Polyamide (Nylon) 6 and 66 Process Summary

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Abstract
Polyamide 6 and 66 (or Nylon 6 and 66) are the most common types of polyamide available commercially. The total volume for the Nylon 6 and 66 polymerization market is 7.2 million tons in 2014, up from 6.4 million tons in 2010. Nylon 6 and 66 polymerization produces either chips or resin in uniform pellets. The chips or resin are further processed into two major applications: fibers or engineering thermoplastics (ETP). The fibers may also be directly produced from the molten state of the polymer, bypassing chip/resin production. The majority of the Nylon chip or resin production accounts for 92% of total polymerization, while fiber production (directly from melting) accounts for 8% market share. Demand is expected to grow at an average annual growth rate (AAGR) of 2.4% for Nylon 6 ETP and fiber. The AAGR for Nylon 66 ETP and fiber demand is 2.6%. Capacity additions have been taking place mostly in China. The Nylon processes have been reviewed by IHS Chemical Process Economics Program (PEP) since its inception in 1962.

In this process summary, we review the key features for Nylon 6 and 66 production processes, and discuss recent technology developments and update the process economics for the following Nylon 6 and 66 stand-alone and integrated processes presented:

1. Stand-Alone Continuous Production of Nylon 6 Chips—similar to BASF, Mitsubishi Chemical, and Unitika
2. Stand-Alone Polyamide 6 chip production by continuous two-stage polymerization—similar to Zimmer
3. Nylon 6 chips by continuous process from cyclohexane via caprolactam (nitric oxide hydrogenation) NOx—similar to BASF
4. Nylon 6 chips by continuous process from cyclohexane via caprolactam (hydroxylamine phosphate oxime) HPO—similar to DSM
5. Nylon 6 chips by continuous process from phenol via caprolactam (hydroxylamine phosphate oxime) HPO—similar to DSM
6. Stand-Alone Nylon 66 resins by the continuous process—similar to BASF
7. Stand-Alone Nylon 66 chips from adipic acid and (hexamethylenediamine) HMDA—similar to Dupont
8. Stand-Alone Nylon 66 chips from a Nylon salt aqueous solution (63%) by a continuous process—similar to BASF
9. Nylon 66 by continuous process from cyclohexane via ADA oxidation and butadiene via HMDA hydrocyanation—similar to Dupont
10. Nylon 66 by continuous process from benzene via ADA, and butadiene via HMDA hydrocyanation—similar to Asahi
11. Nylon 66 by continuous process from butadiene via caprolactam/HMDA from ADN joint development—similar to BASF and Dupont
12. Nylon 66 by continuous process from butadiene via caprolactam/HMDA from ADN joint development—similar to BASF and Dupont with caprolactam by-product credit
13. Nylon 66 by continuous process from cyclohexane via ADA oxidation and HMDA from acrylonitrile via Ascend technology

14. Nylon 66 by continuous process from cyclohexane via ADA oxidation and HMDA from butadiene via Invista technology

The process economics include estimated capital costs and production costs: variable cost, plant cash cost, plantgate cost, and net production cost. Carbon and water footprint data for all competing processes are also included. A brief market overview summarizes the global supply and demand end-use market and demand drivers.

In addition, due to the feedstocks price fluctuation over time, a process with a lower production cost at a given time may have a higher production cost at a different time. A traditional snapshot process economics comparison, given a particular time and region, can often lead to a wrong process selection. A historical process economics comparison over a long period of time gives a better basis for investment decisions. Moreover, feedstock prices vary by global region; a process which has the lowest production costs in one region may not be the best in a different region.

To address the impact of feedstock price fluctuation, this process summary includes an iPEPSpectra interactive data module with which our clients can quickly compare historical production economics of competing processes in several major global regions from 2000 to 2015 quarterly. The interactive module, written as an Excel pivot table, is attached with the electronic version of this process summary. The module provides a powerful interactive tool to compare production economics at various levels, such as cost, cash cost, and full production cost. An iPEPSpectra historical economic comparison provides a more comprehensive way of assessing competing technologies, leading to more valid investment decisions.
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