A new language

Before I start: neither I nor the division have any financial interest in any of the products that may be mentioned in this editorial. I use stuff because it works for me.

I am a big believer in monitoring reactions, especially those that can be rather energetic, with as much instrumentation as possible. On the bench and in the plant, system temperature, time-differential temperature, system pressure and time-differential pressure are the primary indicators that I prefer; though there are others such as flow and pH.

Laboratory-scale instrumentation such as LabView[1] and MeasureNet[2] are frequently used in teaching laboratories for data acquisition. For those that want a little less out-of-the-box experience, a recent article in the *Journal of Chemical Education* talks about an open-source Arduino system.[3] All are available to the researcher with very little learning curve and can be used to provide reaction data. For scale-up experiments, Mettler Toledo has the Process Safety Workstation[4] that is highly versatile for complex process chemistry. With small sensors, blue-tooth connectivity and other modern gadgetry, there is no reason why reactions on the bench and scale-up cannot be monitored. There are just too many easy solutions available to the researcher to acquire the practical thermodynamics necessary to prevent a run away. Data acquisition is not the problem; believing the data as it is presented to the researcher and then acting on that information is the real challenge.

It is been my experience that chemists are trained to acquire and analyze data. They are not trained to react to real-time data and indications that a reaction is starting to run away then do something about it. The problem is not one of education, but one of training. Chemists are not trained to "work inside a box" – the box being monitored reaction parameters such as temperature/rate of temperature increase or pressure/rate of pressure increase or some other parameter. Phrases such as "normal operating temperature/pressure" and "out of normal" are a new language to many chemists. That must change.

To prevent run away reactions at any scale, chemists need to adopt some of the tools used by our engineering colleagues: reaction monitoring at all scales and defining a range of normal operating parameters and procedures on what to do when a parameter is found to be out of normal.

Good work planning and reaction design requires a good idea of the allowable (and measured) parameters to keep the reaction in control and pre-planning on what to do should the reaction move outside those parameters. I have been told "prior planning prevents poor performance" and nowhere is this truer than in chemical research safety.

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