Chemical Toner Technology and The Future

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Abstract

This talk is about "The Chemical Toner Technology and The Future" and its brief history, difficulty, breakthrough technology and potentials.

Although chemically processed toner seemed to be more suitable than melt-mix and crush method, chemically processed toner such as suspension polymerization toner was not launched for a long time. The first reason is its difficulty of charge control and secondly poor blade cleaning applicability. Huge investment for chemical toner plant is also high barriers for hardware companies.

But at the end of 90's, several powerful industries began to produce various types of chemical toners because of their technology breakthrough such as charge control improvement, micro encapsulation method establishment, shape control process and smaller particle toner manufacturing process improvement, color oil-less capability realization and so on. One of the most dominant chemically processed toner is suspension polymerization toner from Nippon Zeon and Canon and the second dominant one is emulsion aggregation method toner from Konica and Fuji Xerox.

The share of chemical toner is still low compared with the conventional methods toners but considering their much higher potentials of super high print quality for graphic arts, ultimate transfer efficiency, relatively environmental advantage for CO_2 reduction and other superior properties of their future possibilities, the volume of the production will increase explosively in near future.

Introduction

Chemical toner had a long history because its manufacturing method seemed to be more suitable than melt-mix and pulverizing method. But actually, chemical toner such as suspension polymerization toner was not launched for a long time.

The reasons are:
(1) Difficulty of charge control
(2) Difficulty of using spherical toner with blade cleaning systems
(3) Difficulty of more sophisticated toner design required by hardware people or customers
(4) Relatively higher investment than conventional toner manufacturing process for hardware companies who were not equipped chemical infrastructures such as equipment for washing water treatment

But since 1999, powerful hardware companies began to launch various types of chemical toners.

The reasons are supposed as:
(1) The success of the pioneer (Nippon Zeon) in B/W market
(2) Microcapsule method established for charge, fusing powder flow control and so on
(3) Toner shape control method established for cleaning
(4) Strong desire for smaller particle size toner for much higher print quality for color reproduction and publishing
(5) Urgent requirement by customers for long life and high reliability fusing system, or oil-less color fusing.

There are various types of chemical toner manufacturing process. The typical methods are suspension polymerization, emulsion aggregation, solution dispersion.

(1) Suspension Polymerization Method

Suspension polymerization is the most traditional and primary method. It enables a simple process of polymerization. A mixture of monomer, pigment and wax are dispersed in water with an inorganic dispersant. Then polymerization is conducted at high temperature. After the polymerization and the removal of dispersant with acid, the toner is washed with water and then dried. In most cases, toner size and distribution are decided in the first step of polymerization. Spherical shape and a type of encapsulated structure can be obtained based on this method. Actually Nippon Zeon and Canon launched toners using this method.

(2) Emulsion Aggregation Method

This Emulsion Aggregation method was invented in the mid 1980's. This process can be divided into two steps, the first step is emulsion polymerization and preparation of pigment and wax dispersions.

The second step is the aggregation of these materials followed by coalescence. A feature of this method is the control of toner shape. Toner shape can be controlled from irregular shape, like conventional toner, to spherical shape like suspension polymerization toner. Konica and Fuji Xerox are manufacturing Emulsion Aggregation toners now.

(3) Solution Dispersion Method

It seems that this method is an extension of the suspension polymerization technology or capsule toner technology.

Therefore, it has similar features to the suspension polymerization method, but toner size and size distribution cannot be decided until the end of solvent removal. By using similar material as conventional toner, spherical toner can be easily obtained. Fuji Xerox and Ricoh are employing this technology. Ricoh's Pxp toner is based on this technology and interfacial polymerization, mechanical non-spherical treatment.

Fuji Xerox EA (Emulsion Aggregation) Toner Technology

Fuji Xerox EA toner has various types of breakthrough technologies that are enabling many performance improvements such as high print quality and ecological features. The followings are superior points of Fuji Xerox EA toner.

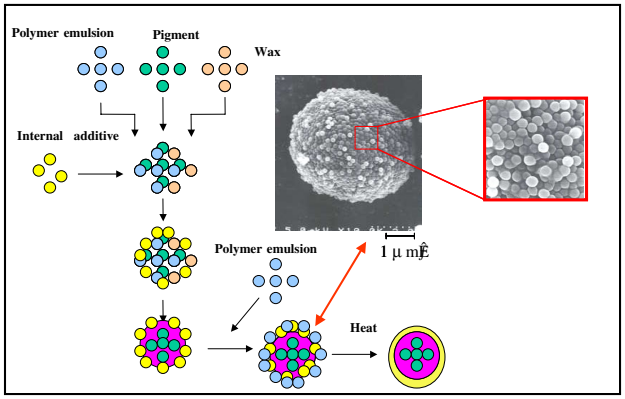

Figure 1. Process flow of EA toner

(1) Very Narrow Size Distribution and Small Size

Fuji Xerox EA process realizes very narrow distribution and very small size toner without any classification. These advantage means high print quality, high transfer efficiency and tremendous energy saving. (Figure 2)

(2) Very Wide Latitude of Toner Shape Control

Fuji Xerox EA toner shape can be changed from spherical to irregular by adjusting temperature, time and other factors through its aggregation and coalescence process. Toner shape control is very important because it has the strong relationship with hardware subsystem matching, such as cleaning and transfer process. The wide design space enables both blade cleaning system and cleaner-less system adaptability for example. (Figure 3)

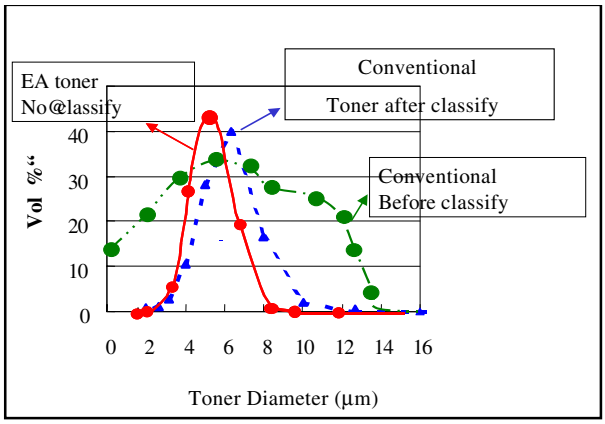

Figure 2. EA toner particle size distribution

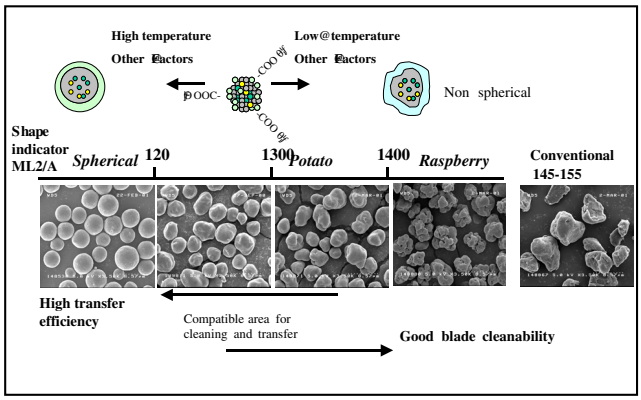

Figure 3. Toner shape control of EA toner

(3) Micro-Encapsulation

EA toner manufacturing method has preferable advantage on forming micro-encapsulation structure compared with other chemical toner manufacturing method because of its stepwise process. The encapsulation structure gives various types of fine compatibility on required toner properties such as low temperature fusing and powder flow.

(4) High Performance Color Oil-Less

Conventional process toner has some limitation on oil-less color toner because wax content, that is effective for oil-less toner, should be low percentage considering enough powder flow. EA method realizes high gloss oil-less color toner by means of encapsulated enough wax and most suitable binder polymer design combination.

(5) Drastic Improvement of Ecology

Both EA toner manufacturing process and low toner consumption due to small particle size EA toner achieved splendid environmental friendly results. The amount of carbon dioxide exhaust is 35% lower than conventional method in manufacturing process.

Toner consumption is 37% lower than conventional toner due to its small size, narrow size distribution and higher transfer efficiency. This means almost 60% CO_2 will be saved in total when EA toner is used. (Figure 4)

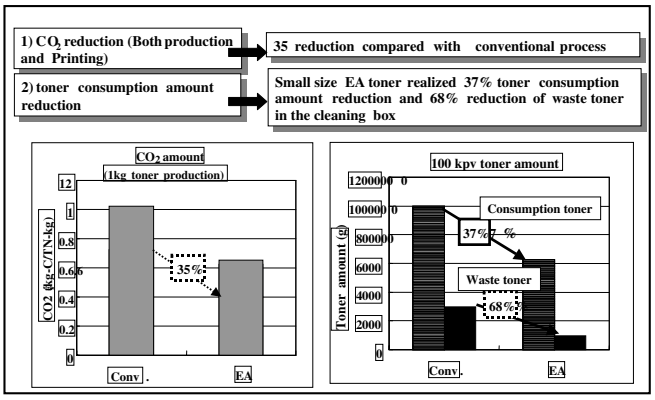

Figure 4. Environmental effect of EA toner

The Future of Chemical Toner Market and Technology

Recently, Ricoh started to sell some machines using chemical toner named Pxp that is being manufactured by Sanyo Chemicals technology and plant. Thus, all Japanese dominant hardware makers such as Canon, Ricoh, Fuji Xerox and Konica are launching chemical toner machines. Other companies are also applying chemical toners from Nippon Zeon and so on. (Figure 5)

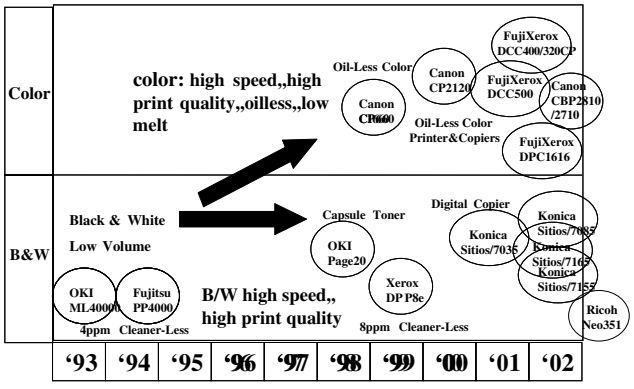

Figure 5. Chemical toner line-up from Japanese companies

The near future business and technology trend of chemical toner may be as follows.

(1) The market share of Chemical toner is still small now, but it will increase very rapidly in the very near future in worldwide market because of their high potentials of quality, cost, ecology.
(2) The production cost of chemical toner is more expensive than that of conventional toner, but it will become equal or cheaper within a few years and the cost per print will be cheaper at that time due to its lower toner consumption and high transfer efficiency.
(3) Chemical toner particle size may become smaller in the interest of high print quality and other advantages, but there will be some limitation due to hardware design or powder dirt.
(4) Low melt technology will be advanced farther using wide design space of chemical toners.
(5) Some of significant innovations which are not existing now may be announced in the near future using chemical process. These breakthrough technologies will be achieved by the potential maximizing activities of each chemical toner method. Off course, the final reach level of each process might be quite different. The following 3~5 years may decide what chemical toner process is the best.
(6) Novel chemical toner manufacturing process or modified process may be developed in order to achieve more drastic breakthrough or new requirement.

Conclusion

EA toner can provide remarkable advantages compared with conventional process in terms of particle size and distribution control, shape control, encapsulation structure formation, color oil-less latitude and ecology.

References

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Biography

Takayoshi Aoki is General Manager of Chemicals Creation Center in Fuji Xerox. He graduated from Kyoto University in 1974 (Faculty of engineering, Organic synthesis) and joined Fuji Xerox in 1982. Main activity was toner and developer material design for 15 years from 1982. After that, he has been managing over all of toner and developer, photoreceptor and other chemical materials for xerography such as fuser. He received 98 Japanese patents, 31 USP and he is the co-author of three books related to toner and developer. He is a member of Imaging Society of Japan.