

PERP Program

April 2001

Chem Systems' Process Evaluation/Research Planning program has published a new report, ***Caprolactam (99/00-4)***.

In recent years process developments in caprolactam technology have revolved around two main aims:

- Reduce or eliminate ammonium sulfate make
- Find alternative feedstocks.

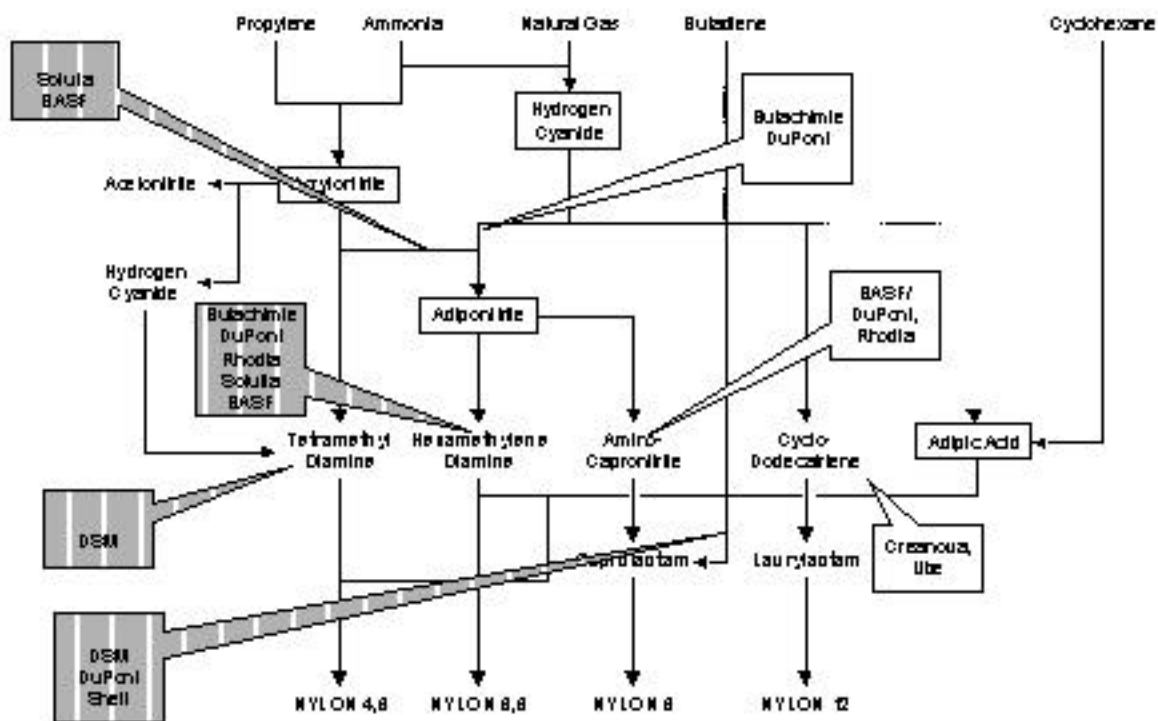
Enhancements to Conventional Technology - the current commercial routes to caprolactam production are based on aromatic feedstocks: namely benzene, phenol and toluene. The typical caprolactam process involves production of cyclohexanone, oximation with hydroxylamine and finally the so-called "Beckmann Rearrangement". Typical caprolactam production routes also unavoidably produce ammonium sulfate by-product. As ammonium sulfate is a relatively low value fertilizer, its reduction or even elimination is favored.

Recently Sumitomo has announced plans to build a new caprolactam plant in Japan using its fluid bed gas-phase zeolite-catalyzed Beckmann rearrangement combined with EniChem's hydrogen peroxide-catalyzed "aminoximation" reaction. Today, DSM HPO-based plants already operate commercially as well as Toray's photochemical process, both of which offer reduced ammonium sulfate make.

Caprolactam from Alternative Sources – Today, hexamethylene diamine (HMDA), one of the components of nylon salt for nylon 6,6 production, is manufactured from adiponitrile. There are only a handful of adiponitrile producers, e.g. BASF, Solutia, Butachimie and DuPont. As shown in the next figure, adiponitrile can not only be manufactured from butadiene and hydrogen cyanide, but also from propylene via acrylonitrile. DSM also uses acrylonitrile as a feedstock for tetramethylene diamine (TMDA) production. TDMA and adipic acid are used in nylon 4,6 production.

Butadiene can potentially be used as a feedstock for adipic acid production, although cyclohexane is the preferred feedstock. Similar chemistry for butadiene to adipic acid has been developed for caprolactam production by DSM, DuPont and Shell. At the time of writing, DSM is contemplating a new Asian investment using this technology called Altam®.

ROUTES TO NYLON FROM NON-AROMATIC-DERIVED FEEDSTOCKS



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In 1996 DuPont and BASF announced plans for a worldscale adiponitrile/HMDA/ caprolactam plant in Nanjing, China. For various reasons this plan has been delayed. However, with the development of similar technology by Rhodia and its current plans to boost adiponitrile capacity at Chalampé in France, there is the potential to develop a caprolactam project based on adiponitrile.

The potential now exists to manufacture nearly all the intermediates for nylon production entirely from butadiene. This makes strategic sense in certain regions where crude C₄s and butadiene markets are long. By the end of the decade a fully integrated worldscale butadiene to nylon complex could be a reality but the total investment is likely to be very high indeed.

Chem Systems new PERP report, 99/00-4, **Caprolactam**, explores the chemistry, process technologies, production economics and markets for a range of conventional, new and emerging caprolactam processes.