# High Precise Classification Technology in Toner Production

## 墨粉生产过程中的高精密分级技术

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## Abstract

*Pulverization and Classification are the key technologies in Toner Production. They decide the toner physical shape; affect the final quality of printing/copying. Pulverization technology is the most direct factor deciding Toner's shape, and it is also the Big Energy-eating process. So, it has cost a lot of attention by Toner Maker; Classification technology is the key to control the Toner Particle Size Distribution. It is not only important to Toner Quality, but also to increasing the output of product under the same Energy Cost, or decreasing Energy Consumption under the same Output. It directly relates to the profit of Toner maker. But it seems not be sufficiently highlighted. No detail analysis seems being reported by now. In this article, one kind of high precise toner classification technology/machine is introduced through an actual example of Toner classification machine reforming. The product quality, Profit, Energy cost reducing affected by this reforming is analyzed. The advantage of adopting high precise classification machine is explained.*

*微粉碎和分级是墨粉制造过程的核心部分，直接决定着墨粉的物理形状。影响最终的印刷、复印品的美观程度。其中微粉碎技术直接与墨粉的物理形貌有关，并且是墨粉生产过程中的耗能大户，这一点已被大多数厂家所认识重视；而分级是控制墨粉粒度分布的关键，在直接影响墨粉质量的同时，还有一个重要的作用是在同样的能耗条件下提高产量、或者在同样的产量时降低能耗，直接与企业的收益相关，但这一点似没有引起足够的重视，目前还未见这方面的详尽论述。本文通过具体的分级设备改造例，介绍了一种在国外（特别是日本）被广泛采用的高精密墨粉分级技术和设备。分析了改造前后分级精度的不同对产品质量以及相关的经济效益和节能降耗的影响。阐述了采用高精度分级设备的优越性。*

## Typical Toner Production System

The typical Toner production process is as Figure 1.

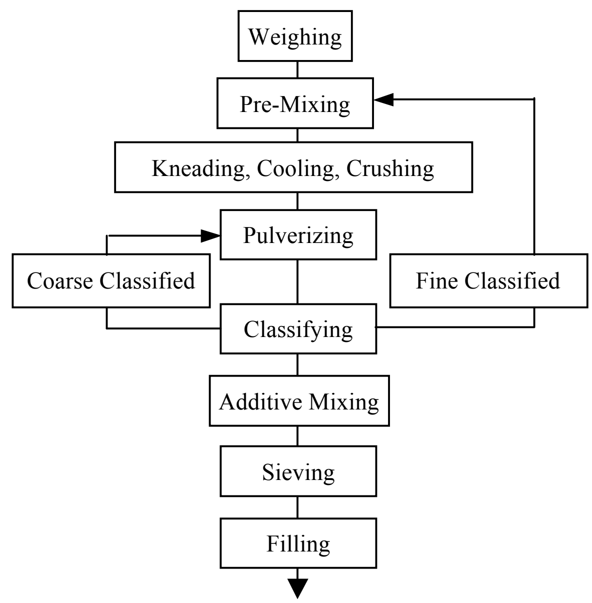



***Figure 1**. Typical toner Producing Process*

## The Precise Classification Technology

In this article, one kind of unique classification Technology is introduced. Prof. Rumpf first primarily invented this technology early in 70$^{th}$. The oldest model published is as Figure 2

This kind of Classifier is also called Jet- Flow/or Coanda Classifier. It was successfully commercialized at Japan from the end of 80$^{th}$, especially at toner production. Many famous producers like Canon etc. adopted this classifier, and developed a lot of new models according to their own experience.

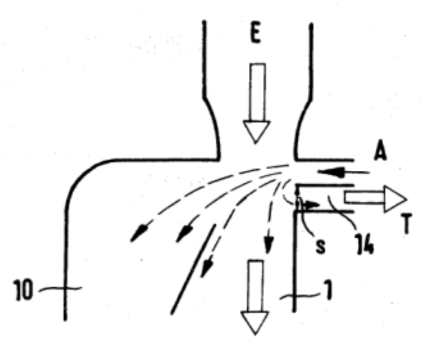



***Figure 2**. The oldest model invented by Prof. Rumpf*

Here one new developed model is introduced. Its classification mechanism is showed at Figure 3: The toner particles with a certain size distribution are shoot out from the feeding pipe by high pressurized air. Because the air jet has the feature of flowing toward the wall (This is called Coanda Affect), it flows along the curved Coanda Block. The Larger Particle brought by airflow is easier to escape and fly further. So, the particles are separated into three portions: Large, Medium and Small. This

Coanda Classifier is known with some obvious advantages as, Simple Construction; Three Portions of Products at Once; Low Running Cost (with out rotating parts, no need motor); No change at Cut-point and Precision when scaled up.

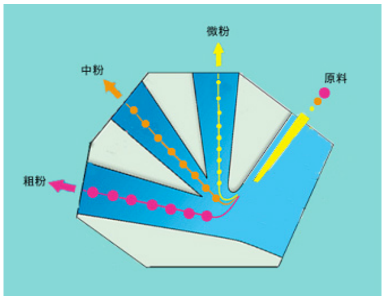



***Figure 3.*** *New model developed by author etc.*

The sketch of the whole system is shown at Fig.4

Particles fed from feeder ① are dispersed by special dispersion device ②, and then go through classification zone ③. The coarse portions classified is collected at cyclone ④ and then sent to the mill for pulverization again. The medium size portion is the product and collected at cyclone ⑤. The fine size portion is collected at filter ⑥ and sent to pre-mixer for reuse. The clean air is vented by induced fan ⑦.

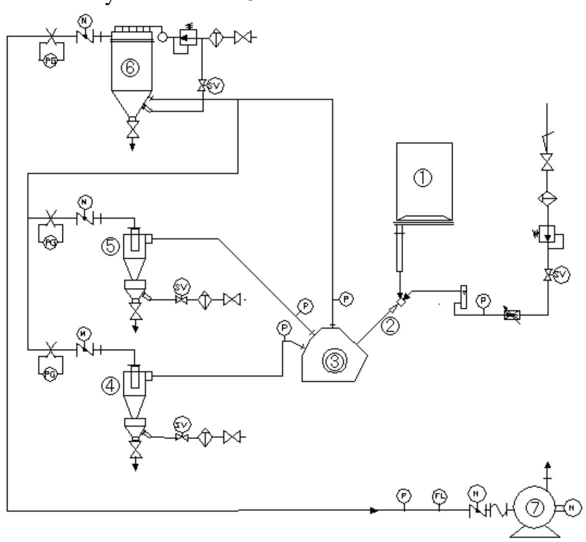


***Figure 4.*** *The sketch of system .*

## The Yield and Particle Size Distribution (PSD) Changing with Classifier Reforming

It is commonly understood that the less of particles bigger than 20micron included in the product, the better of its quality. On the other hand, the particles smaller than 5micron should also be taken out for less copy and/or print splashing.

The domestic toner makers commonly use the fluidized bed jet mill for the pulverization of Toner. There is a classifier roller at the top of this jet mill to avoid the larger particles bigger than 20micron going through (It is the fact that some larger particles bigger than 20micron do go through anyway. And it is clear that further classification to remove it from the product will also prompt the product's quality) .The main purpose of classification here is to remove the smaller size particles efficiently.

**Table 1: The effect comparison between the old and new model classifier**

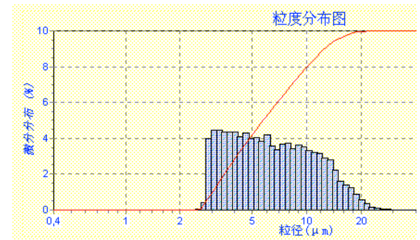
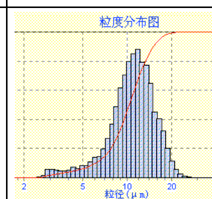
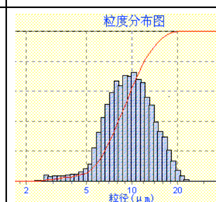
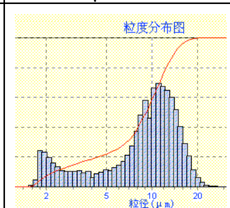
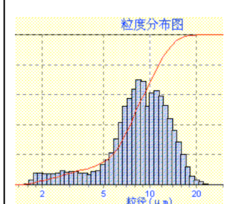
| | | |
|---|---|---|
| Raw materials PSD (Number) (Coulter Counter 100micron hole) |  -5.29μm = 41%pop, +20.65μm = 11%vol | |
| Classification Target | -5.29μm < 27%pop, +20.65μm <3%vol | |
| Classification Results | Old Model Classifier | New Model Classifier |
| Products PSD (Number) (Coulter Counter 100micron hole) |  -5.29μm=6%pop, +20.65μm=5.7%vol |  -5.29μm=5.5%pop, +20.65μm=2.7%vol |
| Products PSD (Number) (Coulter Counter 50micron hole) |  -5.29μm=22%pop, +20.65μm=4.6%vol |  -5.29μm=15%pop, +20.65μm=2.5%vol |
| Product Yield | 70% | 89.8% |

Table 1 shows the comparison of the effect of reforming the old model classifier to the new model classifier introduced in this article. It is clear the particle size distribution is quite better after the reforming. And the yield of product is increased almost 20%

## The Finical Analysis

The product yield is increased almost 20% by reforming to the new model classifier. This is quite meaningful for the enterprise.

The material flow is illustrated at Figure 5 and Table 2. Raw material ***A*** tons pre-mixed with the returned fine particles ***D*** tons, which is ***B*** tons, is kneaded, cooled, crushed, then pulverized together with coarse returned ***C*** tons. The Final product is ***A*** tones after classification balanced with initial raw materials inputted.

For the truth the annual output of this enterprise is 300 tons/y. The old material flow is as Case I. After the classifier reforming, the annual output can be increased to 385tons/y, as shown in Case II without any energy cost increasing, because the energy consumption of kneading, cooling, crushing and pulverizing is not changed.

For some reasons, even if no changing at output, the energy consumption can be decreased 22%, because the material amount need to be kneaded, cooled, crushed and pulverized is decreased form 429 tons to 334 tons, as shown in Case III.

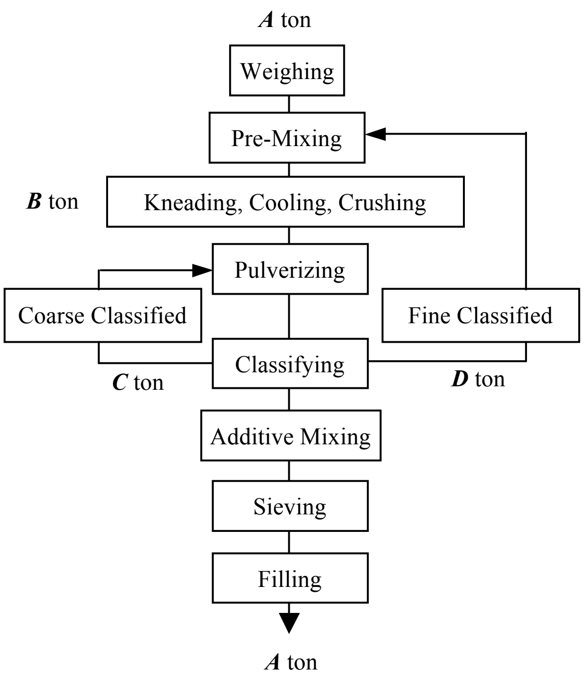



***Figure 5***. *The material flow at toner producing process*

**Table 2: The effect comparison between the old and new model classifier**

| Case | I | II | III |
|---|---|---|---|
| Classification Yield | 70% | 89.8% | 89.8% |
| ***A*** tons | 300 | 385 * 28% increased | 300 |
| ***B*** tons | 429 | 429 | 334 * 22% decreased |
| ***C*** tons | Small | Small | Small |
| ***D*** tons | 429×30% = 129 | 429×10.2% = 129 | 334×10.2% = 34 |

## Two SEM Pictures of Classification Examples

Two SEM pictures of Classification examples are also shown at Figure 6 and Figure 7. They both tell a very good particle size control by the classifier introduced in this article.

The mean particle size of feed toner at Figure.6 is 12.6μm (vol), and Fine/Medium/Coarse is 14%/85%/1%. They are 6.29μm (vol), and 15%/83%/2% at Figure.7,

## Conclusion

In this article, one actual classifier reforming tells the very meaning story for the toner producer. The classification efficiency promotion can not only improve the toner's quality, but also bring the finical benefit for the enterprise (Including increasing output and/or decreasing energy cost). It says 20% improvement of classification yield can bring final product output 28% increasing at the same energy cost, or 22% energy cost decreasing at same product output.

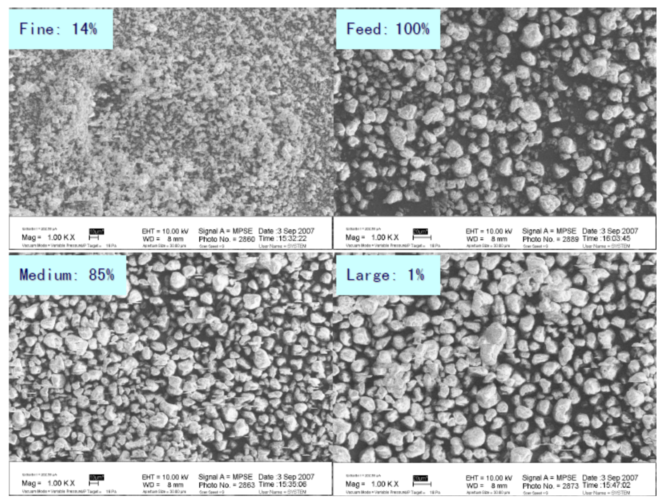



***Figure 6.*** *SEM Pictures of Classification Example 1*

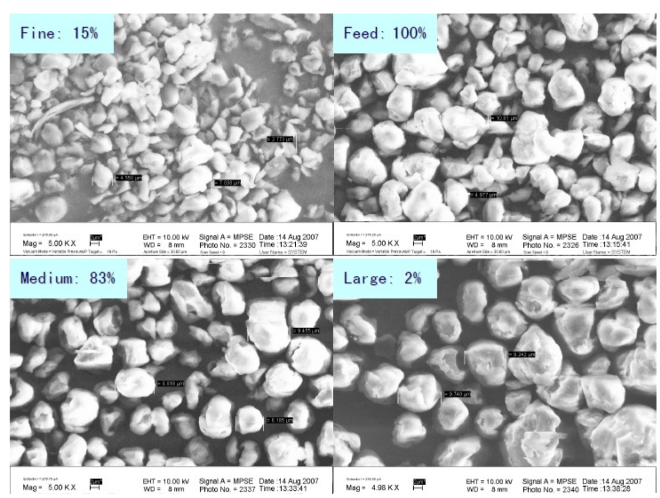



***Figure 7.*** *SEM Pictures of Classification Example 2*

## Author Biography

Jiangbo Chen received his BS and MS in Thermal Engineering from Tsinghua University, China (1989,1995) and his PhD in Fluid Phenomena from Tsu University, Japan (2002). Since then he worked in the Research and Technology Division at Matsubo, Tokyo till 2006. Then came back China built his own Lab at China National Academy of NanoTechnology & Engineering. His work has focused on the Classification Technology Development.