

## TECHNOLOGY BRIEF:

Batch and inline ultra-high shear rotor/stator mixers can effectively disperse nanoparticles into liquid. Advantages include short processing times and volume flexibility, as well as easier maintenance and lower capital cost compared to traditional milling equipment and high pressure homogenizers.

# Ultra-high shear mixing of nanoparticles



## Dispersing nanoparticles

Rotor/stator mixers are commonly used for solids dispersion and particle size reduction due to the high shear conditions they develop. In reality, this reduction of “particle size” refers to the breakdown of agglomerates and not necessarily of individual particles. Typically, the primary particles retain their integrity and the measured size distribution narrows down as a result of the break-up of agglomerates.

The incorporation of nano-sized particles into liquid is especially challenging due to very strong attractive interparticle forces. The degree of difficulty varies from one application to another as dictated by particle size and shape, fluid type, presence of dispersing agent, etc. Not all nanoparticles require extreme shear for deagglomeration. However, when conventional rotor/stator mixers and milling equipment fail to achieve the desired level of dispersion, shifting to a higher intensity device is recommended.

## Advanced high speed mixing

Recent developments in rotor/stator technology present a number of viable methods for dispersing nanoparticles. Called “ultra-high shear mixers”, these new devices deliver more vigorous mixing and greater throughput compared to traditional rotor/stator mixers, colloid mills, immersion mills, etc.

Applications that previously warranted a move to expensive high pressure homogenizers can now be successfully produced in ultra-high shear mixers.

## Ultra-High Shear Rotor/Stator Designs



### PreMax Delta US Patent No. 6,000,840

The PreMax draws batch material from the top and bottom of the Delta rotor/stator. The resulting double vortex promotes fast powder wet-out, uniform product temperature and superior dispersion.



### X-Series US Patent No. 5,632,596

The X-Series head consists of concentric rows of intermeshing teeth. Product enters at the center and moves outward through channels in the rotor/stator teeth. The extremely close tolerance between adjacent surfaces of the rotor and stator is adjustable for fine-tuning shear levels and flow rates.



### QuadSlot

The QuadSlot mixing head is a multi-stage rotor/stator with a fixed clearance. It imparts very high shear levels to process fluids and produces even higher pumping rates than an X-Series set.



### MegaShear US Patent No. 6,241,472

The MegaShear is the most aggressive rotor/stator in terms of shear and throughput. High velocity pumping vanes force the product into semi-cylindrical grooves where it splits into different streams and collide at high frequency before exiting the mix chamber.

## PreMax Batch Ultra-High Shear Mixer



The Ross PreMax is a top-entering batch mixer equipped with a patented “Delta” rotor/stator assembly. The rotor is specially contoured for high pumping capacity and shear intensity. Product is drawn from above and below the mix chamber and expelled radially through the stator slots at high velocity. This generates upper and lower vortices allowing for extremely efficient powder additions and rapid turnover rates. The PreMax is typically used as a stand-alone unit and does not require supplemental agitation for products up to 50,000 cP.

For higher viscosity products, it can be used in combination with an anchor agitator in a multi-shaft mixer arrangement. The PreMax can also be supplied with a powder induction assembly for dust-free, sub-surface incorporation of lightweight nanopowders.

## Series 700 Inline Ultra-High Shear Mixers

Ross Series 700 Mixers are inline devices available in three ultra-high shear rotor/stator designs namely X-Series, QuadSlot and MegaShear (see box for detailed descriptions of each design). Running at tip speeds as high as 11,000 fpm, a Series 700 mixer is capable of far greater flowrates compared to a similarly-sized high pressure homogenizer or colloid mill. In many applications, it is more effective at reducing particle size. It can “de-bundle” strands of carbon nanotubes dispersed in resin, disintegrate agglomerates of nanoceramic particles and prepare superior quality dispersions of nano-sized pigments. Manufacturers that find this to be true for their particular formulations avoid the associated issues of maintaining and cleaning high pressure homogenizers, media mills and colloid mills. By comparison, the Series 700 mixers are easier to clean and disinfect in place. Based on user experiences, the shorter cleaning time equates not only to a faster changeover procedure but also to longer intervals between cleaning cycles (longer production runs). In a typical set-up, a batch mixer is used to combine the raw materials and the resulting rough premix is then passed through the inline ultra-high shear mixer. Users benefit from the flexibility of this device in terms of capacity – a Series 700 mixer can process production-size volumes as easily as it can handle pilot-scale or R&D batches.



### Sample Application: Polymer-Clay Nanocomposites

Simulation trials on Ross Ultra-High Shear Mixers confirm effective dispersion of nanoclay powders into water-latex solutions and rheologically modified emulsions.

