COFLUX® Control – A new Process Analytical Technology based on Calorimetry

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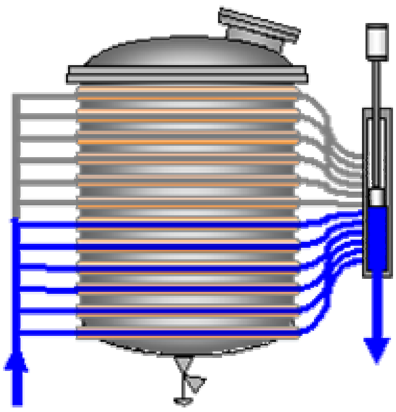
Abstract

Although heat removal (or addition) is one of the most important functions of batch reactors, it has always proved a difficult parameter to measure. The main problem lies in measuring the heat entering or leaving the system.

Whilst techniques like ‘heat flow‘ and ‘power compensation’ calorimetry have been developed for lab use, they are not easy methods to use and they do not scale up well. The main weakness with these techniques lies in the fact that calibration is affected by changes in the process conditions (level, viscosity, phase, agitation rate or temperature affects the calibration).

Heat balance calorimetry should be an ideal method for measuring heat in large (>100 ml to 20 m^3) temperature controlled systems since the reference material for measurement (the heat transfer fluid) has known properties. This should eliminate most of the calibration problems. In practice however, heat balance measurement in traditional reactors is very unsatisfactory. The causes for this are linked to the method of the temperature control and design of the heat transfer equipment. Most vessel jackets have large inventories of heat transfer fluid (which makes changes in jacket conditions sluggish and difficult to monitor). The temperature of the entire cooling jacket is affected by the temperature control valve (which creates excessive heat noise). The temperature shift of the heat transfer fluid is generally very small (which severely limits sensitivity). If the mass flow of heat transfer fluid is reduced to improve sensitivity, the result is erratic temperature control and unpredictable heat balance data.



For the past 5 years Ashe Morris have been developing a new type of cooling jacket. The heat transfer surface in this design consists of multiple small channels rather than a single large jacket. The feed and return pipes to the individual jacket elements are connected to common manifolds. The outlet manifold is fitted with a motorised piston (or rotating cam) which is used to regulate the number of heat transfer elements in service.

The technique used in this design is referred to as **Co**nstant **Flux** control (COFLUX) because the temperature of the process fluid can be modified without altering the temperature of the heat transfer surface. Jackets of this type have a number of advantages over traditional designs These include better temperature control, improved energy efficiency, more uniform heating/cooling and the prevention of heating/cooling to dry surfaces.

Probably the most significant benefit of the COFLUX design however relates to calorimetry. Systems of this type permit heat balance calorimetry to be measured with unprecedented speed, accurate and sensitivity. It also allows crystallisation and polymerisation to be monitored without the need for complex pre-calibration procedures. The COFLUX technology is being developed for both lab and industrial applications and the first commercial system went into service in 2005.

The presentation will cover the concept of the COFLUX design and discuss recent developments. Amongst the examples shown will be a freezing experiment carried out with water. This illustrates how COFLUX control can be used to monitor difficult process operations without the need for complex procedures.

References

1. World Congress of Chemical Engineering (July 2005): “Constant (heat) Flux control - An alternative method of controlling and monitoring processes” by Robert Ashe – Ashe Morris Ltd
2. World Congress of Chemical Engineering (July 2005): “A modelling study for constant flux heat transfer for improved process development and operation” by Robert Ashe, David Morris and Richard Barker – Ashe Morris Limited and Professor Nilay Shah and Dr Nouri Samsatli – Imperial College