Research on Filtering Conditions of UV ink-jet ink

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Abstract

Filtering is an important production link in effective control the particle size of ink. In order to obtain good filtering effect, use the millipore filters with different diameter, material and structure to filter the same ink respectively , test the particle size and distribution of ink , examine the diameter, material and structure of millipore filter influence on the filtering effect of UV ink-jet ink; use different millipore filters with filtering effect from poor to strong to filter the same ink step by step, test the particle size and distribution of ink , examine the filtration process influence on the filtering effect of UV ink-jet ink, finally to determine the optimal filter conditions and process. The results of the study indicate that , the diameter, material and structure of millipore filter and filtration process have a great effect on the filtering effect of UV ink-jet ink, using the determined best filtering conditions and process can obtain good filtering effect.

Keywords: *UV ink-jet ink filtering conditions filtering effect*

Introduction

Along with the digital technology in printing and printing industry, ink-jet technology has developed rapidly. Ink for ink-jet printing and printing, including water-based ink, solvent ink and UV ink. UV ink-jet ink became the most watched new printing ink with its energy saving, environmental protection, high efficiency and other advantages, with great development prospects.

Nozzles of ink-jet printer for UV ink-jet with very small diameter, require the particle size of ink is very small. Filter can filter out the larger particles in ink, control the ink particle size effectively, and can filter out impurities in ink, make sure the ink to achieve the requirements of printing, Spew from the nozzle smoothly, not plug nozzle.

Filtering conditions have a great influence on filtering effect, millipore filter's diameter decide the particle size of ink after filter, and effect the speed of the filtering effect; because the fiber filled in millipore filter have different size and arrangement, their catch ability of particles is different, so millipore filter's material and structure can effect the particle size of ink and filter speed too; the pressure main effect filter speed, have little influence on particle size of ink after filter.

Experiment

Materials

Prepolymer: Hyperbranched polyester acrylates Viajet100, Viajet400; Monomer:2-(2-Ethoxyethoxy)ethylacrylate(EOEOEA),1,6-Hexanedioldiacrylate(HDDA),Trimethylol propyl triacrylate (TMPTA); Pigment: phthalocyanine blue(Ciba); Photo-initiator:907, ITX; Dispersant: BYK-9077; millipore filter: PP（polypropylene） 1.2μm, nylon 1.2μm, glass fiber 1.0μm, PP 2.5μm, PP4.5μm（PALL）; PP0.5μm, PP 1.0μm（Beihualiming）

Instrument equipment

Grinding equipment:GJ-2S high speed grinding machine(Qingdao haitongda), 81-2constant temperature magnetic blender, JJ-1mechanical agitator; Test instrument: S3500 Laser particle size analyzer(America Microt-rac)

Sample preparation and test method

Sample preparation: Will a part of prepolymers, monomer, pigment, dispersant to mix in proportion according to formula of UV ink-jet ink, pre-dispersed 20 minutes by electric blender, then grind 75 minutes by GJ-2S high speed grinding machine(grinding media is1.6～1.8mm zirconium bead), get UV ink-jet ink color paste. Will quantitative monomer and another part of prepolymers mix, add photo-initiator and will it melted, add color paste, rabbling2.5 hours prepare into UV ink-jet ink.

Filtering method: After set up filtration equipment,put the millipore filter into monomer to wetting, then put it on the filtration equipment, seal the equipment, add ink into equipment, extract air from the equipment by circulating water vacuum pump to provide vacuum negative pressure in order to finish filtering process.

Test method: Test the particle size and distribution of samples by using S3500 Laser particle size analyzer, characterizes the filtering effect of ink.

Experimental Results and Analysis

The effect of millipore filter's diameter on filtering effect

Test the particle size and distribution of ink sample before filter, as shown from figure 1; use PALL pp millipore filters with diameter 4.5μm, 2.5μm, 1.2μm to filter ink respectively , test the particle size and distribution of ink after filter, as shown from figure 3.

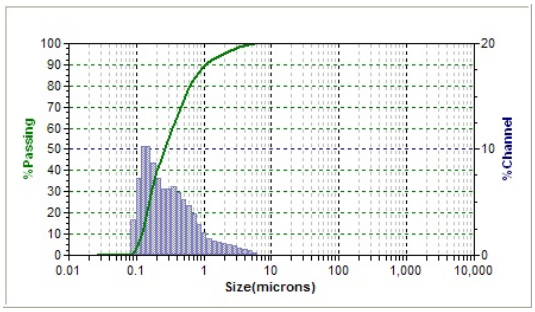


Fig 1 Particle distribution of ink without filter

We can see from figure 1, the distribution of ink is wide before filter, now, just 90% particle size of pigment below 1 μm, but 95% particle size of pigment at 1.92μm, the particle size is big.

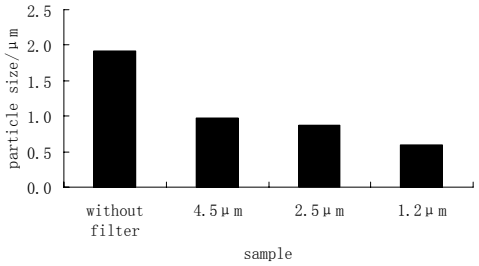
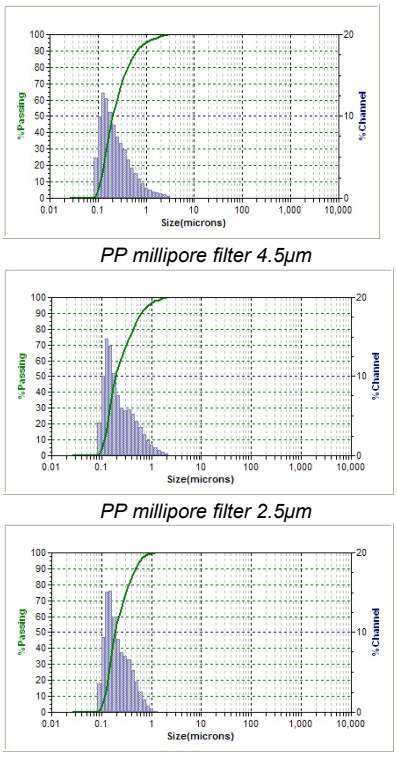


Fig 2 95% particle size of ink filtered by different millipore filters



PP millipore filter 4.5μm

PP millipore filter 2.5μm

PP millipore filter1.2μm

Fig 3 Particle distribution of ink filtered by millipore filters with different diameter

Can be seen from figure 2, the particle size of 3 kind ink is decreased significantly compare to before without filter, and with the decrease of the millipore filter diameter, the particle size of ink reduce; from figure 3 we can see, compare to figure 1, the distribution become narrow significantly, and with the decrease of the millipore filter diameter, the particle size distribution show a trend that become narrow, shows the distribution become better.

This is because, in the filter process, microporous millipore filter can effective filter out larger pigment particles and impurities, only particles less than millipore filter's diameter can through the millipore filter, but the larger particles will be blocked, the smaller the millipore filter diameter is, the more larger particles will be blocked, and the particle size of ink after filter is smaller, the distribution is narrower. When the millipore filter material is same, with the decrease of the millipore filter diameter, the particle size of ink after filter become smaller, explains filtering effect is better.

During the experiment, the smaller the millipore filter diameter is, the slower the filter speed will be, and the diameter will be blocked by particles accumulate on the surface, lead to the efficiency reduce. Filtering can't change the particle size of ink, it just filter out larger particles in the ink. If the diameter is too big, filtering effect will not obvious, the filtering effect is poor; if the diameter is too small, the particles will not to through the millipore filter, filtering efficiency is too low, so when the millipore filter's diameter to match the ink, the filtering efficiency will be high.

The effect of millipore filter's material and structure on filtering effect

Use PALL pp1.2μm millipore filter, glass fiber1.0μmmillipore filter, nylon 1.2μm millipore filter to filter the same ink, test the particle size and distribution of ink after filter, as shown from figure 4, figure 5.

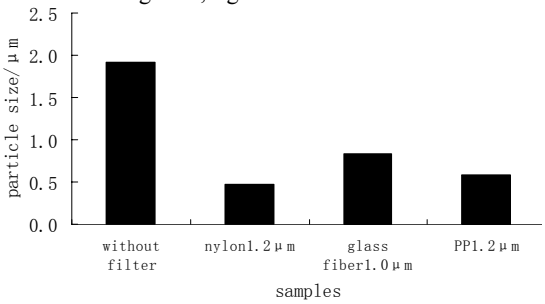
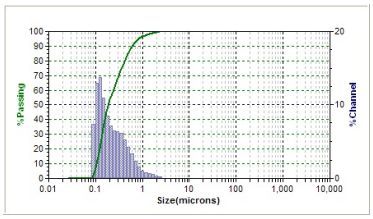
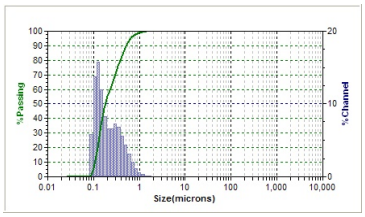


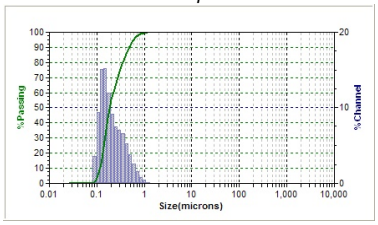
Fig 4 95% particle size of ink filtered by millipore filters with different material



glass fiber 1.0μm



PP1.2μm



nylon1.2μm

Fig 5 Particle distribution of ink filtered by millipore filters with different material and structure

Can be seen from figure 4, figure 5, 3 kind ink after filter compare to ink without filter, the particle size is decreased significantly, the distribution become narrow, the effect is obvious. Particle size of ink which filtered by 1.2μm nylon millipore filter is smallest, 95% at 0.47μm, particle size distribution is narrowest, filtering effect is best; particle size of ink which filtered by 1.0μm glass fiber millipore filter is biggest, 95% at 0.83μm, particle size distribution is the most wide, filtering effect is worst; and particle size of ink which filtered by 1.2μm PP millipore filter is in the middle, 95% at 0.65μm, distribution is in the middle, this shows that the millipore filter's material and structure have great influence on filtering effect.

Analysis from the structure, millipore filter is a extremely thin millipore filter, in the internal is porous spongiform structure. Different material millipore filter have different structure. Glass fiber millipore filter is thicker, fiber distribution in the middle, filter hole size is uniform, and evenly distributed, filter hole is tapered, filter hole on rough surface is big, filter hole on smooth surface is small, when use it, the rough surface up, the smooth surface down; pp(polypropylene) millipore filter is thin, in the middle is made by fiber which was pressed flat, filter hole evenly distributed in a plane, but the size of the filter hole not unified; nylon millipore filter is thin, material is aliphatic nylon, have good hydrophilic, filter hole distribution uniformity, size uniform, filtering effect is fine.

Nylon and pp material millipore filter's diameter used in experiment is bigger than glass fiber millipore filter, but the filtering effect is better than it. This is because, in the filtering process, different millipore filter on particles have different interception effect, some millipore filter can't intercept larger particles effectively. Filter hole will expand under the pressure, so in the filtration process of liquid, larger particles will squeeze from filter hole because liquid inertia and pressure, so the actual size after filter is bigger than the millipore filter's diameter, judge the filtering effect should according to the practical results of the experiment, select the suitable millipore filter.

From the experiment results can be seen, nylon millipore filter's filtering effect is best, pp filtering effect is second, and glass fiber is worst. But the filter speed of glass fiber millipore filter is fastest, and the filter speed of two other kinds of millipore filter is slow, especially the nylon millipore filter is very slow.

The effect of filtration process on filtering effect

PP 1μm、PP 0.5μm (Beihualiming) millipore filter's actual diameter is big, filtering effect is poor, can filter out impurities and larger particles in ink; PALL 1μm glass fiber millipore filter, can control the ink particle size in the lower range; PALL1.2μm pp millipore filter's filtering effect is good, and filtration efficiency is high. Use above 4 kinds millipore filters with filtering effect from poor to strong to filter the same ink one by one, test the particle size and distribution of ink after filter, as shown from figure 6.

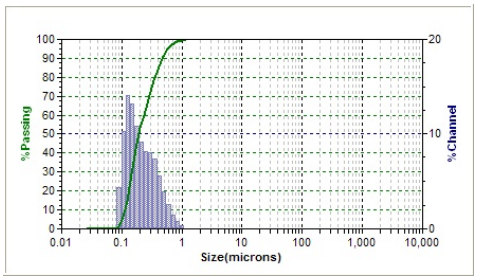


Fig 6 Particle size of ink filtered by 4 kind millipore filters

Can be seen from figure 6, after filtered by 4 kinds millipore filters, the particle size of ink can be controlled under 1μm, and particle size distribution is narrow, explain that the filtering effect is good. Compare to use one kind millipore filter only, use above process to filter, the filter speed is faster, particle size distribution is narrower, and filtering effect is better.

Conclusion

Through the research, we can get the conclusions:

1. Diameter of millipore filter have a great effect on the filtering effect of ink, with the same material, the smaller the diameter is, the filtering effect is better.

2. Material and structure of millipore filter have a great effect on the filtering effect of ink, millipore filter with the same diameter, but different diameter, the filtering effect of nylon millipore filter is best.

3. The filtration process have a great effect on the filtering effect of ink, compare to use one kind millipore filter only, use millipore filters with filtering effect from poor to strong to filter the same ink one by one, the filter speed is faster , and filtering effect is better.

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