

INK FOAMING — WHAT IS THE REASON AND CAN IT BE RESOLVED?

All printers using water based inks will have encountered the problem of ink foaming. It is a costly problem resulting in machine downtime and operator frustration. Ink suppliers are doing their best to provide solutions, and machine suppliers are paying extra attention to the design of ink metering systems — but the problem is never completely eliminated.

The printer first needs to establish if foaming ink really is a problem to the customer — who more likely will complain about colour consistency, register, edge sharpness, not being able to read a bar-code or defects in the print. In this article we will show the results of tests done with different ink suppliers in which we have monitored water based ink foam and the printed colour consistency.

The problem

Flexo water based ink nearly always foams — mostly it goes unnoticed. From time to time it can become a problem. This can happen with any ink on any machine using water based ink. It is more commonly reported on machines equipped with chambered doctor blade systems. The presence of foam means that there are now two ink phases instead of one. The foam phase has a different composition per unit volume of foam to the ink phase. The industry has many explanations for ink foaming, however, there is now proof of some of these explanations and the solutions suggested.

Basics

There are three components involved that have an effect on ink foaming:

- The ink
- The system that holds the ink (ink pumps, pipes and metering system)
- The operator

The ink supplier can influence the formulation to make the ink less sensitive for foaming. The ink system can exacerbate foaming if the ink flow is turbulent or air gets into the ink. The operator can take the wrong action which results in increased ink foaming. When ink foams, it is unlikely that there is only one factor or component responsible. Each of the three components has their own responsibility to create a stable situation that minimises the risk of excessive foaming.

Ink foaming is the enclosing of a gas in the ink. The density of the ink decreases significantly when foaming starts. The viscosity increases when measured using a flow cup. The foaming increases if the operator adds water to reduce the viscosity. If ink is foaming, then measuring the ink viscosity might result in taking the wrong corrective action.

Ink suppliers often advise operators to add antifoam when ink starts foaming. However, this only works if the foam is on the surface of the ink. If the ink foam is evenly distributed (micro foam) throughout, then there is nothing either the operator or the ink supplier can do to correct this.



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There is little known about how ink starts foaming. Common belief is that it is related to the use of chambered doctor blade systems and that it happens at the forward positioned doctor blade. It is assumed that air is pulled into the chamber by the screen roll. It is also believed to be linked to the ink pumping system and ink flow. No information is available about the "gas" that is contained in the foam of the ink when the ink starts foaming. Most materials can foam. Heat is mostly used to start the foaming process. For foam bubbles in a liquid, physics tells us that when a bubble of radius "r" in a liquid of interfacial tension "Y" is formed, the vapour it contains is at a pressure P given by:

$$P = \frac{2 * Y}{r}$$

Heat is used to release vapour from the liquid or solid. The vapour bubbles remain partly captured by the solid to produce rigid foam — in liquids, the bubbles rise to the surface and burst. Part of the chemical components of which water based flexo inks are made resemble soap. The formation of bubbles has been very thoroughly investigated by detergent people who have published many articles on stability of foams in terms of interfacial energy.

What can be done to minimise the risk of water based Flexo ink foaming:

- Minimise the agitation of the ink caused by the system used for ink circulation;
- Minimise unnecessary water addition (by the operator and from the water left in the ink system after wash-up);
- Use an ink formulation that is less sensitive to foaming (eg avoid solids in the ink formulation);
- Have an agreed procedure for maintaining the ink properties (Ink supplier and operators);
- Keep a log of what happens during production. Record the time and event for each individual ink. This log will help to take corrective action when foaming occurs. It also allows you to discuss the event with the ink supplier and/or the supplier of the ink metering system.

The Test

Three ink suppliers were each asked to provide two inks: Black and Green. The ink formulations had to be stable over time and show minimum foaming. Before putting the ink on the machine the ink density was measured and recorded. During the test, the following were measured and recorded:

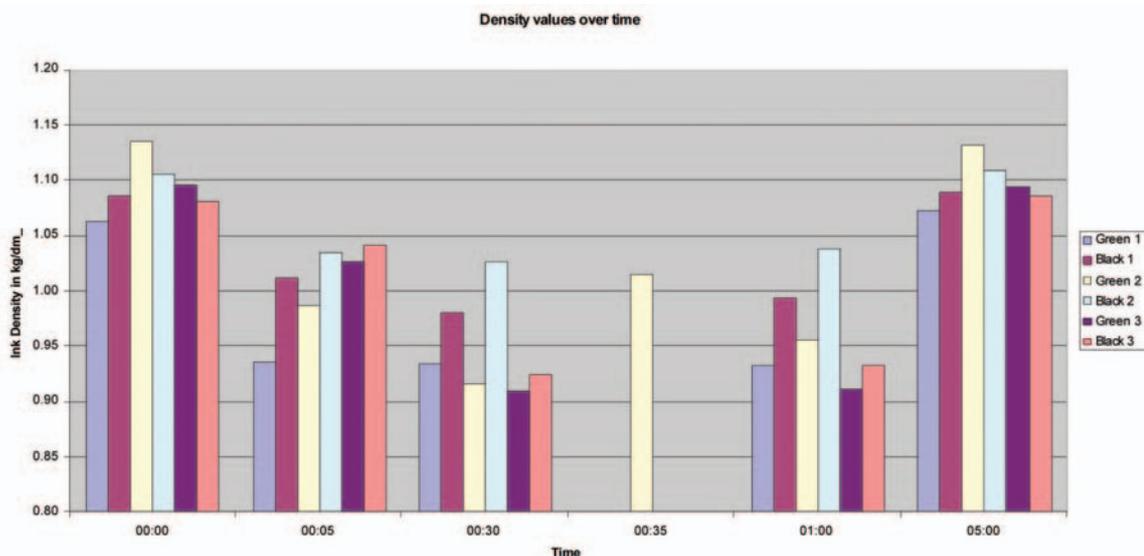
- Printed colour (using a spectrophotometer);
- Paper colour (using a spectrophotometer);
- Ink density.

More than five hours after each test, the ink density was again measured and recorded. Each test was conducted over a production period of one hour at a production speed of 4,000 sheets/hour. The ink density was measured using an Eppendorf Multipet with a 50 ml tip. The 50 ml tip was filled with ink and put on a scale with a resolution of 0.01 g. The scale was set to Zero. 50 ml was dispensed back in the ink bucket and the pipette put back on the scale. The value indicated by the scale was divided by 50, resulting in a value for the density of the ink in g/ml, equal to kg/dm³. The ink suppliers were allowed to make adjustments to their ink. Time of any adjustment was recorded as was the quantity added. At regular intervals, photos of the ink surface in the bucket were taken.

Results

The graph below shows the results of the density measurements.

- All inks dropped in viscosity after a short period circulating in the system.
- The black of Supplier 2 was probably least effected of all inks.
- Supplier 2 made an adjustment, by adding a small quantity of antifoam to the green ink 30 minutes after the start of the test. The impact was visible 35 minutes after starting the test, but disappeared at the end of the test.



- The densities of the black inks dropped less than that of the green inks.
- The inks returned to a similar density five hours after the test compared with the density measured before starting the test.

The colour variation during the test, for the three ink suppliers and the two colours plus the paper, is shown in the graphs below.

- The colour variation for all suppliers was within an expectable level.
 - The green colour variation for Supplier 2 was a result of paper colour.
- It has to be noted that two paper types were used for the board in this test. Supplier 1 was printing on paper type A, Supplier 3 was printing on paper of type B and Supplier 2 had a mixture of paper A and B.

There was ink foaming, as can be concluded from the density measurements, but it did not affect the

printed colour nor were there any problems with the ink related to foam.

The order used for testing was completed running the same ink for four hours adding 1 dm³ of fresh ink every 30 minutes. During this period, the colour printed was stable and foaming did not increase more than was noticed during the test using the inks of the three different ink suppliers.

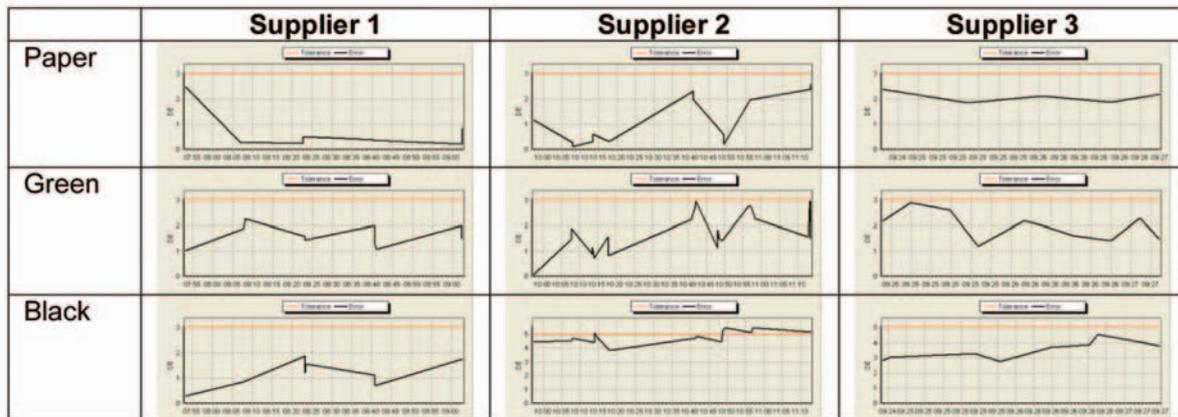
Conclusion

- The inks supplied by all the suppliers for this test foamed.
- The foaming of the ink did not result in a significant colour variation over the time of 1 hour.
- The inks started to foam immediately after the ink system started and the foaming did not significantly change over the testing period.

- Supplier 2 showed that its antifoam was able to reduce the foaming but that this reduction was only temporary.
- The ink density readings taken more than five hours after the tests were completed indicated that ink foam disappeared and that there was an insignificant change in density, not affecting the ink viscosity.

Recommendation

- Add fresh ink at regular intervals (e.g. every 30 minutes) at press viscosity. The ink supplier has to optimise the ink formulations for this.
- Measuring of ink viscosity can be done before ink is put into the inking system, but during production, the viscosity measurement does not provide information for corrective action when ink is foaming.



Below: Photo's of ink surface in bucket:





- Avoid high solids in the ink formulation, especially when chambered doctor blade systems are used.
- Ensure that there is sufficient ink flow through the system.
- The ink system (fittings, pipes, pumps, and chamber) should not have sharp edges. Changes of the inside diameter of the piping should be avoided.
- A good interaction between operators, ink supplier and the design of the ink metering system, together with positive measurable and achievable targets (colour consistency) help overcome problems caused by foaming ink.

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