Experiences of a SAIChE president

In this first issue of *MechChem Africa*, we talk to Dawie van Vuuren, president of the South African Institution of Chemical Engineers (SAIChE), about his experience of the industry and his views of chemical engineering as a career choice.

"I started my career at CSIR and have worked here, although not continuously, for 35 years in total," says Van Vuuren. " I received my chemical engineering degree from Pretoria University in 1976 and began my career here as part of my National Service," he tells *MechChem Africa*.

Qualification wise, Van Vuuren also holds an MSc from Wits and a PhD from Pretoria University, awarded for a thesis entitled, *'In search of low cost titanium'*.

"Like many chemical engineers of my generation, I was initially involved in synthetic fuels and the Fischer Tropsch process – and many of my team members ended up joining Sasol. I worked on slurry-bed Fischer Tropsch synthesis and I played a role in the initial work of Sasol to develop this process," Van Vuuren relates, adding that the slurry bed process is now in use on Sasol's Qatar gas-to-liquids plant.

In principle, the Fischer Tropsch process uses carbon monoxide (CO) and hydrogen (H_2) – which come from the gasification of coal or more directly from natural gas (CH_4) – to make *inter alia* longer-chain alkane-based liquid fuels such as diesel.

"Sasol 2 and 3 use fluidised bed reactors with all of the reaction products in gaseous phase. These are then condensed and distilled. By using lower temperatures heavier components, such as oily and diesel-like stock, can be produced in fixed or slurry bed reactors," he explains.

A slurry-bed reactor uses molten wax in which the catalysts are suspended. Describing the reaction, Van Vuuren says: "basically CO and H_2 dissolve in the molten wax, which, via the catalysts, react to form more wax and other products."

Related technologies in Van Vuuren's experience include energy technologies. "The CSIR has a boiler called the National Fluidised Bed Combustor (NFBC) that can produce 10 t of steam per hour. I was not directly involved in this research, but the team that reported to me for a time designed several commercial fluidised combustion units for a variety of different applications. I also got involved in coal briquetting, gasification, calcination and drying, along with some minerals reduction investigations," he recalls.

In 1993 Van Vuuren joined AECI in Modderfontein, where he worked for five years. "AECI was a wonderful company to work for and I thoroughly enjoyed my time there. It was there that I began to learn about titanium, starting with titanium effluent treatment for a titanium dioxide pigment plant," he continues. "I was also involved in phosphoric

The CSIR's Titanium Pilot Plant, which produces titanium directly from titanium tetrachloride ($TiCl_4$) feedstock. This is reacted with a strongly reducing metal such as magnesium, sodium, calcium or lithium to remove the chloride and to give titanium powder and a salt.

acid purification, also fascinating, and solid waste treatment of waste fly-ash.

"Unfortunately, AECI decided to close down its engineering department in Modderfontein, so I rejoined the CSIR and became involved in titanium dioxide (TiO_2) recovery from waste slag. On the road to Middelburg, is a 40-million ton slag dump that contains about 30% TiO_2 – and 30% of 40-million tons is a lot of TiO_2," Van Vuuren suggests.

CSIR, together with Highveld Steel and Anglo American were challenged with the task of developing a way of extracting this TiO_2 in an economically viable way. "The team developed a chemical to do it, but struggled to upscale the technology. I joined CSIR and was tasked with leading the upscaling. We developed a successful method that worked for relatively high volumes, which resulted in a 10 kg/h $TiCl_4$ plant for extracting titanium metal from the waste materials. After purification, $TiCl_4$ can be converted back into pigment grade TiO_2 via existing commercial processes.

"The risks became too high for Highveld and, since Anglo's main interest was associated with the Namakwa Sands operations, when that operation was sold, Anglo's interest in the project also waned.

"The dump is still there, though, as is the opportunity. There is also vanadium in there, comparable to the annual vanadium production from the now shut down Highveld operation. So if someone can develop a process to beneficiate TiO_2 and the vanadium, the economic equation might look attractive again," he points out.

"That is how I became involved in titanium metal research. My current job at the CSIR is to develop a competitive technology to produce titanium metal powder. We have developed some methods and have settled on a route. We are now piloting the titanium production process to service the envisaged titanium production and manufacturing industry in South Africa," Van Vuuren continues.

"Because titanium is so strong," he explains, "one cannot manufacture powder by directly grinding or milling larger pieces". To overcome this problem one must first react titanium metal with hydrogen to make a substance called titanium hydride, which is brittle and can be ground. After grinding, this is then heated and converted back to form titanium powder.

"But we make titanium directly from titanium tetrachloride (TiCl4) feedstock. This has to be reacted with a strongly reducing metal such as magnesium, sodium, calcium or lithium to remove the chloride and to give titanium powder and a salt," Van Vuuren tells *MechChem Africa*.

"I also dabbled a little in the hydrogen economy and hydrogen fuel cells and I played a role in promoting research into hydrogen," he adds.

"The thing about chemical engineering as a profession is the immense variety of applications of chemical engineering principles. This makes the profession incredible interesting. There are so many different opportunities and issues to resolve that it becomes one of the most interesting careers. As I say to young people, in my career I have often been frustrated but I have never been bored."

Chemical engineering in South Africa

"In South Africa, our minerals processing industry employs a large number of our professionals," Van Vuuren suggests. "There is a huge overlap between chemical and metallurgical engineering and, as I often say to my metallurgical colleagues, the metallurgical engineering discipline is really a branch of specialisation of chemical engineering." He argues that metals are simply different chemical compounds, so many chemical engineers end up in the key metallurgical industries such as chrome, platinium and gold – "because most minerals processing involves complex chemical processes".

"Then there is the petrochemical side, with Sasol being a big player, but one should not ignore Engen, PetroSA and rest of the refinery side of the petrochemical industry."

Chemical engineering also has an enormous role to play in cleaning up and protecting the environment. "The people who understand chemical processes and the consequences of contamination are those with the skills to put in place solutions to reduce negative impacts on the environment and to clean up affected areas," Van Vuuren believes.

The water industry is an example where removing contamination is of vital importance. "In Afrikaans, the word we use for chemistry is 'skeikunde', which actually means 'separation knowledge'. The underlying principles of separation technology are fundamental to the work of chemists and chemical engineers," he points out.

The water sector is split into two key areas: municipal water treatment for the supply of safe drinking water and the treatment of sewage; and industrial water treatment of waste process water streams.

"In South Africa civil engineers tend to dominate the municipal water treatment sector. The industrial side, however, is more the domain of the chemical engineer. Acid mine drainage (AMD), for example, is currently a big topic and significant strides are being made in establishing large-scale treatment plants for this dangerously contaminated water," he says.

Inorganic chemicals, the plastics industry, biochemistry, pharmaceuticals and the food industry all require chemical engineers to help them to develop and manage large scale reactions and processes. "Making food safely, efficiently and with economies of scale is also the work of an engineer, not of a chef," Van Vuuren says.

"The role of SAIChE in South Africa is not to regulate and control the profession. By law that is the role of ECSA. Our role is to promote chemical engineering as a profession and as a career choice for the younger generation.

"We strive to help with the development of chemical engineers and to assist members to perform and succeed in South Africa's chemical industries. Our members serve on university advisory boards to help align university programmes with industrial needs and our branches function well when they have strong university representation.

"SAIChE is about fostering and supporting the chemical engineering fraternity and community, via opportunities for professional development such as conferences, seminars and accredited training courses, with the shared involvement of universities and industries," Van Vuuren concludes. ❑

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