

Ink Tank Having Visible Ink Level and End Leg For Ink Supply System of Printer

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Abstract

A new design of ink tank for the ink supply system of thermal ink-jet printer was presented in the paper. Some past and current designs of ink tanks for thermal inkjet printers were reviewed first in the paper. At the mean time, some comparisons of them were done for analysis. Hence, the fundamental design principles (nondimentional similarity) have been applied to explore what geometrical properties would be defined as the good configuration of ink reservoir. It's found that one tall and narrow appearance of ink tank, as first feature, could be preferred to offer many advantages, such as compact spacing, ease for replacing, good readability for ink level, and so on. In addition, one new feature of end leg was added onto the present design in order to minimize the remaining ink, which can be useless for ink supply. Another feature of simple visible ink level was also offered for users to show how much ink was remained all the time. The performance of ink supply, as one example, was demonstrated in the end. The new presented tank here will meet basic needs of ink supply and further own many advantages, including compact spacing, visible ink level, minimum residual ink, and so forth.

Introduction

Ink tank's designs for thermal inkjet printers have been much explored and studied since 1980s when the large ink supply system (LISS) was introduced and getting more important in the wide format printers.[1] It's recalled that one flexible and long tube is always equipped to connect the ink tank (source) and print head (ink output) in the LISS. Meanwhile, the tanks could be divided into two basic categories: (1) fixed and refillable tanks (2) disposable (replaceable) tanks. Since the tanks in first category are mounted and embedded in the printers, the capability of refilling ink is very necessary.[2] On the other hand, the tanks in second category are expected to be replaced with new ones rather than be refilled once again when they are empty of ink in usage.[3,4,5]

Comparing these abovementioned tanks, there were three main issues regarding the design of them. First of all, the configuration (shape) of tanks, related with the space occupied by the tanks, is one concern of design. Secondly, the issue regarding capability of ink level detection is much studied. Thirdly, it's very desirable to minimize the residual (remaining) volume of ink that cannot be used out any more almost in the end of use. It's not very satisfactory for these past designs of tanks to meet all need of three issues. Hence, it's major our goal for this paper to study the issues and find a good design of tank which can serve as a nice ink source to pass liquid ink into the targeted print head in the LISS.

New Design for Ink Tank

Characteristics of Geometry

In past related studies, it seems that the geometrical shape of ink tank was not paid much attention to. However, the geometry concerns about a lot of significant factors in the performance of supply of LISS.[6] It does really matter. Given that one design of ink tank is to be characterized with depth of D, width of W, and height of H. Then, by the nondimentional similarity of geometry, two characteristics numbers α,β have been defined as the equation (1).

$$\alpha = \frac{H^2}{W \times D}$$
$$\beta = \frac{W}{D} \qquad (1)$$

Supposed that the capability of ink tank is targeted to be 500 ml and characterized with tall and narrow geometry to yield compact space in occupying. Then, it implies the conditional results of $\alpha > 1$ and $\beta < 1$. Meanwhile, it's noted that more than four tanks (due to ink color: yellow, magenta, cyan, black) in one LISS is often required because of the need of color printers. Consequently, one preferred configuration of ink tank system with the combination of specified width, depth, and height is shown in **Table 1**. and *Figure 1*. It's also noted that there are eight tanks in the system, composed of four for pigment-base type of ink and four for dye-base type of ink.

Table 1. Geometry of Ink Tank

Capability	500 ml
Width(W)	2 cm
Depth(D)	12 cm
Height(H)	25 cm

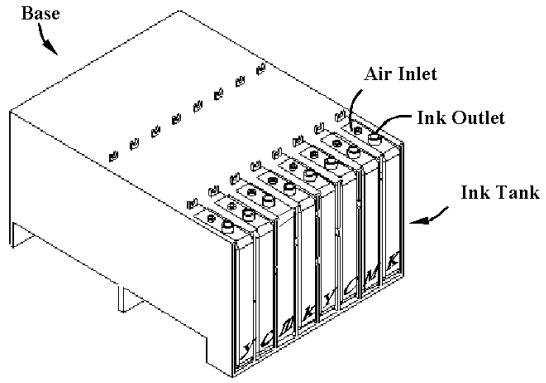

Figure 1a. Ink Tank System(onto base)

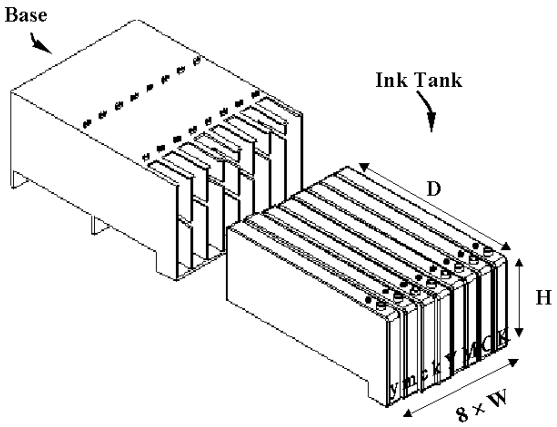

Figure 1b. Ink Tank System(out of base)

In addition, the rise height of liquid ink (h_R) mainly due to the effect of surface tension should be taken into careful consideration; it can be simply expressed in terms of surface tension σ, contact angle θ, specific weight γ, and spaced distance between two planes δ.

$$h_R = \frac{2\sigma\cos\theta}{\gamma\delta} \qquad (2)$$

Hence, it's straightforward now to evaluate the characteristics of geometry which includes α number, β number, and rise height hR where the σ of 48 dyne/cm, θ of zero, γ of 9800 N/m^3, and δ of 2cm are assumed. The computational results can be found in the Table 2. It meets the definition of type of tall and narrow tank and yield small rise height enough.

Table 2. Characteristics of Ink Tank

W:D:H	1: 6 : 12.5
α number	2.88
β number	0.08
h_R	1 mm

Feature of End Leg

It's reminded that the minimum residual ink (maximum availability of ink) is desirable for the design of ink tank. For this purpose, one important feature of end leg is offered in our tank design shown in Figure 2. The end leg is located on the bottom of the tank such that all of ink inside the tank will be delivered out at the region. Moreover, comparing the total capability of tank, the volume of end leg is so small that the residual inks could be as few as possible.

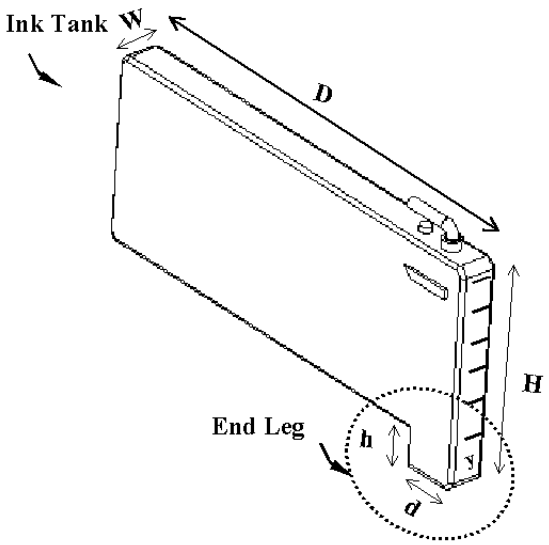

Figure 2. Feature of End Leg

In one preferred design (see *Figure 2*), the end leg has depth (d) of 3cm and height (h) of 2cm to yield the capability of 6ml which is roughly 2% of total capability of ink tank. The estimated residual ink should smaller than 1ml if the drawer can almost reaches the bottom of the tank.

Feature of Visible Ink Level

As mentioned before, ability of ink level detection is important for many ink tanks. Note that the excellent optical sensors to 'see' ink level are our human eyes. Based on the simple idea, one feature of visible ink level can be implemented in our ink tank, which owns a visible (transparent) window on the front. In addition, the reading label of ink level is also clearly put on the window, shown in *Figure 3*. Therefore, users can detect the remaining ink all the times just by themselves. It's particular convenient for our tall tank since enough height can provide a good reading scale of ink level herein. The advantage for characteristics of $\alpha > 1$ is demonstrated at the point thereof.

Performance for Features

It's good to understand further how the ink height of tank changes as the ink being consumed in the present tank. The relationship between ink height (cm) and level (ml) is clearly demonstrated in *Figure 4*. Two major points should be noticed here. One of them is the range of ink height

change that is equal to twelve centimeters. The readability of minimum change of ink level could be around 5ml. So it can provide good performance for the feature of visible ink level. The other point is the abrupt change of line's slope from line *a* to line *b*. It is actually corresponding to the feature of end leg that targets to small residual ink in the end of use. The performance for second feature seems also satisfactory in the case.

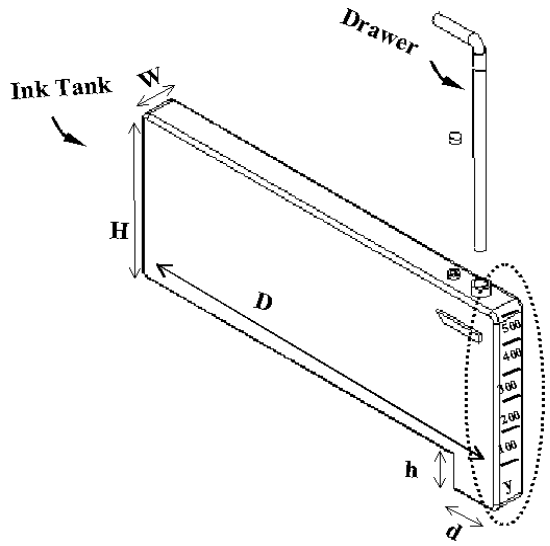

Figure 3. Feature of Visible Ink Level

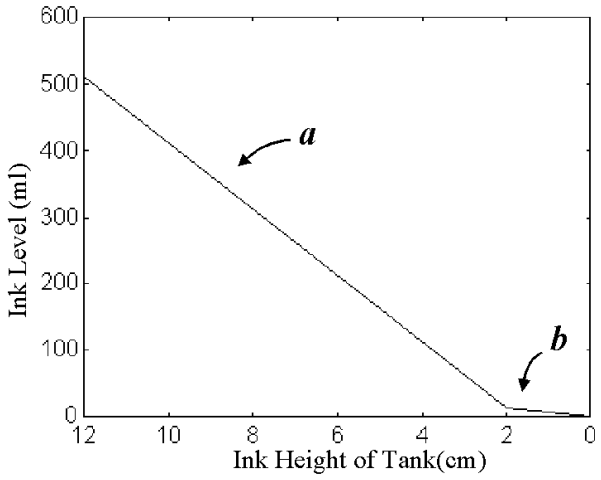

Figure 4. Performance for features

Meanwhile, it's noted that the structure of end leg could be other shapes, including semi-circular shape, triangular shape, and so on. This does not matter in the feature and should have nothing to do with the target.

Conclusion

This paper presented a new design of ink tank for large ink supply system (LISS) of printers. It's found that the method of nondimentional similarity is helpful to define the basic configuration of targeted tank. Therefore, by applying method, one tall and narrow ink tank characterized with α=2.88 and β=0.08 was taken as a compact design of space. Subsequently, two main issues were dealt with in the study, which include the minimum residual ink and the ink level detection respectively. Hence, two corresponding features of design were presented herein: (1) Feature of end leg was offered to get the goal of minimum residual ink in use (2) Feature of visible ink level by one transparent window and reading label was provided to meet the need of ink level detection. As a result, the performances for features were nice and satisfactory in the design of in tank.

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Biography

Chin-Tai Chen received his B.S. degree in Engineering Science from the National Chung-Kung University at Tainan of Taiwan in 1992 and an Engineer Degree in Aeronautics&Astronautics from Stanford University at Palo Alto of USA in December,1997. Since 1998 he has worked at Optics-Electronics & System Labs of Industrial Technology Research Institute in Hsinchu, Taiwan R.O.C.. His work has primarily focused on the ink supply system of thermal inkjet printer, including ink reservoir, ink transport,ink level detection and pressure control issue.