Application Summary

Final Filtration in Ink Jet Ink Formulation

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The final filtration step in the ink jet ink formulation process is, as expected, the most critical one. The quality and value of the final product depends on the efficiency and cost-effectiveness of the filters chosen.

Of course, the objective is to remove all the particles and other contaminants that might adversely affect print quality. The amount of particle reduction and what needs to be removed can vary widely. For pigment based inks, filters need to remove larger particles that can block ink jet ports but let smaller particles pass and assure that they are evenly dispersed in the ink. For some dye based inks, removing undissolved particles or gels is the main goal, assuring that printheads remain clear and print quality is maintained.

The housing marked "3" in Figure 1 below are where "final" filtration is performed. This is just before packaging and is shown as a single step process. However, formulators need to be aware if the type and number of particles in their products along with the size distribution of those particles. A very highly loaded stream may require multiple "final" filtration steps, even if the filtration goal is only removal of larger particles.

In addition, if the goal is removal of very small, sub-micron sized particles or gels, operators will often use 2 or more stages of filtration to prevent premature fouling of the final filter. Using multiple filter steps often improves filtration process efficiency and cost-effectiveness.

The schematic in the figure shows a simplified ink jet ink formulation system. This simplified version shows a single of final filter, the housing marked "3", just before ink packaging.

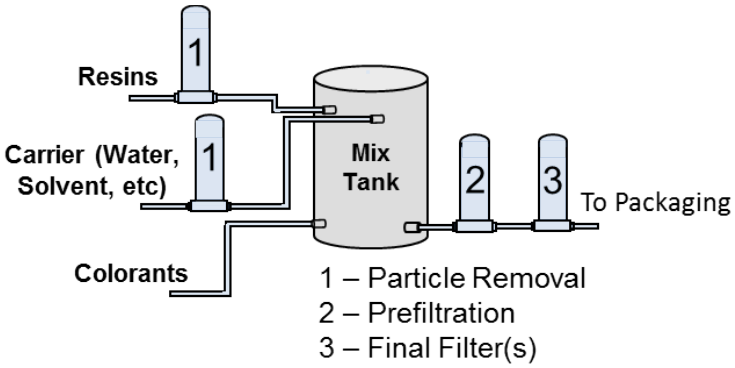

Figure 1: Common Filtration Steps in Ink Jet Ink Formulation

The particles to be removed can be introduced to the process with ingredients from outside sources or even created as part of the process. Adding solid ingredients during the formulation may result in undissolved particles. Impurities can also be carried downstream and through the process. Particles can also be created by chemical reactions used in the formulation or from normal wear and tear on system components such as pumps and valves. The housing marked "3" is often protected by a prefilter (marked "2") with a larger pore size rating. Prefiltration is discussed in a separate paper available from Critical Process Filtration.

Considerations for Pigmented Inks

The housing marked "3" represents the location of the final filter in this simplified system, though more than one filter may be used in series for inks with very high particle loads, like pigmented inks. The biggest challenge in final filtration of pigmented inks is removing large particles while allowing most of the small particles to pass through the filters and remain evenly dispersed throughout the product. Depth filtration is the most often used technology, but selection of the specific filters is critical. The filtration results depend upon grind, dispersive agents and the specific filters used. It is important to note that different grinding systems dramatically affect filter performance and may result in excessive filter use and lower "small particle" yield. Contact Critical Process Filtration for assistance in evaluating filters for your pigmented ink formulation.

Removing particles to levels required by your customers is a critical process that protects the quality of your final product and results in high quality images for their clients.

Choosing the Right Filter

The decision on which filters to use for final filtration applications is based entirely on the types and sizes of particles or other contaminants to be removed. In dye based inks, membrane filters are used as the final filter although a small number of manufacturers use glass fiber as the final filter. Membranes are the only way to assure that the smallest gels are removed and will eliminate any problems with ink jet orifices plugging. Also in dye based inks, solid particles are not much of a problem because the carriers (water or solvents) are usually filtered before entering the process (such as with RO for water). Hard particles are usually easy to remove with the final filter without any clogging issues. In cases where a dye lot containing a high amount of gel material is received, depth filters are used as a prefilter (housing "2") to extend the use of the membranes by removing the majority of gels.

For particles larger than 1 or 2 microns, depth filtration media is almost always used. Cartridge filters use two forms of depth media. The standard depth filter is a self-supporting, thick media tube made using a polymer, most often polypropylene but also available in nylon, which may have better compatibility with some ink jet ink chemistries. The other form of cartridge depth filter uses pleated flat sheet media, available in polypropylene or fiberglass. Polypropylene is the most widely used material for water and chemical filtration, but fiberglass has better filter efficiency and generally allows higher flows and throughput than polypropylene in many applications and may be chosen if fiberglass is compatible with the ink jet ink chemistry.

Standard depth filters will capture a range of particle sizes through the thickness of the media. Pleated media filters have the advantage of a large surface area that can hold a higher quantity of particles on that surface than standard depth filters.

For particles smaller than 1 micron, membrane filters are used. In almost all cases, the membrane filters will be used as part of a 2-step process. That filter will be protected by a filter with a larger pore size rating, which could be another membrane-based filter or a depth filter with pore size rating only slightly above the final filter rating. The most cost-effective choices are usually determined by testing media combinations on a small scale.

Filter Options

Depth filtration products such as Critical Process Filtration Melt-Blown Polypropylene, Melt Blown Nylon or Nano-Spun Polypropylene cartridges are commonly used for removal of particles larger than about 2 microns. These products will remove a large quantity of particulates from a variety of product chemistries before requiring replacement.

Particles between 1 and 2 microns may be removed from the fluid stream using pleated media filters. Pleated filtration products, such as pleated

polypropylene depth filters, have several times more surface area than melt-blown or nano-spun depth filters and will hold a much higher quantity of particles. While pleated filters do generally cost more, the increased life in high-particle-load applications and savings from the reduced number of cartridges used for batch processes often make pleated filters economically advantageous.

If sub-micron sized particles or microorganisms need to be removed, membrane filters do so most efficiently. Membrane filters are often used in two-step filtration configurations with a prefilter protecting the membrane filter from excess particle loading.

Filter Media Options for Final Filtration in Ink Jet Ink Formulation

Process Area	Filter Application	Filtration Function	Media **
Final Filtration	Small Particle Reduction, Gel Removal	Remove particles that may interfere with ink jet ink printing processes and adversely affect print quality	MB, NMMB, NS, PD, GD, NC, NM, PS, CWPS, PVWB, PVWL, TM

**Media Codes

MB = Melt-Blown Polypropylene Depth Media
NMMB = Melt-Blown Nylon Depth Media
NS = Nano-Spun Polypropylene Depth Media
PD = Pleated Polypropylene Depth Media
GD = Pleated Fiberglass Depth Media
NC = Positively charged Nylon 6,6 Membrane
NM = Nylon 6,6 Membrane
PS = Polyethersulfone Membrane
PVWL = High Capacity Hydrophilic PVDF Membrane
PVWB = High Capacity Hydrophobic PVDF Membrane
TM = PTFE Membrane
CWPS = High Capacity PES Membrane

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