

## Editorial

## As father is to son, Green is young and learning is lifelong

“*Green Processing and Synthesis*” has been launched. The journal’s first edition debuted in January 2012, with papers given in a review-style manner mirroring the different aspects of green process and synthesis innovations. At the International Conference on Microreaction Technology (IMRET12) in Lyon late in February, several renowned scientists in the field joined young students at the journal’s celebration, each adding their distinctive flavor to the party. As observer as well as editor, I found that their interchanges reflected a sort of symbolism, not just for the field but for life itself: Being green and developing (as a green scientist) is somehow also a matter of age. As with settling (“aging”) of a new technology, a younger generation inevitably and dependably comes along; their new ideas become the most normal part of their growth although seeming to be revolutionary for those long established in the field. It is a corollary to how issues that once triggered a lot of dispute among the pioneers are approached now in a matter-of-fact manner and solved in ways the first generation never imagined. And, so grows the field.

To illustrate, consider this: there were many discussions about fouling and clogging of microchannels in microreactors at the beginning. The whole idea of chemical production with such devices was questioned, so difficult it was to imagine an operation taking place many times over days and weeks, even with solutions that are considered quite pure and particle-free. But today, it is taken for granted that microreactor production plants will run continuously in a 24/7 mode. When solids need to be handled, they are atomized using ultrasound, strong pressure pulses, or other means of agitation – still problematic, no doubt, but a problem tackled. As in living organisms, systems “know” how to react to keep the environment constant for its reliable functioning, or processing.

There were also many heated discussions about micro distillation in the early discussions about microreactors. It was even doubted if such an operation would be possible on such miniature scale as it essentially needs gravity; gravity only works with larger bodies, they thought, whereas surface forces dominate in micro-scale systems. That the latter could be employed also for distillation, and even that there are other methods that would work on the micro scale, the first generation of green processing and synthesis scientists could not fathom. They had not been taught this; yet we know now that education can sometimes create unidirectional habits in a way to think instead of inspiring innovators to be critical thinkers, as is popular today in higher education. As a matter of fact, a keynote presentation by Asterios Gavriilidis at IMRET12 summarized the immense progress made with microdistillation and microrectification, among the hottest topics in the

field. It is good that time goes by, fears and old beliefs are forgotten or set aside, and new generations refine the first steps previous generations have made. New knowledge is imperative for progress.

A third controversy among the microreactor pioneers was whether there are specific microfluidic effects. The traditionalists tend to say that everything has been described in their textbooks and micro is just a “very small macro: fully covered and understandable through classical equations and models”. I remember being harshly criticized by a scientist for having stated there are “micro effects.” Though he basically mis-cited me in an obvious manner the episode was burned into my memory and I think of it even today, years later. This small example shows such discussions can have an almost religious quality, typifying the eternal juxtaposition between the old and the young. As we now know, the fundamentals in micro heat exchange show that the truth lies between both the claims of the old and young: there are supposed to be a few micro effects, but many findings can also be described by traditional equations, though usually in an extended version if including some terms which usually are not needed for accurate description.

Some researchers still have a “classification traditionalism” stating that microreaction technology and process intensification should not be regarded as their own disciplines, but rather be part of the traditional reactor and process engineering curriculum. Just a “specialty,” not standing on their own. However, the facts paint a different picture – the impact factors of correlated interdisciplinary topics raise so much information, and the interdisciplinary topics of today may be the singular disciplines of tomorrow. I have developed a full course about “Micro Process Technology” in the Master’s degree program at my university; to my best knowledge, it is the only one worldwide that addresses the topic in such a comprehensive manner.

In contemplating growth in our field and the tensions that may generate between scientists, I am reminded of the age-old struggles between the old and the young as they try to respectfully go in different directions. In 1970, songwriter and performer Cat Stevens (now Yusuf Islam) set the battle to words in his “Father and Son” song recorded on his popular album “Tea for the Tillerman.” Originally written about a son telling his father during the time of the Russian Revolution that it was time for him to break free and leave, the song lived on to become a symbol of societal conflicts. It has since been recorded by many artists, each putting a new, personal twist on it, taking it each time, as it were, in a new direction. To change the world, we need to be open to learning. We need to be lifelong learners, in fact. Thus,

green and very innovative technologies are for those who are young – not necessarily in age but certainly in mind. We should be cautious today about making definitive pronouncements about emerging technologies. As history has often shown us, in another 10–15 years somehow those may be cited as misinterpretations or antiquated ideas. Life is

full of constant change. Today's son may well be the tomorrow's father.

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