The Toner Replenishment System Using Auto Volume Decreasing Soft Toner Cartridge

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1. Abstract

We have developed a new toner replenishment system that automatically decreases volume of the toner cartridge by using the screw pump while supplying the toner to the developing device.

The Auto Volume Decreasing Soft Toner Cartridge is a the plastic bag, which is made of thin, flexible, plastic film ,and the volume of the toner cartridge decreases gradually with toner consumption.

This technology enables the resource saving, the reduction of disposal cost due to the volume reduction, and the very easy exchange of the toner cartridge.

2. Introduction

In recent years, the approach to the negative environmental impact decrease, and gather global attention in connection with global warming.

We are demanded the development the less energy use of the electrophotographic copier and printer. The conventional toner containers of the electrophotographic copiers and printers are used toner cartridges or toner bottles often made of thick , hard, plastic containers. The conventional toner containers need many number of parts, a large amount of fabricate materials in quantity and kinds, then the negative environmental impact is considerably large. Because a used toner container is the same spatial volume as before use, the efficiency of transport is bad and the distribution cost is expensive, moreover, the amount of the CO_2 exhaustion increase.

We developed a new toner replenishment system using the plastic bag toner container, which enables to reduce the amount of the fabrication material, to decrease negative environmental impact, and to achieve the extreme easiness to use.

3. The Auto Volume Decreasing Soft Toner Cartridge

Figure 1 shows the photograph of the Auto Volume Decreasing Soft Toner Cartridge (STC) comparison with the conventional type toner container.

The conventional toner container is often made of plastic, so it is hard and the volume of the used toner container is the same as before use.

On the other hand, the STC is a type of a plastic bag made of thin, flexible, plastic film, and the volume of the toner cartridge decreases gradually with toner consumption , and finally the toner cartridge is folded smoothly.

Because the STC is made of thin plastic film, the STC needs considerably less fabricating material than conventional toner cartridge.

Conventional type New type

Figure 1. *Comparison with the conventional and the newly developed STC*

In Figure 2, the left side is the photograph of the STC comparing before and after the use, and the right side is the photograph of the cap of the STC.

We can separate the cap of the STC from the STC body, recycle the cap of the STC , and change the remainder into thermal energy.

STC after the use Cap of the STC

Figure 2. *Photograph of STC after the use*

Figure 3 shows the carbon dioxide emissions during lifecycle between conventional type and STC, except for the cap of toner container. The STC decreases 77% of CO_2 exhaust than the conventional type bottle and is recycled 5 times.

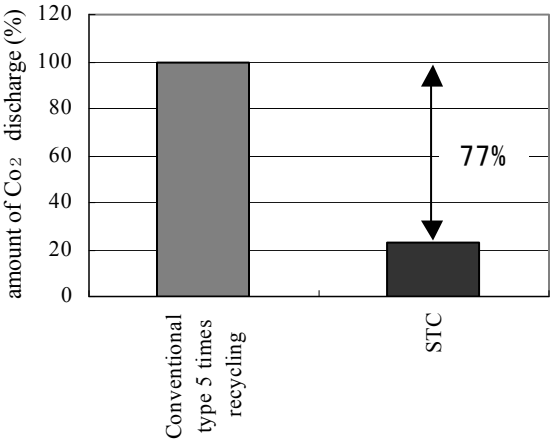

Figure 3. *Comparison of carbon dioxide emission between conventional type and the STC*

4. New Toner Replenishment System

Figure 4 shows the construction of the New Toner Replenishment System. The STC is connected through the suck nozzle and the flexible tube to the screw pump (One axis eccentric screw pump), which is arranged near the development system.

Toner particles in the STC are transported to the development system through the flexible tube by the negative pressure which is generated by the screw pump. As toner particles are transported by the negative pressure through the flexible tube, we don't need to arrange the STC near the development system, and we can locate the STC at any desired place.

The screw pump is composed of the metal rotor formed male screw and the rubber stator formed double female screw and wrapping the rotor. As the space between the rotor and the stator moves along the axis of the rotor, then the toner in the screw pump move along the axis of it.

The amount of transportation of the toner depends on the size of the rotor and the stator, and this is in proportion to the rotation angle of the rotor. So our new system can transport the toner continuatively with very high accuracy.

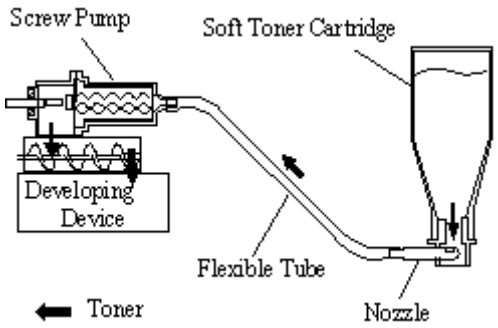

Figure 4. *The diagram of the toner transferring system*

5. Technologies to the Automatically Decrease Volume

The STC have no mixing device in itself, such as any screw, nor any paddle. Therefore in our new system, it's very important to prevent the void and the bridge phenomenon of toner for the stability of the transportation.

We design our new system to transfer the toner to the space on the nozzle using the change of the shape of the STC. As the toner is discharged from the STC by the suck pressure of the screw pump, the pressure in the STC gradually decreases. And the wall and the bottom of the STC is folded, and the volume of the STC decreases, and then the pressure in the STC returns to the atmospheric pressure.

The change of the shape of the STC transfers the toner in the STC from the upper side of the STC to the lower side, and the nozzle is buried in the toner.

However, because the plastic bag is made of thin plastic film, in many cases the plastic bag is disorderly folded and the large amount of toner remains in the plastic bag. Then we choose the type of the plastic bag, now we call as STC, the sheets of the bag of the bottom and the right and the left side have "creases" and, have effect on breaking the mass of the toner.

Moreover, to achieve a little toner remainder in the STC, we used 'the quality engineering method' to get the optimum condition.

Figure 5 shows the parameters we use; the material and the thickness of the plastic films, the thickness and the size of the reinforcement boards and the shape of the assist parts in the machine and so on.

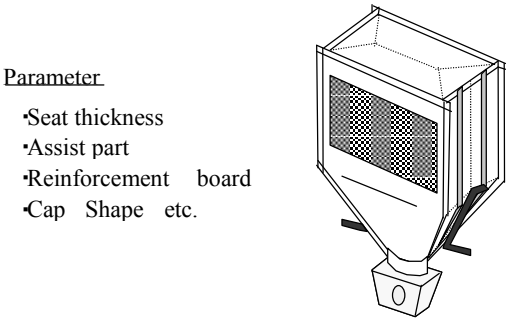

Figure 5. *Parameter experiment of STC*

Figure 6 shows the experimental results of the toner transferring experiment in the system figured. In Figure 4, after getting the optimum condition, in the experiment, we set up the parameters of the screw pump in the condition of 2 grams of the replenishment of the toner per one cycle.

The toner of 600 grams is filled to the STC, and Figure 6 shows the relation between the amount of the toner remainder in the STC with the capacity of 600g and the amount of the toner replenishment.

As you see in Figure 6, the amount of the toner replenishment is within the limit of 2±0.2 g, and the final amount of the toner remainder is 4.2g.

As described above, the optimum condition of the New Toner Replenishment System achieves the enough replenishment stability and the considerably small amount of the remainder.

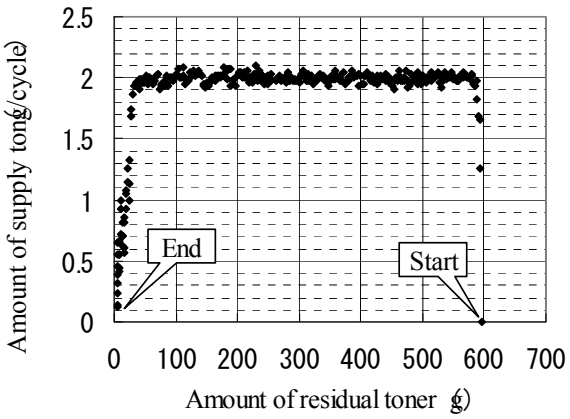

Figure 6. *The Toner transferring experiment*

6. Usability of the STC

Figure 7 shows the photograph of the digital, multifunction full-color machine , imagio MP C6000 series which is applied this toner replenishment system. We arrange the STCs in the front of the machine in a line with the consideration of the usability for the user.

When the STC holder is shut and opened, the suck nozzle is inserted into the STC and removed from the STC respectively.
So the machine user only removes the used STC and drops the new STC above the STC holder without removing the caps from the STC. So the machine user can exchange the STC very easily.

Figure 7. *Auto volume reduction cartridge in Multifunction color copier*

Figure 8 shows the photograph of the cap of the STC.

The size of the outlet of the STC is very smaller than any other toner container and formed on the container cap side, so the weight of the toner cling to the used STC is 1/5 compared with the conventional type.

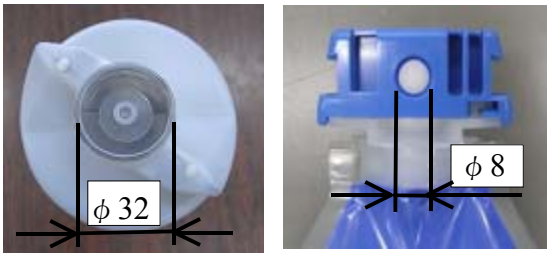

Figure 8. *Photograph of toner cartridge cap*

7. Conclusion

In this report, we have developed the new toner replenishment system, using the fold-able plastic bag toner container.

By adapting a thin and plastic bag as a toner container, we can remarkably reduce the amount of the fabricating material, and decrease the negative environmental impact.

Moreover, we achieved the extremely easy exchange of the toner container.

References

[1] Jun-ichi Matsumoto, Emi Kita, Nobuo Takami, Satoshi Muramatsu, and Nobuo Iwata, Toner supply system applying auto volume reduction cartridge, Imaging Conferrence JAPAN 2009, pg. 75

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Author Biography

Emi Kita received received her MS degree from Osaka University, Japan in 1996, then joined Ricoh Co., Ltd., in 1996, where she has been working on research and development of printing technologies. Her work has primarily focused on the developing of toner replenishment systems and development systems