Polymer research, community service and containing malaria

In this issue we profile SAIChE IChemE member Walter Focke, who talks to *MechChem Africa* about the link between chemical engineering and his passion for reducing the impact of malaria in Africa.

"When I was young, I didn't have a home computer, but I did have my own chemistry lab. I was forever doing experiments, making rockets and firing them off, with only occasional mishaps.

"I always wanted to become a vet, though. I grew up on a farm, and had visions of taking over the care of the cattle. But after some real farming experiences, and the realisation of how hard it would be to study veterinary science at Onderstepoort, I soon realised that life in the service of farm animals was not for me," Focke tells *MechChem Africa*.

After completing his matric at *Hoërskool Brits* in 1973, Walter Focke applied to study chemical engineering at the University of Pretoria (UP) where he graduated with a Bachelor's degree, *cum laude*, in 1977.

"After completing my military service, I then went to work at the CSIR, where I designed heat exchangers for the Sasol 2 and 3 plants that were erected in Secunda. We were using one of the early CDC supercomputers at that time, and programming was done in Fortran. We charged only R100 per individual heat transfer design and perhaps up to R300 for a big layout, which seems incredibly little by today's standards," he recalls.

After several years at the CSIR, during which time he completed a Diploma in Datametrics at UNISA, followed by a Masters degree in chemical engineering at UP, Focke decided to read for a PhD in polymers with the department of Material Science and Engineering at Massachusetts Institute of Technology in the USA, which he completed in 1987 with a theses entitled: *'Conduction mechanisms in polyaniline'*. Polyaniline (PANI) is an advanced polymer that, due to its conductivity, can be used for applications such as muscle tissue regeneration.

Following his PhD studies, Focke returned to the CSIR to join the polymer programme, a division that was known as MATEK at the time.

"In 1990, I started a small business in the polymer industry called Xyris Technology, which manufactures custom additives and masterbatches for the plastic industry. Our product lines include flame-retardants, volatile corrosion inhibitors, barrier additives and purging compounds. We are unique in South Africa for in-house formulation development that focuses on specific customer requirements, such as flame, retardant compounds for deep underground mining applications; and our vapour phase corrosion inhibitor system (VCI) for mild steel (Xyro-Sorb VCI 39 E)," he tells *MechChem Africa*.

A major research focus for Focke and Xyris is the development of plastics from renewable resources such as starch. "We anticipate that these materials may well become cost-effective alternatives to conventional plastics. We have also worked on technology for the controlled photo-degradation of polyethylene and polypropylene," he explains.

Walter Focke joined the department of Chemical Engineering at UP in 1997 and has been there ever since. "In June this year, I will be celebrating my 21st year with the University," he says, proudly.

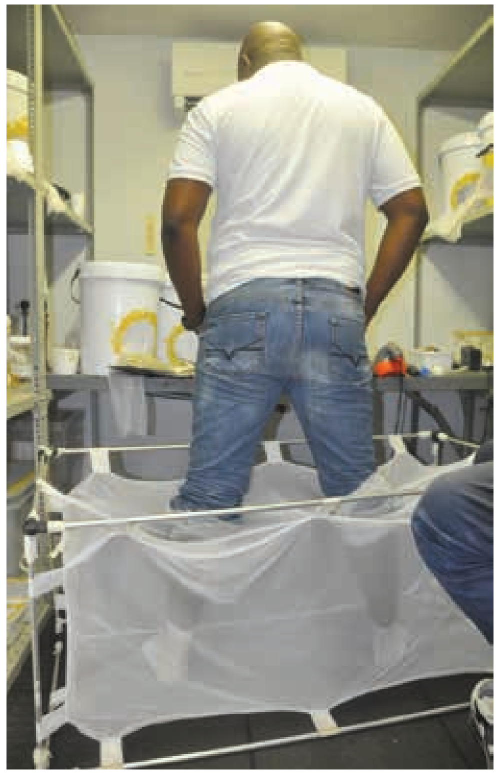
His teaching responsibilities include the Thermodynamics courses for undergraduates as well as Polymer Processing; Additive Technology; and Chemical Engineering for graduates as well as delivering short courses on Surfactant Technology; Polymer Additives and Polymers in Chemical Product Design – and he is also the director of the Institute of Applied Materials within the Chemical Engineering department.

Bongs Sibanda installing a polymer wall lining impregnated with slow release repellent/insecticide. ***Inset:*** *the installed lining.*

Malaria research and community service

Out of the community service responsibility, which is part and parcel of his role as a UP professor, Focke has developed a particular passion for mitigating against malaria, one of Africa's deadliest diseases. "I developed a particular interest when one of my family was hit by cerebral malaria. He was ill for eight months and the doctors told us that if we had brought him in just a few hours later, he would have died," Focke recalls.

This personal experience led Focke to start research into the spread of the disease as a community service issue: with considerable success. "We are now developing and testing a range of products through research funded by the Medical Research Council, the Bill & Melinda Gates Foundation and the Deutsche Forschungsgemeinschaft (DFG)," he says, adding that due to global warming, the spread of malaria, which thrives in hot climates with a lot of moisture, is likely to get worse in many places on the continent and in South Africa.



Testing the effectiveness of new mosquito repellent formulations.

Malaria is a vector-borne disease, explains Focke, which means that it is transmitted from one individual to another. When a mosquito bites an infected individual, it is infected by the parasite. After a short incubation time, it spreads the disease to the next individual it bites.

So to better control the spread of malaria, mosquito populations must either be controlled or they must be prevented from biting people and surviving to bite other people. Traditional solutions, therefore, include insecticides, repellents, and barrier bed netting.

Combining polymer technology for netting with an insecticide, for example, Focke and his team have managed to impregnate a physical bed net with insecticide. "Common bed nets are made from polymer fibre, most commonly PET, but polypropylene (PP), and polyethylene (PE) are also used.

"The trick we developed is to modify the structure of polymer fibres so that the impregnated insecticide or repellents are released in a controlled fashion. The difference here is that, instead of an insecticide simply sitting on the surface of the net to be washed off instantly, our system enables the slow migration of insecticide to the surface over time – and the insecticide will remain active over several months and survive many washes. This means that, even if a mosquito gets though the net and bites you, she is not likely to survive long enough to bite or infect anyone else," Focke explains.

One particular polymer design consists of bi-component fibres with a core and a semi-permeable sheath. The liquid repellent/insecticide is trapped in the hollow core, and it leaks slowly to the surface through the containing sheath. "The fibre dimensions can be manipulated in order to control the permeability and therefore the rate of release. This is one of our solutions that is currently being commercialised," notes Focke, adding that the possibility of knitting socks impregnated with repellent is also being looked at; "with a 20 washes and six month active repellent life."

Another repellent-based solution has been developed based on filling polymer materials with slow release liquid repellents. "There is a much greater risk of being bitten by a mosquito while sitting or walking outside. To reduce this risk, we have developed a microporous polymer matrix that can contain a large amount of repellent. So instead of a bangle or anklet that can protect for a day or two, ours should be effective for several months.

"Since mosquitoes tend to bite near to the ground, feet are particularly susceptible when walking, hence the anklet. But for people sleeping in huts near or on the ground, we have also used this fibre to produce wall linings, which can be 100% effective when impregnated with repellent or insecticide for up to five years. Traditional commercial surface insecticides, such as DDT spray, degrade with time, but ours, originally developed as a repellent, not only lasts, but is also significantly more effective," he points out.

One of Walter Focke's PhD students, Homa Izadi, has also come up with a very promising new mosquito repellent formulation, which is already proving far more effective and long lasting that the commercially available DEET-based versions (diethyl-*m*-toluamide).

The idea was to reduce the apparent vapour pressure and, therefore, the rate of mass loss of the repellent to produce a longer-lasting effect, without reducing it to the point where the amount of repellent vapour is insufficient to provide adequate protection.

Focke and Izadi came up with the idea of applying the concept of using negative pseudo-azeotropes. These are mixtures of two or more substances that, together, produce a lower vapour pressure than the parent compounds at a particular azeotrope composition. The reduced vapour pressure translates into slower repellent release.

"By luck, the two repellent substances chosen by Homa to make the azeotrope also proved to have a mortality effect. So this product is nontoxic and contains a food grade mosquito repellent forming an insecticide that outperforms all those currently on the market," suggests Focke.

At the University of Pretoria a large team is involved in this work, including multi-disciplinary staff members of the Institute for Sustainable Malaria Control and some 50 students studying the disease from all sorts of different angles.

"This is one of the things I like most about chemical engineering. It is a very diverse field that engages engineers of almost all disciplines as well the full suite of scientists: chemists, bio chemists, entomologists; doctors, climatologists, cartographers and many more. There is nothing limiting about being a chemical engineer," Walter Focke concludes. ❑

SAIChE IChemE

SAIChE Board members:

President:	C Sheridan
Imm. Past President	D van Vuuren
Honorary Treasurer + Vice President:	L van Dyk
Honorary Secretary:	EM Obwaka
Vice President:	D Lokhat
Council member:	JJ Scholtz
Council member:	AB Hlatshwayo
Council member:	K Harding
Council Member:	M Low
Council member:	BK Ferreira
Council Member:	H Mazema
Council Member:	M Chetty
Council Member:	A de Bondt
Council Member:	M Mabaso
Council Member	NN Coni
Member (co-opted):	MD Heydenrych
Chair Gauteng:	C Sandrock
Chair KZN:	D Lokhat
Chair Western Cape:	H Mazema

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