

Nufarm Polymerization Inhibitors for Acrylonitrile

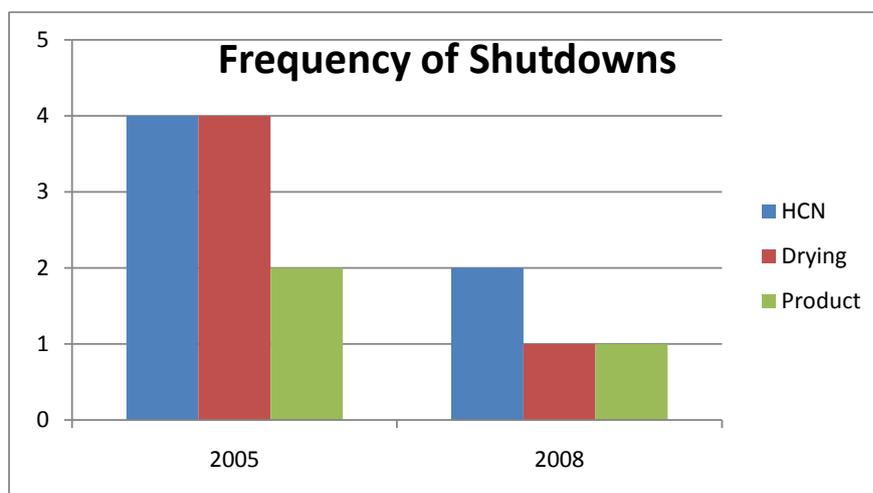
Acrylonitrile (ACN) is largely produced using the SOHIO process with propylene, ammonia and air (oxygen) as the raw materials giving acrylonitrile, water and HCN as products. The HCN can be recovered as a commercial product (a raw material for MMA production) or incinerated. The purification of ACN is essentially split into two sections (i) Recovery of ACN by quenching the gaseous reaction product in water and (ii) Purification of ACN to give the polymer grade product. Purification of the product includes a HCN column, a drying column and then the final product column.

Fouling in the acrylonitrile plant can occur in the HCN column but this is largely anionic polymerization of the HCN and cannot be controlled by free radical inhibitors. It can be mitigated by addition of acids and good engineering techniques combined with dispersants are used to keep this column free of fouling.

Free radical polymerization occurs in the acrylonitrile, causing fouling of the column plates and the reboiler, and can be inhibited using stable free radical inhibitor products. Nufarm have developed a proprietary product for acrylonitrile polymerization inhibition that has provided excellent results as the **case history** below demonstrates.

2005: Hydroquinone/Phenylenediamine treatment

2008: **Nufarm treatment, Inhibitor AHM N720**



The reduction in annual cleaning costs for this plant was in the order of US\$570,000. In addition to the reduced fouling, AHM N720 eliminated the need for manual handling required for the previous treatment and reduced operator exposure to acrylonitrile. The Nufarm treatment also increased ACN/water separation rates in two decanters, thus increasing plant efficiencies.



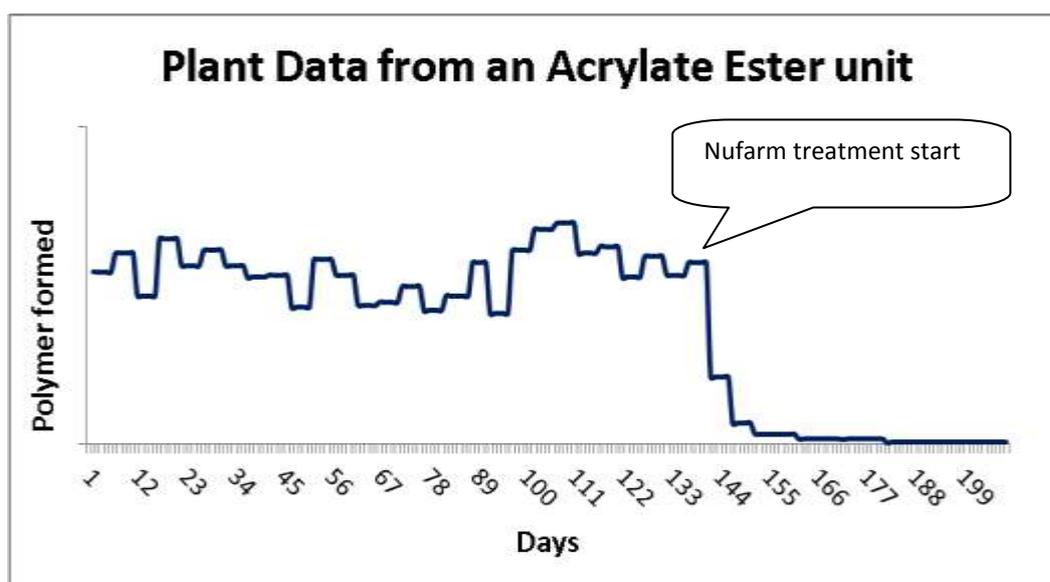
Nufarm Polymerization Inhibitors for Acrylic Acid / Esters

Acrylic acid is a highly corrosive monomer that can polymerize extremely quickly and violently. The prevention of polymerization is not only critical to improving plant efficiencies but also to the safety of the process. Polymerization is affected by many competing influences including the metallurgy of the plant, the amount of water present in different areas, temperature and the amount of air (oxygen) present, all of which influence the tendency and rate of acrylic acid to polymerize.

Nufarm stable free radical inhibitors have been used in acrylic acid distillation and through our own research, and working closely with our customers, Nufarm has gained a high level of expertise in the prevention of acrylic acid polymerization in all areas of the plant. Our Technical Service Team is available to give advice on the best products for each area of the plant.

Acrylic esters are produced from the esterification of acrylic acid with a range of different alcohols. Nufarm has products that will prevent polymer fouling in both the esterification reactors and in the purification section.

The **case history** shown below shows what can be achieved with the correct product selection.



Before treatment started with Nufarm, the customer had to clean the pump screens many times per day, now the screens are checked only during plant maintenance.

Acid Stability of Inhibitors: Not all inhibitors are equal when it comes to acid resistance, some are much more stable than others in the presence of acrylic acid or the acid catalysts used in the manufacture of acrylic esters. The inhibitor will not provide the desired performance if it decomposes in acid conditions. Nufarm has data on the acid resistance of different inhibitors and can advise you on the best products for your process.



Nufarm Polymerization Inhibitors for Methyl Methacrylate

Methyl methacrylate (MMA) has been made principally using the Acetone Cyanohydrin (ACH) route developed in the 1930s. Recently Lucite have introduced the Alpha Process and started the first operational plants using this technology.

Nufarm has provided inhibitors for plants operating using both technologies and our Technical Service Team can offer advice on product selection depending on the part of the plant to be treated.

One of the main fouling locations in the ACH route occurs in the reactor section. The data below compares the efficacy of two Nufarm products under typical high acidity conditions encountered in this section



Data shows that both Inhibitor S4 and AHM P500 (a more acid stable inhibitor) exhibit high efficacy in reducing MMA polymerization compared to the conventionally used hydroquinone. Inhibitor P500 has higher partitioning into the organic phase when used in the esterification reaction and therefore gives a higher effective concentration of inhibitor in the monomer phase.

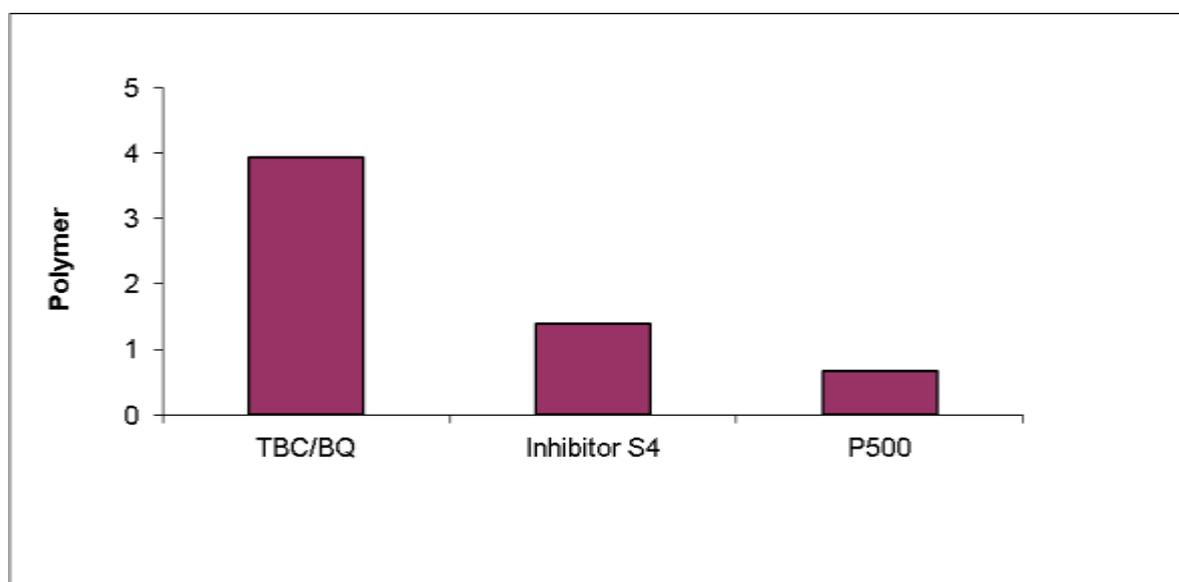
Inhibitor P500 is a next generation product and is in commercial use. Nufarm's experienced and skilled Technical Service Team will be on hand to guide you through all aspects of a plant introduction.



Nufarm Polymerization Inhibitors for Vinyl Acetate Monomer

Vinyl acetate monomer (VAM) requires inhibition to prevent polymerization during purification by distillation. Old inhibitor technology has now been displaced by the use of stable free radical chemistry in this monomer.

Nufarm currently supply an SFR product (AHM V180) to a European VAM unit. This is liquid product which virtually eliminates the requirement for manual handling of inhibitors; such as p-benzoquinone and solid SFR. This significantly reduces operator exposure to monomer vapours, as well as simplifying the treatment process. The package is completed by a custom delivery system to make the product handling as simple as possible.



The above graph compares the efficacy of Nufarm inhibitor products (Inhibitor S4 and AHM P500) with the conventionally used treatment system of tert-butyl catechol (TBC) and p-benzoquinone (BQ).

Both Nufarm products provide a significant reduction in the amount of polymer formed.

