and the plant side of chemical engineering – and I quickly became involved in the very early PFD and simulation design of the Mossgas project."

The refinery was being built to further process synthetic crude oil being produced from the offshore gas in Mossel Bay using the Sasol-developed Fischer Tropsch process.

After 18 months at Fluor, Cousins took a leave of absence from Fluor and, with his new wife, spent 18-months travelling and working around Europe. "I worked for Fluor in the UK for three months during that time, as a contractor, which was of benefit later in my career from a networking point of view," he says.

After returning to South Africa, he rejoined Fluor and spent the next 29 years honing his EPC skills. "I was a full-time employee at Fluor until December last year, when I took a voluntary retirement package and became a consultant to them. I have worked on many different projects over the years, built up good networks with overseas expats and learned a lot from them.

"Fluor has done an excellent job of building a knowledge base. It has used the wealth of expertise from engineers with 30 to 35 years experience who were due to retire, those involved with Sasol 2 and 3, for example, as well as other high profile projects all over the world.

"Fluor has effectively captured this knowledge in a huge database and they also now use their people as subject matter experts. An engineer from anywhere in the world can post a query with a selected scope and a subject matter expert will respond within 48 hours. This is a superb modern tool," Cousins says.

Giving advice for youngsters, Cousins says the strength of South African engineers, "is that we are very good generalists. We love the overview, the early financial modelling, the feasibility studies, the conceptual design, etc. I have very seldom done anything more than twice, which forces one to become a 'Jack-of-all-trades'."

Citing the experience of his godson who graduated in 2015, Cousins says that, having failed to secure a job in chemical engineering, he talked to people in the financial sector, who persuaded him to take a short course in financial management. He is now employed in the banking sector.

"Engineers are taught to tackle problems in very systematic ways: investigate the problem; identify solutions; test solutions; evaluate them; and then implement. Chemical engineering forces one to look into systems in detail. Chemical engineers tend to know the big picture because the actions of everyone upstream and downstream of the process affect one another.

"Not many other professions offer this skills set. So the financial sector often prefers to take in engineers and teach them the necessary financial skills," he says.

"When I graduated, the career of a qualified chemical engineer was very well mapped out and fairly narrow. Now, however, engineering skills are applicable and recognised everywhere and chemical engineers are being poached into careers across the spectrum.

"If you like coming up with solutions to practical problems, there are only a handful of professions that are available to you, with chemical engineering being one of them. And you will never be trapped watching fumes come out of a vessel. Today's chemical engineers end up taking posts in management and financial sectors as well as in the development of numerous interesting new technologies and plants," Cousins advises. ❑

Gauteng Members Group's process safety talk

On 15 February 2017 the Gauteng Members Group of SAIChE-IChemE arranged a talk on the topic of process safety. The speaker was Trish Kerin, who is the full-time director of the IChemE Safety Centre (ISC).

The ISC is a consortium of members from operating companies, consultancies, academic institutions and regulatory bodies, whose objective is to improve process safety practice across the chemical industry.

Trish Kerin is a mechanical engineer based in Australia who has worked in the oil, gas and chemical industries as a process safety specialist. She has worked in Australia and throughout Asia and is a Professional Process Safety Engineer with IChemE.

Kerin spoke about the ISC framework for process safety, which is based on the foundation that good performance in process safety must be built on leadership across six elements: the more 'technical' ones of knowledge and competence; engineering and design; systems and procedures; together with the 'softer' elements of assurance; human factors; and a healthy safety culture. ❑

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Contact details

SAIChE
PO Box 2125, North Riding, 2162
South Africa
Tel: +27 11 704 5915
Fax: +27 86 672 9430
email: saiche@mweb.co.za
saiche@icheme.org
website: www.saiche.co.za

SAIChE training course diary

Layer of Protection Analysis (LOPA)

24-25 October, Boksburg, South Africa

Covers the methodology of LOPA and the detailed stages of its application. Delegates are shown how to identify significant scenarios, estimate frequencies for worst-case events and assign risk categories while learning how to lead a LOPA study.

Fundamentals of Process Safety Management

6-10 November, Boksburg, South Africa

Contact Femmy le Roux
+27 11 704 5915.
saiche@mweb.co.za
www.saiche.co.za