COSI PI Sneak Peek:

Peek into the World of a Principal Investigator

Rik Tykwinski

"Why?" That is the fundamental question that has shaped Rik Tykwinski's career as a physical organic chemist. Although initially interested in biology, Tykwinski's undergraduate professors at the University of Minnesota guided him towards chemistry. From there he got hooked on making and studying molecules, so much so that he went on to graduate studies at the University of Utah and did a Post Doctoral research at ETH in Zuerich, Switzerland before starting his academic career at the University of Alberta.

"I knew I loved research and trying to answer the question 'Why?'" he says. "There's always this thrill of discovery because until you're done, you don't really know what happened. You're always finding bigger and better [questions] to answer."

Although he reports that the U of A has some of the world's best facilities for organic chemistry, Tykwinski moved to Germany three years ago in order to pursue his passion for more fundamental research. He is now the Chair of Organic Chemistry at the University of Erlangen-Nürnberg.

As a physical organic chemist, Tykwinski is intrigued by molecules and how they interact. "We're very curious in the properties of molecules as a function of their structure," he explains. "How characteristics change in a series of molecules based on one small change, to colour or shape, for example."

It was with this curiosity that he became involved in the Centre for Oil Sands Innovation. Along with Drs. Jeff Stryker (fellow chemist and COSI Principal Investigator) and Murray Gray (COSI Director and Principal Investigator), Tykwinski undertook a project to investigate the molecules of asphaltenes and bitumen. He likens it to working with Lego: "we predict that the

Lego pieces (or individual molecules) can only go together in a certain way, making a bigger species. At some point they become big enough that they aggregate and fall out of the solvent that is used for extraction, which clogs pipelines and causes all kinds of processing problems." He goes on to explain that they want to know exactly how these pieces come together, in order to prevent it: "If we know that a red block likes to bind to a blue block, and a blue one likes to bind to a yellow, then we can figure out how to prevent all these little combinations and that will keep everything in solution."

Tykwinski began his project with COSI while still at the U of A, but despite the distance to Germany, he still remains actively involved. "We've got such a strong team of researcher," he says, "that it seemed ridiculous to give that up just because of the fact that we're separated by a 9.5 hour flight."

His continued participation is good, because so far they've made an interesting discovery: the behaviour of the model compounds (which they've created to mimic asphaltenes) changes dramatically when a small amount of water is added. Although it seems simple, it could have important consequences considering the amount of water that is currently used in oil sands processing. This discovery has contributed significantly to the hypothesis that, rather than asphaltenes being very large, island-like molecules that come together and precipitate out (which is termed the Continental Model), they are really a bunch of small molecules linked together. "It's the combination of a bunch of all the little building blocks that go into the asphaltenes that cause them to come out solution, or to aggregate," he explains. "We call this the Archipelago Model", a hypothesis initially advanced by collaborator Murray Gray.

Tykwinski has a vision of building up the model compounds, controlling how they come together, and comparing that to what is seen in the asphaltenes. Right now they're in the process of asking 'did we do it right? Did they stick together? How strongly did they stick together? Can we observe that they stick together?'. From there he says they'll go on to a more complex model, "adding more and more of these types of molecules to see if eventually this huge gamish acts like asphaltenes."

If correct, this hypothesis could change the way oil sands are currently processed. At the moment, industry has been designed primarily around the old, Continental model, meaning that many value-added processes would need to be rethought. "Continental molecules are thought to be held together almost entirely by something called pi-stacking. So anything that's been done to prevent this or to process these molecules has used this as a guideline," says Tykwinski. "If we're correct, rather than having one factor that controls aggregation, there [might be as many as] six or seven factors, each one of which might be used to process the asphaltenes differently. So, if you're planning an attack on this asphaltene chemistry using only one rule, your attack is going to be much different than if somebody gave you seven rules to consider."

Ultimately Tykwinski hopes to share the molecules they're creating with other COSI projects. "What we would really like to do," he says, "is take a handful of molecules, throw them together and have them look like bitumen or asphaltenes. At that point it would solve problems for [the other] projects because they would know exactly what they're working with." At the moment though, he is enjoying bringing oil sands chemistry to his Germany colleagues and students: "once you start describing the traditional petroleum, what it is, the molecules, the chemistry behind it, the engineering behind it, and where it is that Canada has almost as much oil as the Middle East – people are quite interested in it."