High Precise Classification Technology in Toner Production

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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.

Typical Toner Production System

The typical Toner production process is as Figure 1.

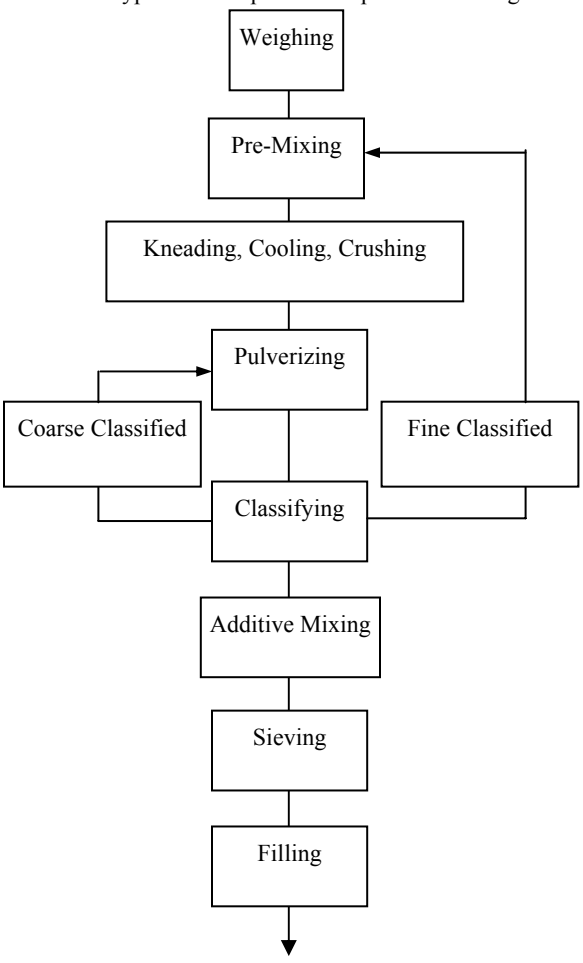


***Figure 1**. Typical toner Producing Process*

The Precise Classification Technology

In this article, one kind of unique classification Technology is introduced. Prof. Rumpf first primarily invented this technology early in 70th. 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 80th, 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.

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.

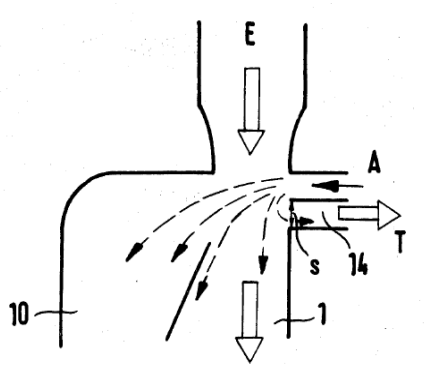


***Figure 2**. The oldest model invented by Prof. Rumpf*

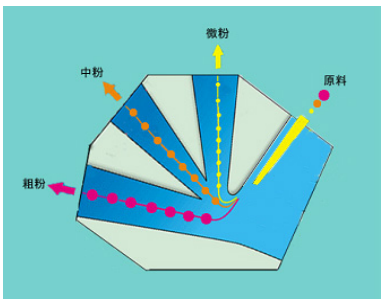


Figure 3. New model developed by author etc

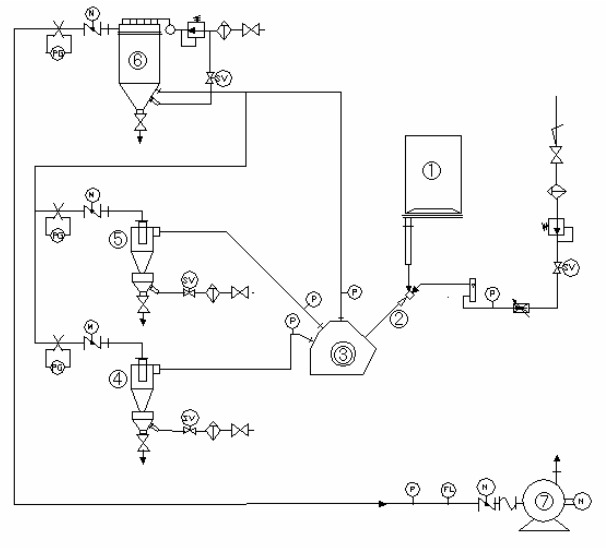


Figure 4. *The sketch of system .*

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

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

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 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

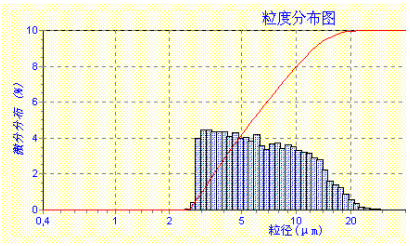
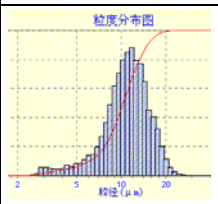
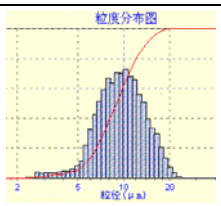
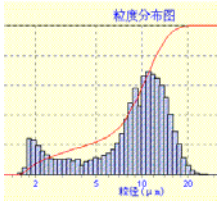
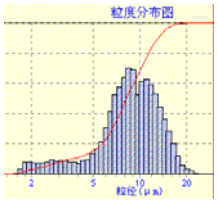
The product yield is increased almost 20% by reforming to the new model classifier. This is quite meaningful for the enterprise.

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.

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%

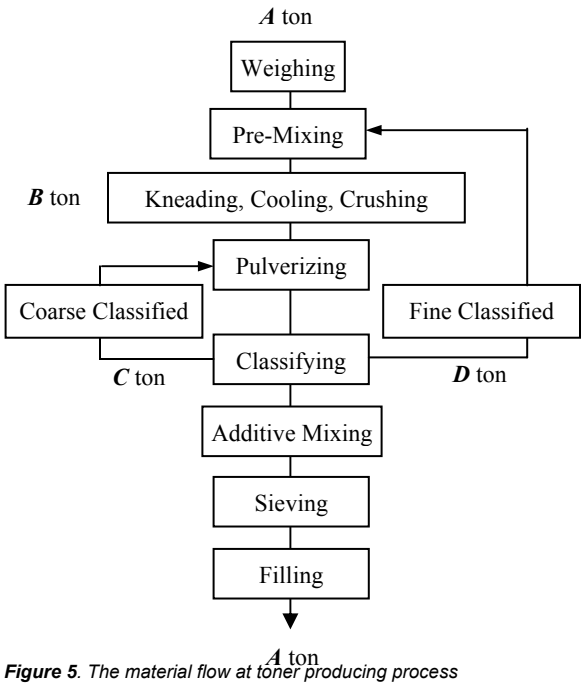


***Figure 5**. The material flow at toner producing process*

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

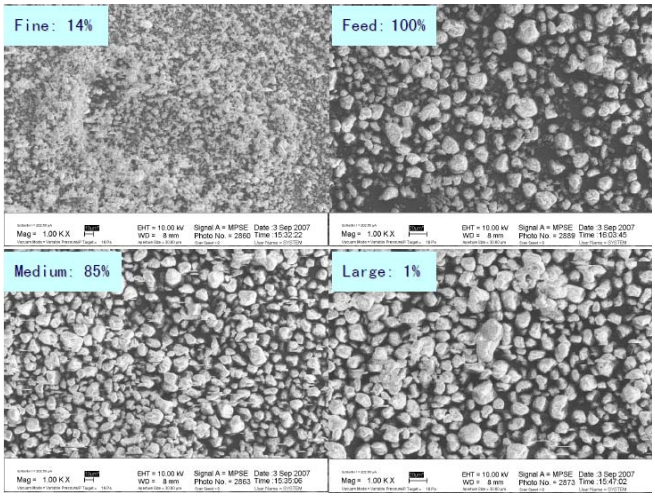


***Figure 6.** SEM Pictures of Classification Example 1*

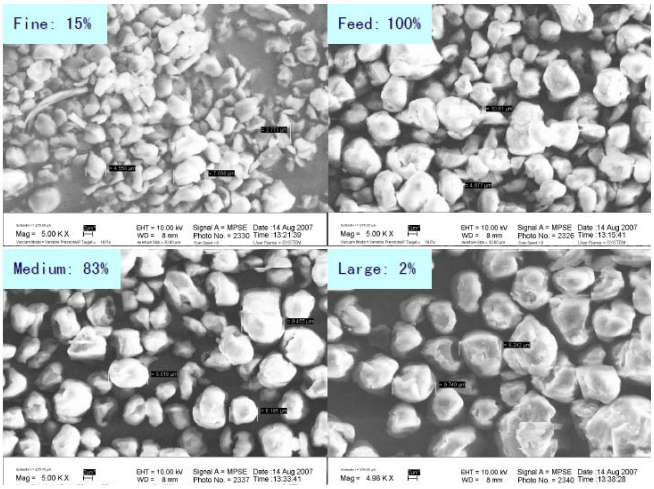


***Figure 7.** SEM Pictures of Classification Example 2*

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.

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.