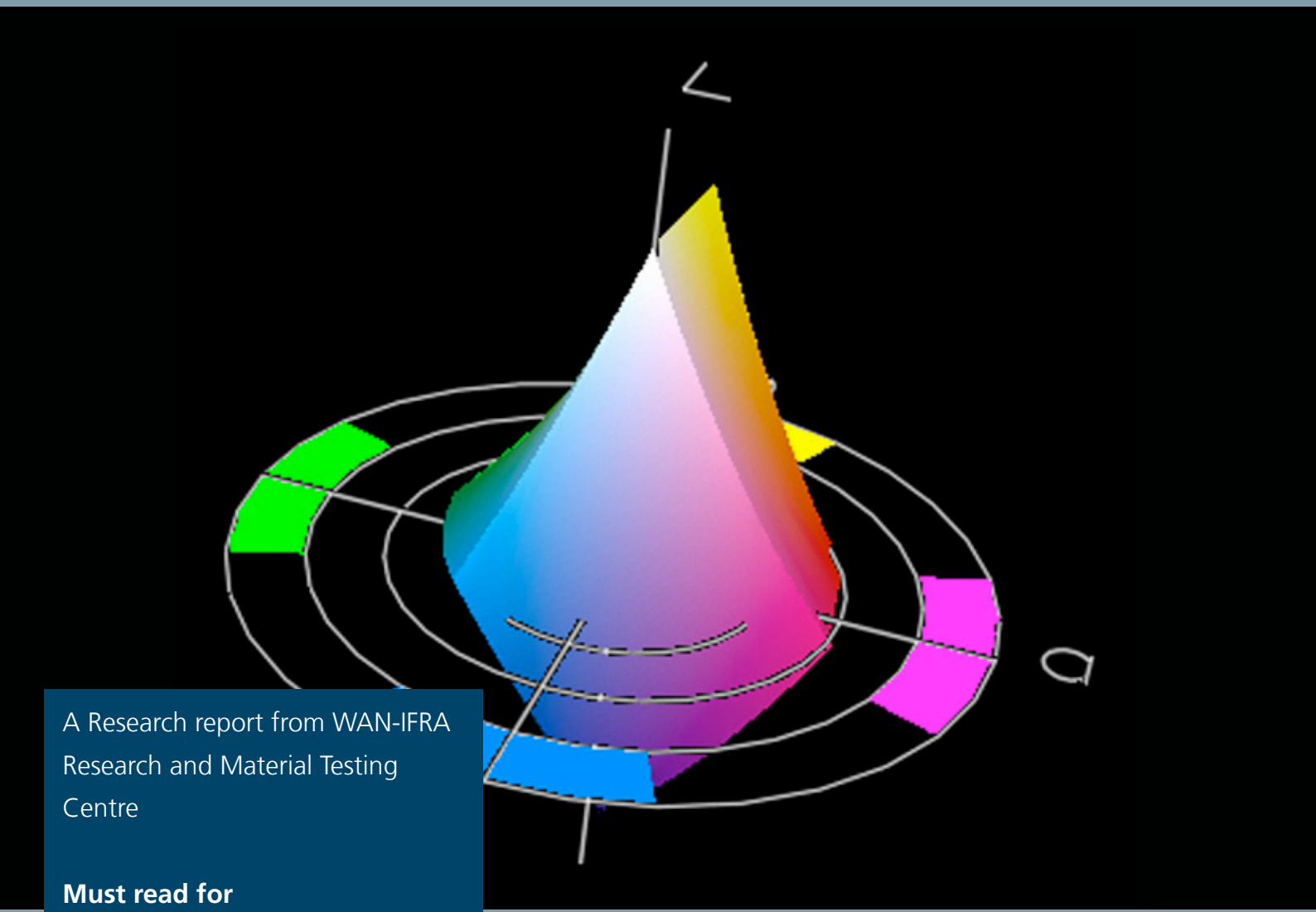
WAN IFRA
World Association of Newspapers and News Publishers

RESEARCH

Reduction of colour gamut after printing in a coldset process



A Research report from WAN-IFRA Research and Material Testing Centre

Must read for

Prepress managers
Production managers
Technical directors
Ink manufacturers
Paper manufacturers

www.ifra.com/testinglab

Introduction:

It is a known fact that the colour gamut of a coldset web offset press reduces over time, the reason mainly being the ink drying behavior and the properties of newsprint. Cold set inks set/dry mainly by absorption. During the drying process, the ink penetrates into the paper substrate and loses its gloss and some saturation. This results in a reduction in colour gamut when compared to a fresh printed sample. At the WAN-IFRA Research and Material Testing Centre, we tried to find out how much the colour gamut reduces over time and what is the effect of different paper and inks on the colour gamut reduction.

For this, we tested three different newsprint samples (45 gsm) and three sets of C, M, Y, K ink samples from different manufacturers. Each paper sample is tested with the three sets of ink samples and each ink sample is tested with three paper samples. We shall call the three paper samples as Paper1, Paper2 and Paper3 and the ink samples as Ink1, Ink2 and Ink3.

Equipments used:

1. IGT printability tester is used to print the samples
2. Colour measurements are done using X-rite 530, D50, 2-degree observer, black backing without polarisation filter.
3. Density measurements are done using X-rite 530, Status E, black backing with polarisation filter.

How the tests are done?

The test paper samples are printed with the test inks using IGT printability tester. ISO standard densities are used, 0.90 for C, M and Y and 1.10 for K. The printed samples are measured immediately after printing. Then the samples are measured 30 minutes after printing, again 24 hours after printing and then 4 days after printing. The samples are measured for both density and colour. The colour gamut is calculated by finding the volume of the polyhedra formed by 8 points i.e C, M, Y, R, G, B, Paper and Mono black.

Findings:

1. The colour gamut reduces by 7% to 12% in the first 30 minutes after printing.
2. The colour gamut reduces by further 6% to 10 % in the next 24 hours.
3. There is no significant change after 24 hours. The colour gamut remains almost same.
4. Though there is a huge reduction in colour gamut, the status E density (with polarisation filter) remains practically the same.
5. Though newsprint plays a major role in ink drying, the percentage of volume reduction in colour gamut mainly depends on the properties of the ink.

Details:

Table 1 shows the reduction of colour space from fresh print to 30 minutes after printing.

	Paper1	*Paper2*	*Paper3*
Ink1	*9.30%*	*6.90%*	*8.95%*
Ink2	*9.61%*	*9.85%*	*8.51%*
Ink3	*10.25%*	*12.82%*	*10.41%*

Table 1

Table 2 shows the reduction of colour space from fresh print to 24 hours after printing.

	Paper1	Paper2	Paper3
Ink1	15.73%	12.69%	14.13%
Ink2	23.32%	22.41%	22.61%
Ink3	18.46%	21.04%	19.77%

Table 2

Ink1 and Ink2 showed similar loss in colour space after 30 minutes while ink3 showed the highest reduction in colour gamut after 30 minutes. However, after 24 hours, Ink1 ended up with the least loss 12% – 16%, followed by Ink3, which lost 18% – 21% and finally Ink2 had the highest loss 22% – 24%. This clearly shows that different inks react differently while drying. It can be concluded that Ink1 is the best (in terms of color gamut reduction) as the reduction in colour space is significantly smaller than the other two inks. However, there is an important factor to be considered before concluding that.

Table 3 shows the volume (CIELAB^3 of the colour gamut of the freshly printed samples

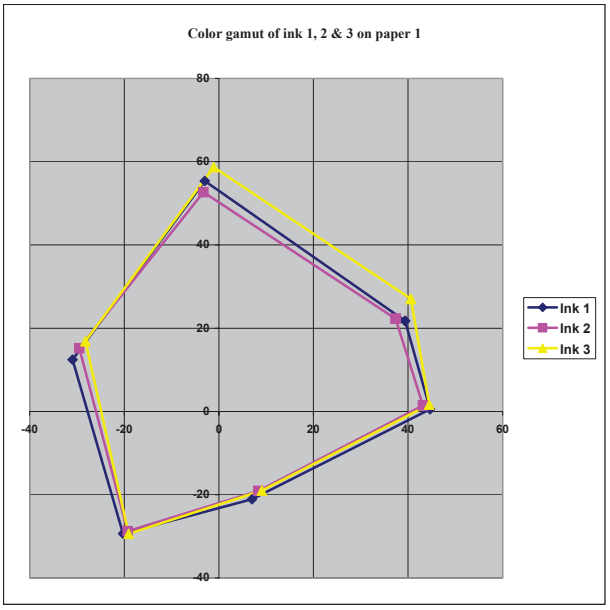
	Paper1	Paper2	Paper3
Ink1	65078	82456	73169
Ink2	67208	87847	76987
Ink3	69935	94127	80511

Table 3

Table 4 shows the volume (CIELAB^3 of the colour gamut of the printed samples after 24 hours.

	Paper1	Paper2	Paper3
Ink1	54839	71993	62831
Ink2	51537	68158	59578
Ink3	57025	74326	64595

Table 4



Pic 1: Colour gamut of all the 3 inks on paper1, measured and plotted 24 hours after print

Ink1 started with the least volume on all the three paper samples followed by ink2 and ink3 produced the highest volume. After 24 hours, ink2 lost around 22% to 24% and ended up with lesser volume than ink1, which lost only 12% to 16%. Ink3, though it lost around 18% to 21% ended up with the highest volume compared to other two inks as it started with a significantly higher volume than the other two inks. If the properties of ink1 and ink3 are combined, i.e. an ink with high pigment strength and lesser reduction in colour gamut over time, then we can have a really bigger colour gamut.

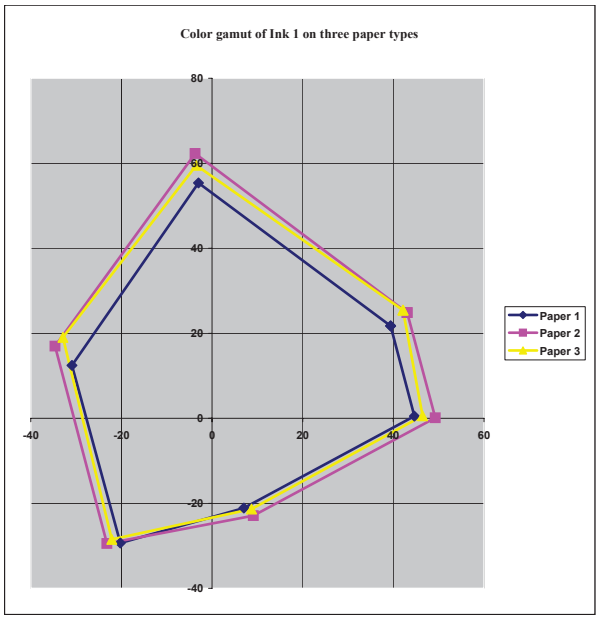
But it has to noted that an ink cannot be formulated with only color gamut as criteria. A good ink should set fast, no set-off, no smearing, less show through and also produce bigger color gamut.

Table 4 is also an example for how different paper shades produce different colour gamut. The three papers that are used for testing were of different shades. Table 5 is the L*a*b* values of the three paper samples.

	*L**	*a**	*b**
Paper1	*77.9*	*0.6*	*1.6*
Paper2	*82.5*	*0.1*	*4.1*
Paper3	*80*	*0.3*	*4.5*

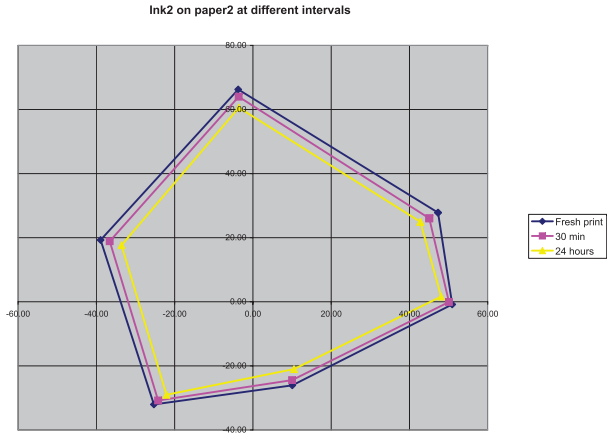
Table 5

From table 5, The difference in lightness between paper2 and paper3 is 2.5 and the diference in colour gamut volume is close to 12%. Paper2 produces around 12% bigger gamut than paper3 and around 30% bigger gamut than Paper1. Hence, brighter is the paper shade, bigger is the colour gamut.



Pic 2: The difference in colour gamut between three paper types when printed with same ink

The volume of colour gamut for all the three inks in three papers remained almost same when measured after 4 days as compared to what we measured after 24 hours. At some instances, there was 1 to 2% loss.



Pic 3: Reduction in color gamut over time

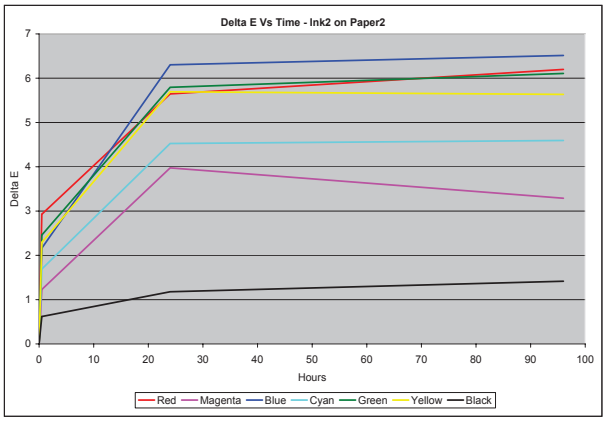
Moreover, no tables here give any relation as if a particular paper always resulted in more/less reduction in colour gamut. Therefore, we suggest that though newsprint plays a crucial role in ink drying, irrespective of the newsprint type, the volume of reduction in colour gamut is mainly dependent on the properties of the ink.

A newspaper usually reaches the readers in 6 to 8 hours after it is printed. It is very important to know how much the colour gamut reduces in 6 to 8 hours time. Though we could not do the measurements after 6 to 8 hours for all the paper and ink combinations, we did the measurement six hours after printing for ink1 on paper3. The colour gamut reduced by 12% after 6 hours and lost a total of 14%, 24 hours after print. It is only a minor reduction after 6 hours. So we suggest that most of the gamut reduction occurs within 6 to 8 hours and then it

slows down.

Change in Delta E over time:

Pic 4 shows the change in Delta E over time for ink2 on paper2.



Pic 4: Change in Delta E over time

What we analysed is that the secondary colors i.e Red, Green and Blue showed the highest Delta E variation over time compared to the primary colors

Change in density over time:

Table 6 shows the reduction of density over time of Ink1 on paper1

	C	M	Y	K
Fresh print	*0.89*	*0.92*	*0.91*	*1.09*
30 Minutes	*0.87*	*0.90*	*0.90*	*1.09*
24 Hours	*0.86*	*0.88*	*0.88*	*1.08*
4 Days	*0.86*	*0.88*	*0.87*	*1.06*

Table 6. Status E density with polarisation filter

As per table 5, Density reduces around 4% after 4 days. In other paper and ink combinations, the density reduction is similar or even lesser. The only problem we found is with the Cyan of ink2 which reduced by 6 to 7% in density while the M, Y and K practically remained the same even after 4 days. We are not sure whether there is a problem in the ink vehicle or it is the property of the Cyan pigment used.

Conclusion:

The process of ink drying continues for a long time after printing. So whenever we measure copies for standardising the printing process, we have to give sufficient time for the ink to dry completely. However, after 24 hours we can safely assume that the colours will not change much. So publishers who participate in competitions like INCQC and BIP has to measure their copies after giving sufficient time for drying. The favourable part is the densities of ink remains almost the same from fresh print to dried print. So it should be easy for controlling the quality of reproduction using solid ink densities.

It is also interesting to note that the composition of the ink plays a crucial role in the amount of loss in colour gamut. So a detailed study over the raw materials used for ink manufacturing is necessary to find out the best raw materials that produce least loss in colour gamut.

For more information please contact
Anand Srinivasan
Research Engineer
WAN-IFRA
E-mail: anand.srinivasan@wan-ifra.org
www.ifra.com/testinglab
Phone: +91.44 4211 0640