PERP Program – New Report Alert

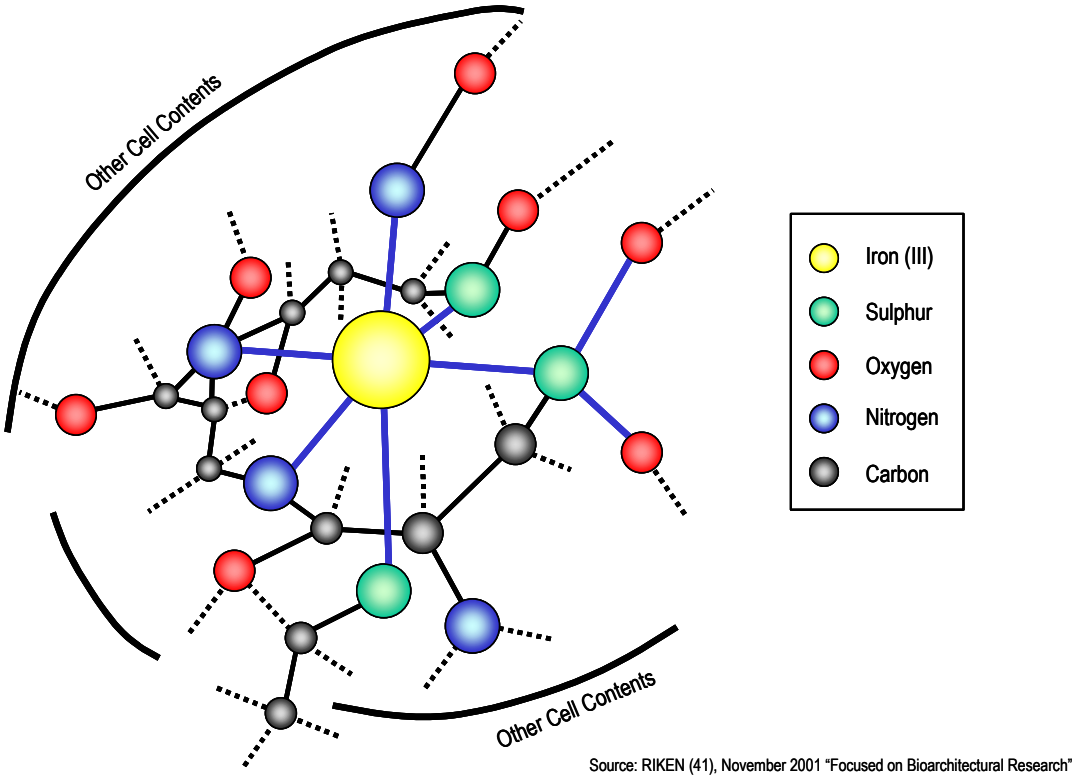
December 2002

Chem Systems' Process Evaluation/Research Planning program has published a new report, ***Acrylamide (01/02S10).***

Acrylamide was first produced by American Cyanamid Inc., in 1954. The original chemistry to hydrate acrylonitrile used sulfuric acid and ammonia. Subsequent developments included the use of heterogeneous catalysts based on copper and chromium oxides. The heterogeneous process was an improvement over sulfuric acid, but still was costly given the need to separate and recycle acrylonitrile and concentrate the solution for polymerization use. In the 1980s work began in Japan on the development of a biotransformation process for the hydration of acrylonitrile. Several organisms were developed containing the active enzyme *nitrile hydratase* including *Corynebacterium*, *Pseudomonas*, etc. The first generation biotransformation plant using immobilized cell technology still needed a recycle/concentration step. However, later generations based on *Rhodococcus rhodochrous J1* enabled full acrylonitrile conversion and a concentrated solution to be made without any need for recycle/concentration with commensurate savings in energy cost. In recent years the heterogeneous process has been improved through the use of catalytic distillation *(CD Acrylamide®)*.

In the 1980s in Japan, Nitto Chemical developed a first generation biotransformation process which used micro-organisms (i.e. “whole cell”) immobilized in a polyacrylamide matrix. In effect the catalyst acted as a heterogeneous catalyst. The micro-organisms contained the active enzyme *Nitrile Hydratase,* shown in the figure below. One of the challenges facing the biochemist was to provide cells with not only high nitrile hydration activity but also low hydrolysis activity to prevent the conversion of acrylamide into acrylic acid and ammonia. The hydrolysis reaction is catalyzed by the enzyme *amidase*.

Nitrile Hydratase Enzyme



Source: RIKEN (41), November 2001 "Focused on Bioarchitectural Research"

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Intensive work continued on new micro-organisms with longer life, higher tolerance for acrylamide and higher conversion. The answer to all these problems was found with the micro-organism *Rhodococcus rhodochrous J1*. This new micro-organism could now enable acrylamide to be made through biotransformation without recourse to any recycles or concentration steps.

Acrylamide production in this way was a triumph for biotransformation chemistry and in a way set the scene for further developments in commodity chemical production using biochemistry.

In recent years CDTECH has revisited the heterogeneous process and applied catalytic distillation to the process to improve economic performance. In this process acrylonitrile is

converted to extinction and concentration occurs in the same column where acrylamide is made. The result is a much improved process compared to the original.

For its technoeconomic comparison Nexant/Chem Systems has considered as a base case a plant of 20,000 tons per year located on the United States Gulf Coast, Western Europe and Japan on an average 2001 timeframe. The cost comparison is based on acrylonitrile available at domestic price. Three cases are considered: conventional, biotransfomation, and catalytic distillation.

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