CLEARWATERBAY TECHNOLOGY, INC.
The Process Development Company

CLEARWATERBAY TECHNOLOGY

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WORLD FORUM FOR CRYSTALLIZATION FILTRATION & DRYING

INSIDE THIS ISSUE:

7th International workshop on Crystallization, Filtration, Drying, Milling and Granulation was held from February 21-23, 2013, at K. V. Auditorium, Institute of Chemical Technology (Formerly UDCT), Matunga (E), Mumbai 400 019 INDIA

The brochure for the conference can be found at http://www.wfcfd.com/App_Themes/FrontCSS/images/7thWFCFD2013.pdf

There were several notable speakers at the conference on topics related to filtration, drying, etc. Prof. Ka Ng, our senior adviser and two CWB members were invited to speak at the forum.

SPEAKER	TOPICS
Prof. Ka M. Ng Dr. Christianto Wibowo Dr. Ketan Samant	• Basics of solid-liquid equilibrium (SLE) phase behavior and phase diagrams • Synthesis of Crystallization Based Separation Process • Industrial Crystallization- Case Studies • Design of Crystallization Experiments and Data Analysis • State-of-the-art software tool for crystallization process development.

PROCESS DEVELOPMENT COURSE IN YANTAI, CHINA

SPECIAL POINTS OF INTEREST:

- WFCFD, India
- Process Development Course, China
- TECH TIP: Understanding a SLE Diagram

CWB Tech recently conducted an extended training course titled '***Process Development: from Lab to Plant***' at the Yantai Wanhua Polyurethane Co. in Yantai, Shandong province, China. The course was taught by Dr. Vaibhav Kelkar and CWB Tech president Dr. Lionel O'Young, with help from Dr. Jia Li, over 5 days.

Participants were provided with an in-depth look into process development activities starting from the time a process chemistry is invented in the lab, to the development of a commercial scale process. Using numerous industrially relevant examples and workshops, the participants were taught systematic ways to conceptualize, design, and evaluate process and unit operation configurations. Technologies available for solving process engineering problems were discussed, along with the key information necessary for design and development.

Topics

- A systematic workflow for process development
- In-depth review of process engineering activities
  - Identifying the best synthesis route for a product
  - Conceptual process design and process flowsheeting
  - Synthesis and design of a variety of industrial reactor types
  - Synthesis of separation systems based on distillation, crystallization, and many other driving forces, include hybrid processes
  - Heat integration via pinch analysis and total site analysis
  - Qualitative and quantative evaluation of process alternatives
- Effective use of experimental data on phase equilibrium, reactions, as well as unit operations
- Discussion and recommendations on modeling and the use of software tools
- Scale-up issues in process development

This was an extended version of CWB Tech's flagship 2 day course on process development. The course is invaluable for chemists, engineers and technology managers involved in chemistry, design, development, scale-up, or production of new or existing chemical processes. For further details, or to request an in-house short course, please contact us at short-course@cwbtech.com

TECH TIP: UNDERSTANDING A SLE DIAGRAM

This TECH TIP has been explained in the paper by Dr. C. Wibowo of CWBTech, "*Developing Crystallization Processes*" in Chemical Engineering Progress, March 2011 Issue, pg. 21.

Change in phase equilibrium behavior of a chemical system (e.g., heating, cooling, addition or removal of a component) is depicted in a *phase diagram*, which maps various regions of composition, temperature, and pressure within which the system exists as a single phase or a mixture of multiple phases in equilibrium. Process streams are represented as points on the diagram indicate whether the stream will stay as a single phase or split into multiple phases.

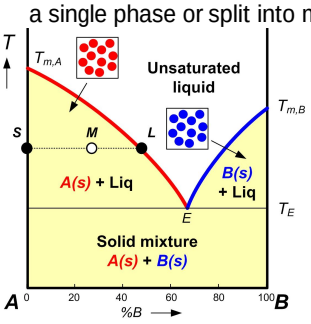

Figure 1: Two-component SLE Diagram

Figure 1 shows typical temperature-concentration (T-x) diagram for a two-component system at constant pressure, with temperature on vertical axis and weight or mole percent composition on horizontal axis. The white region in the diagram is the unsaturated single liquid region. Below the melting point of pure *A* ($T_{m,A}$), pure *A* in solid phase is in equilibrium with a liquid phase. Any mixture in this two-phase region such as point *M*, will phase-split into pure solid *A* (point *S*) and a saturated liquid (point *L*) that lies on the saturation (or solubility) curve of *A*. Line *SL* is often called the *tie-line*. A simple material balance shows that the proportion of solid and liquid phases in the mixture is equal to the ratio of segment lengths *ML* to *SM*.

Below the melting point of pure *B* ($T_{m,B}$), pure solid *B* is in equilibrium with a liquid phase. The saturation curves of *A* and *B*, form a boundary of this region and meet the at the eutectic point (*E*), where both are saturated and the liquid phase is in equilibrium with a solid mixture of the same composition. Below the eutectic temperature (T_E), the system can exist only as a mixture of two solid phases. The location of the eutectic point is an important characteristic of the SLE behavior, as it sets the boundaries between the different regions.

For a three-component system at constant pressure, the SLE phase diagram resembles a triangular prism, shown in Figure 2. The 3D diagram is constructed by combining the T-x diagrams of the three binary systems (*A*-*B*, *A*-*C*, and *B*-*C*) and filling the interior with the solubility surfaces for each of the three components. The three surfaces meet at the *ternary eutectic point*, at which all three components are saturated. Since identifying various solid-liquid regions below the saturation surfaces is difficult, it is more convenient to consider isothermal cuts, indicated by the blue triangle in Figure 2. A series of such cuts can be taken at different temperatures for the three-dimensional figure.

The isothermal cut at temperature T_1 is shown in Figure 3. Since this temperature is above the melting point of component *C*, there is no region associated with solid *C*. Instead a region of unsaturated liquid is present at the *C*-rich portion of the diagram. Solids of pure *A* exist in equilibrium with a liquid phase in the yellow wedge-shaped region. A mixture at point *M* in this region will phase-split according to tie-line *SL* into a liquid phase and pure solid *A*. If the composition of a mixture lies within the lavender wedge-shaped region, pure *B* solid will be obtained at this temperature. Inside the green triangle, both solids A and B will crystallize out of the solution. The solid mixture is in equilibrium with a liquid phase composition at the double saturation point (*D*). In the prism in Figure 2, point *D* is part of the trough connecting the *AB* binary eutectic and ternary eutectic. The location of the double saturation point – and hence the region boundaries in the isothermal cut – change with temperature.

Many real systems involve more than two or three components, and include additional complexities, such as: polymorphism; formation of hydrates, solvates and compounds; dissociation into ions; etc. Although the corresponding SLE phase diagrams will be more elaborate (and even high in dimensionality), the basic idea of mapping various single and multiple-phase regions remains the same.

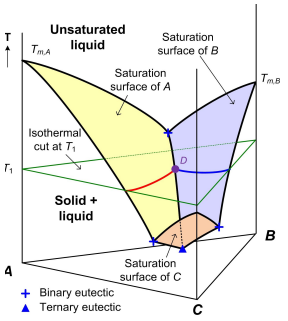

Figure 2: Three-component SLE Diagram

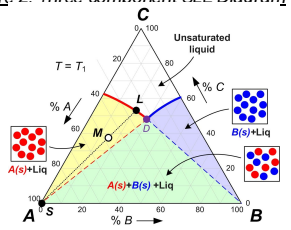

Figure 3: Isothermal Cut at T for three-component SLE Diagram

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