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Vegetable oil based Newsinks and their Printability Properties and Deinkability

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ABSTRACT

Two to three years ago the wave of soya-bean oil based newsinks entered the European continent from the USA, where these inks had been claimed to be superior to mineral oil based newsinks, especially in 4-colour printing, and this in addition to the fact that this material is a regrowing one that is also highly environment-friendly.

First tests of European ink manufacturers showed more negative than positive results, though printers seemed to be happy with these newly developed inks in their daily work. That is why ink manufacturers looked for more economic alternatives to soya-bean oil, like linseed, rapeseed and tall oil, to meet the cost requirements as well.

To clarify the situation and to present its members test results which are based on scientific investigations of independent research institutes, IFRA and NATS decided two years ago to initiate the project about which this report will inform in the following.

In general it is shown that the differences are not as great as claimed before. Emulsification behaviour is one parameter where vegetable oil based newsinks show advantages over mineral oil based newsinks. Larger differences in relative contrast and print-through occured when the super-concentration of pigments entered the game.

At this time there is no explanation available why deinkability with flotation (DEM values) fall so much after around 3 months of aging of the samples and why some mineral oil based newsinks are following the same pattern. The only conclusion in this respect which can be drawn is that even mineral oil based inks differ very much from each other in their basic compositions.

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1. Introduction

In 1980, after the second gasoline shortage, the ANPA Board of Directors asked their Technical Research Department to develop non-petroleum inks to secure member newspaper printers a supply of newsinks. The new inks should:

- Resist rub-off.
- Consist of non-petroleum ingredients.
- Be environmentally safe.

An ink chemist was hired to develop this new product. A laboratory as well as a pilot plant were established.

Initially an ink based on a tall oil, which is a side product from chemical pulp production, was developed. In 1983 patents were obtained for ink based on tall oil fatty acid. Trial runs were performed in letterpress and offset with tall oil based ink and gilsonite based ink, in both cases pigmented with carbon black.

In 1986, a soya-bean oil based newsink was developed. The purpose of changing to soya-bean oil was that soya-bean oil is a much more available and faster growing source in the U.S.

The American Soybean Association was very interested as there was a large surplus production. The production of soya-bean oil in the U.S. today is about 10-15 billion pounds annually but varying from year to year — the last two years showed low harvest. At present the amount for newsinks is approximately 3% of the total soya-bean oil production.

The technical experiences in the U.S. are good and the demand for regrowing sources for raw materials is increasing, which are reasons for testing several types of vegetable oil based newsinks. The organizations IFRA and the Scandinavian Newspaper Technical Cooperative (NATS) have initiated this project.

The approach for comparing the different types of newsinks was made in two major steps:

- Laboratory tests were performed on nine samples of European newsinks based on vegetable oils. These tests included rheology, emulsification behaviour, surface energy, and laboratory printing tests (ink requirement, colour strength and rub-off).
- Full scale testing at two newspaper print sites. Tests were performed on the printed matter, where density levels, relative contrast, print-through, set-off, rub-off, and a subjective evaluation was included. Furthermore, deinking tests were performed on four printed samples from a full-scale test in Tampere.

The project has been performed as a commission of IFRA and NATS at the Nordic Institute for Coatings Research (NIF). The Graphic Arts Laboratory of the Technical Research Centre of Finland (VTT/GRA) has been working as a subcontractor to the project.

The project leadership has been taken care of by Eva Wallström, M.Sc. (NIF, now EnPro ApS), who also has been responsible for the printing trials in Denmark. The rheological measurements were performed by Erik Jensen, B.Sc. and the laboratory measurements by Annette Jensen.

Ulf Lindqvist, Dr.tech, acted as contact person at VTT/GRA. Hannu Linna, M.Sc, and Pertti Moilanen, M.Sc., were responsible for the printing trials in Finland, and Anneli Kartunen, M.Sc., was responsible for measurements of surface energetics and emulsification.

Due to the liquidation of NIF, which closed August 1st, 1990, the final report was compiled by Eva Wallström at EnPro ApS, which is a private laboratory in Copenhagen. EnPro ApS is working with research and development within the printing ink field as well as calculation/modelling methods for technical properties of blends containing solvents and polymers.

The project has been accompanied by a working group with the following members:

Boris Fuchs, IFRA, (D) Chairperson
William Hansen, Drubin-Lorilleux A/S (now DDPFF), (DK)
Erik Jönsson, NATS, (S)
Matti Kuusela, Aamulehti Newspaper, (SF)
Peter Menzel, Hostmann-Steinberg, (D)
Juha Punnonen, IFRA, (D)
Ingrid Quarnström, Stora Paper Technology, (S)
Michael Brinckmann, Siegwerk Farbenfabrik, Siegburg (D)
Björn Svedheim, NATS, (S)
Anthony McEwen, Blekinge Läns Tidning, (S)
Herbert Janser, Wifag Printing Press Manufacturing, (CH)
Maurits Roosen, Vlaamse Uitgevermaatschapij, (B)

The following companies have contributed to the project by offering experience, test performance, materials, and press time free of charge:

Aamulehti, Tampere, SF
Fredriksborg Amts Avis, Hillerød, DK
Hostmann-Steinberg, Celle, D
Drubin-Lorilleux Trykfarver A/S, Skovlunde, DK
Magenta, Espoo, SF
Winter, Tampere, SF
United Paper Mills, Kaipola, SF
Trenal SA, Lessines, B
Stora News, Falun, S
Blarke & Mahrt, DK

IFRA and NATS are greatly indebted to the members of the working group for valuable comments, advice and positive critisism during the entire project, as well as to the contributing companies for their valuable support.

2. Technical Experiences

The aforementioned ANPA inks have been produced by several ink companies and tested in many newspaper printing plants.

The common experiences in the U.S. are that the coloured newsinks based on soya-bean oil are as good as the conventional mineral oil based newsinks. Some claim that the coloured inks based on soya-bean oil are even better, they have reduced rub-off, offer better mileage and greater (improved) colour reproduction.

Besides this, the cost-quality parity exists between soya-bean oil based newsink and conventional newsink.

The rub-off was one of the greatest problems that ANPA tried to reduce/solve with its development. Table 2.1 shows some rub characteristics between the first patented ANPA-INK (based on tall oil) and a conventional newsink.

Commercial regular newsink	10.0
ANPA-INK 247	3.4

Table 2.1: Three hour rub-off values of newsink letterpress type. The rub-off test was developed by ANPA-NAPIM. (Measured by a Techni-Brite reflectometer)

The mileage p-oved to be very high and the runnability showed no problem. The ink carried a high percentage of pigment but still it had a good flow characteristic (if the mileage was reduced to a conventional ink the print became "brown"). Listed in table 2.2 are rub-off values relating to conventional low rub ink for offset and an ANPA-INK for offset based on soya-bean oil.

ANPA-INK, Offset, Black	11.3
Low Rub ANPA-INK, Offset	4.3
Typical Commercial Low Rub Ink	3.8
Control Standard Newsink	14.8

Table 2.2: ANPA-INK soya-bean oil based newspaper offset and commercial offset rub-off values. The rub-off test was developed by ANPA-NAPIM. (Measured by a Techni-Brite reflectometer)

For the soya-bean oil based ink the viscosity is increasing rapidly in a few minutes, but it showed no print-through or strike-through as has been seen before with some conventional inks.

The Michael Huber GmbH has verified whether there are advantages of using soya-bean oil based newsinks instead of mineral oil based newsinks in Germany. Michael Huber GmbH tested black inks. The conclusion was that it is not possible to confirm that a black ink based on soya-bean oil should be better than a conventional black Coldset newsink.

Hostmann-Steinberg performed their first test in December 1987, and it was very satisfying, where 30,000 issues were printed without problems. Deinking tests (flotation) showed that soya-bean oil based newsinks have good de-inking properties.

As a conclusion it can be said that vegetable oil based newsinks seem to have some technical advantages, as well as environmental advantages, which mainly are low rub-off and good colour reproduction. Concerning black vegetable newsinks there are no evident technical advantages. The choice of vegetable oil will not be based only on technical advantages but also on the home market situation.

2.1 Production of vegetable oils

From 1950-87 the world production of vegetable oils and fats nearly quadrupled, while the world production of animal oils and fats in the same period only doubled (table 2.3).

Year	Vegetable oil and fat	Animal oil and fat (incl. fish-oil)	Total
1950	13.9	9.3	23.2
1960	18.6	13.6	32.2
1970	26.2	13.9	40.1
1980	43.2	17.3	60.5
1985	49.4	18.8	68.2
1987	52.8	19.7	72.5

Table 2.3: World production of natural oil and fat (mio.t.).

The world production for the 17 most important oils and fats [1] for nourishment and technical purpose has increased during the last 37 years from 23.2 mio.t. to 72.5 mio.t.

[1] the 17 most importants oils and fats: Soya-bean oil, linseed oil, sunflower oil, rape-seed oil, groundnut oil, gingili oil, olive oil, palm oil, palm nucleus oil, coconut oil, butter, lard, fish oil, castor oil, wood oil, tallow/fat from animal bodies.

Of a production in 1987 of 72.5 mio.t., vegetable oils represented 73%, of which 71% were edible and 2% non-edible, (terrestrial) animal fats represented 25%, while (sea)animal oil represented 2%. Of the total production 15% were chemically used, 19% went to consumption production, 60% became nourishment and 6% feed stuff.

Vegetable oil and fat with a chain length of at least C16 amount to 800,000 t/year. Most of it has to be imported from countries outside Europe. Europe itself produces nearly 300,000 t, of which the main part comes from sunflower oil and erucic low-acid rape-seed oil.

Ricinoleic and rape-seed oils come from East-Europe, Brazil and India, while the oil-fruits (linseed, soya-bean) come from Canada, USA, China, Brazil and Argentina.

By making an analysis of the production outlook for the most important vegetable oils and fats (see table 2.4), it is shown that the greatest increase is expected to be for palm oil.

Year	Soya oil	Palm oil	Sunflower oil	Rape oil	Total
1958-62	3.3	1.3	1.9	1.2	29.1
1963-67	4.0	1.4	2.9	1.4	34.0
1968-72	5.9	1.8	3.6	2.0	39.6
1973-77	8.5	2.8	3.7	2.5	45.4
1978-82	12.6	4.5	4.9	3.8	56.2
1983	13.6	5.3	6.1	4.9	62.6
1984	13.3	6.2	5.9	5.2	63.8
1985	14.0	6.9	6.6	6.1	68.7
1986	14.3	7.6	7.1	6.5	71.6
1987	15.5	7.8	7.1	7.4	72.5
Prognosis					
1988-92	17.3	10.4	6.8	6.3	75.5
1993-97	19.2	13.9	7.4	6.8	84.4
1998-02	22.3	18.0	8.0	7.9	95.2
2003-07	23.5	22.6	8.5	8.1	104.5

Table 2.4: Total production and production outlook for selected oils and fats (world production) in mio.t.

The prognosis for the production development is based on the existing production area, further planned plantations and a fixation of the limits of the oil content by improvements of the sorts.

In table 2.4 it is shown that soya-bean oil, since the end of the seventies, has contributed with over 20% to the total production.

A comparison of the world production of oils and fats and the prognosis with the production of soya-, palm-, sunflower- and rape-seed oil shows that there seems to be an increasing part of the world production for the four above mentioned oils.

As a conclusion we may say that the possibility for using vegetable oils is good, especially when considering that the experiments with vegetable oils have produced remarkable results, especially in view of the short time spent for research and development. There is still much R&D to be done, in particular for the black inks.

2.2 Description of some important vegetable oils

Linseed oil is a drying oil from seeds of the flax plant (Linum usitatissimum). Many countries in Europe, as well as Canada, Argentina, U.S.S.R. and India are the main producers of linseed oil.

There are many different flax plants with a great different percentage of oil content all depending on the growing conditions. For most purposes a linseed oil with a linoleic acid content of 50% and a iodine value of 170-190 is used. The composition of linseed oil is typically 5% diunsaturated-monounsaturated, 43% monosaturated-diunsaturated and 52% triunsaturated glycerides. The majority of the glycerides contains on average 7 double bonds in every molecule.

Most of the refined linseed oil is used in the technical preparation of paint. A smaller part — especially the cold squeezed — is used in the Middle- and East European countries as food oil (edible oil).

The linseed oil has a characteristic smell and taste. By heating the refined oil to 260-285°C, a stand oil is produced, which is used for special purposes, in paint and ink, e.g.

Soya-beans (and groundnuts) belong to the legumine-family and is one of the most important oil-plants. The soya-bean comes originally from China, where it belonged to the oldest cultivated plant. Another place was Manchuria, but from 1942 the U.S. has produced more than China. Brazil is also one of the main countries for growing soya-beans.

There is a great number of different sorts of soya-beans. In the U.S. alone there are at the moment 73 different sorts in a 80 km. broadly area (Northern latitude). Refined soya-bean oil is light yellow and has a mild taste. The saponification value is between 188-195 and a iodine value of 120-136.

The refined soya-bean oil has a fatty acid composition of 60% tri-unsaturated glycerides, 30-35% di-unsaturated glycerides and up to 5% mono-unsaturated glycerides.

The world production of soya-bean oil is mainly used as edible oil (salat- and mayonnaise oil). For margarine, non-hydrogenated soya-bean oil is used but only in a concentration up to 20%, because of the change in taste that occurs with time.

Soya-bean oil is a semi-drying oil, which can also be used in combination with e.g. wood oil and some part in alkydresin for paint purposes.

The extraction of soya-bean oil has been increasing, in 1960 amounting to 3,800,000 t, in 1965 4,850,000 t and in 1972/73 close to 7,900,000 t. In table 2.4 the productions from 1958 to 1987 are specified and the production outlook towards year 2007.

Sunflower oil is a seed oil of Helianthus annus, which grows in abundance in many parts of the world. It can only be regarded as a semi-drying oil, but has the useful property of being non-yellowing. In composition it is very like soya-bean oil.

Rapeseed oil is obtained from the seeds of the species Brassica which is being cultivated mainly in Canada, Poland, Sweden, Germany, U.S.S.R., France, China, India and Pakistan and some East European countries.

The quality of the rapeseed oil has been considerably improved in the last years through breeding research and cultivating (culture-) and harvesting methods.

The fatty acid composition of rapeseed oil glycerides contains about 54% monooleo-dierucin, 28% dioleo-monoerucin and 18% mono-unsaturated oleo-erucin. The oleo connection contains also linoleic acid and 7-9% linolenic acid. For rapeseed oil the saponification value is 174-182 and the iodine value is 90-130.

The refined rapeseed oil is light yellow and is used in salad oil, edible fat, glazing fat and margarine (it doesn't change taste with the passage of time). By more treatments rapeseed oil (the erucic acid) can be used as starting material for lubricates and as defoamer in synthetic detergents. The productions and the production outlook for rapeseed oil to year 2007 are shown in table 2.4.

Tall oil is the name for a number of products obtained from the manufacture of wood pulp by the alkali (sulfate) process or more popularly known as the kraft process.

Crude tall oil is a dark brown mixture of fatty acids, rosin, and neutral materials liberated by the acidification of soap skimmings. The fatty acids are a mixture of oleic acid and linoleic acid with smaller amounts of saturated and other unsaturated fatty acids. The rosin is composed of resin acids similar to those found in gum and wood rosin. The neutral materials are composed mostly of polycyclic hydrocarbons, sterols and other high-molecular weight alcohols.

The production of crude tall oil is found in USA, Sweden, Finland, Austria, Poland, etc. The composition of crude tall oil varies a lot as well as the wood quality varies from country to country.

Distilled or acid refined tall oil are qualities that can be used in paint and ink production. The distilled quality is obtained by distilling crude oil in fractionating equipment under reduced pressure and under such conditions that the ratio of rosin acids to fatty acids is varied over a wide range.

Acid refined tall oil is produced by treating crude tall oil in solvent solution with sulfuric acid under controlled conditions to remove dark colour bodies and odoriferous materials. Removal of the solvent yields a product with lighter colour and higher viscosity than crude oil with approximately the same fatty acids-to-rosin ratio.

The most important quality is the distilled tall oil and the world destillation capacity is about 650,000 tons.

3. Laboratory Report

In this project 8 black newsinks, based on vegetable oils, and 3 black newsinks, based on mineral oil, were tested in the laboratory. The newsinks were supplied by different European ink manufactures. In table 3.1 the names and types are listed together with a code for each newsink.

Ink	Ink code	Ink type
Magenta 25-76500	1	Finnish standard newsink
Winter 2062-3556	2	Soya-bean oil based newsink
Winter 2062-3557	3	Tall oil based newsink
Winter 2062-3558	4	Linseed oil based newsink
Trenal 22 535	5	Linseed oil based newsink
Hostmann 669708/16	6	ANPA-INK
Hostmann 48 R 3360 09	7	German standard newsink
Hostmann 49 RK 5050 19	8	Super-conc. soya-bean oil based newsink
Lorilleux DK-31	9	Danish standard newsink
Coates Colset	10	Rape-seed oil based newsink
Lorilleux A99318104	11	Rape-seed oil based newsink

Table 3.1: Names, codes and types for the tested newsinks.

3.1 Viscosity

The viscosity of the inks was measured on a falling rod viscosimeter (Laray) and a cuvette type viscosimeter (Bohlin VOR).

The measured results have to be corrected for the temperature and values at 25°C. The shear stress and the shear rate had been plotted in diagrams. By using linear regression it is possible to estimate the viscosity of the ink, see table 3.2.

Ink code	Average viscosity Poise	Std. dev.	Viscosity, Poise (P=27455 dyn/cm)
1	24.1	0.4	25.0
2	27.5	1.1	29.4
3	33.5	0.7	33.7
4	26.7	0.2	28.5
5	64.2	1.6	91.2*
6	32.6	1.6	32.6
7	40.6	0.4	41.7
8	9.4	0.3	10.2
9	48.8	0.7	58.5
10	51.2	2.9	53.5
11	69.2	2.4	81.8

Table 3.2: Viscosity measured on Laray.

* = (P=32340 dyn/cm)

3.2 Tack

The tack of the newsinks was measured on a DIAF-tackmeter. The tests were carried out in an airconditioned room at 23°C and 50% RH. In table 3.3, the results for 2 velocities are tabulated.

Ink	Temperature (°C)		60 m/min		180 m/min	
code	to*	ts*	up	down	up	down
1	23.8	24.2	1.7	1.8	2.4	2.4
2	25.2	25.6	2.2	2.2	3.0	3.0
3	23.2	23.8	3.0	2.9	4.4	4.4
4	24.6	24.9	2.2	2.2	2.9	2.9
5	24.8	25.1	2.1	2.1	2.6	2.6
6	23.3	23.6	2.1	2.2	2.8	2.8
7	24.7	25.1	2.0	2.3	3.1	3.4
8	23.8	24.2	1.1	1.3	1.4	1.4
9	25.2	25.4	2.2	2.3	3.1	3.2
10	24.0	24.2	3.2	3.7	4.8	5.1
11	24.2	24.5	3.1	3.2	4.4	4.5

Table 3.3 Tack measured on DIAF-tackmeter.

to = temperature in the beginning; ts = temperature at the end.

In addition to the tack measurements on DIAF, tack measurements have been carried out on a Prüfbau Inkomat 364 at Drubin-Lorilleux (DK). Also these measurements are reported at 2 velocities, and for the highest of them 2 times. If there is a significant difference of the value at 1 and 10 minutes, this is a measure for the drying of the ink.

Ink code	Temperature (°C) room	system	50 m/min 0 min	200 m/min 1 min	10 min
1	24.5	24.8	2.2	4.9	4.9
2	24.5	24.8	1.7	4.0	3.8
3	24.6	24.7	1.5	3.7	3.5
4	24.7	24.7	1.9	4.6	4.3
5	24.4	24.7	2.2	4.2	4.2
6	25.1	25.1	1.6	3.6	3.7
7	24.2	24.7	1.6	3.6	3.8
8	25.2	25.3	0.9	1.8	2.2
9	24.0	24.7	1.8	4.1	4.3
10	24.1	24.8	2.0	5.5	5.9
11	24.4	24.7	1.2	2.8	2.9

Table 3.4: Tack measured on Prüfbau Inkomat 364 (Lorilleux).

3.3 Emulsification tests

The emulsification tests were carried out by mixing first 50 g ink and about 50 ml fountain solution for 1 minute. The amount of water emulsified in ink was determined by weighing the ink sample after pouring the surplus water back into the water vessel (the total amount of fountain solution was 200 ml at the beginning of the test). The test was continued by adding 50 ml water to the ink vessel and mixing for 1 minute. This procedure was repeated until 10 minutes mixing time and correspondingly 10 levels of emulsification were reached.

This kind of emulsification test is based on the Surland method and is performed by means of a DUKE Ink-Water Emulsification Tester.

This test is widely used and has been proposed for an ASTM Standard Test Method. This proposal supposes the use of the DUKE-tester or modified Sunbeam Mix Master as a mixer.

According to Surland typical emulsification curves can be classified into 5 classes (A,B,C,D,E) which are shown in Figure 3.1. The curves A and E which are nearly straight line functions, indicate poor performance. If the Y-axis represents full mixibility between two phases (ink and fountain solution) and the X-axis represents absolute repellency between the phases, one can suppose the ink A to scum, i.e. to transfer to image and non-image areas indiscriminately whereas the ink E will not produce an image at all.

B-type inks show a rather narrow water balance, printing with a tendency to dot spread, mottled solids and low print density. Due to narrow water balance the feed of ink and fountain solution has to be readjusted frequently on the press. Attempts to increase the print density will often result in scumming.

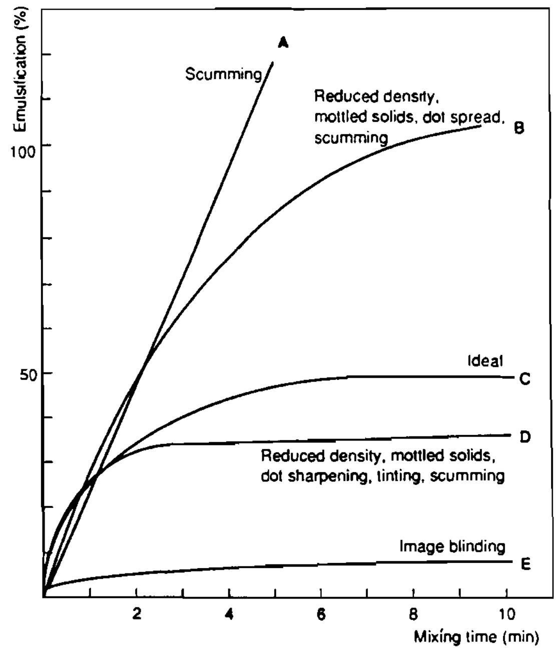

Figure 3.1: Typical emulsification curves according to Surland.

The C-type inks represent the ideal behaviour on the press with wide water balance. D-type inks have a very narrow water balance with tendency to tinting, dot sharpening, solid with high contrast mottling and low print density. Scumming can also occur if the print density is increased. As described above, the water take-up of the ink was measured as a function of the mixing time. Table 3.5 give the results of these tests. The fountain solution used in these tests was Vadic Wet-74 in the concentration 3 volume-% (the same as used at Aamulehti).

Ink	Ink code	Emulsification (%) Mixing time (min)										Emulsification rate
		1	2	3	4	5	6	7	8	9	10	x = 1 min
Magenta 25-76500	1	33.1	46.4	58.8	71.0	76.1	81.1	86.8	87.2	88.1	92.9	15.68
Winter 2062-3556	2	13.4	15.4	17.8	20.0	21.3	23.1	22.6	24.7	26.7	28.1	4.10
Winter 2062-3557	3	3.8	6.0	8.8	7.9	10.0	10.8	11.4	13.1	14.9	13.6	2.25
Winter 2062-3558	4	11.3	11.6	12.9	14.8	16.5	16.9	17.8	18.4	19.8	19.9	2.88
Trenal 22535	5	12.5	19.1	24.8	29.9	31.9	35.0	35.2	37.9	40.1	47.5	6.97
Hostmann 669708/16	6	32.1	38.6	43.4	46.9	51.4	52.9	54.7	54.8	57.7	62.4	8.99
Hostmann 48R336009	7	26.1	27.1	39.0	40.7	51.1	57.5	65.8	68.5	72.9	74.1	11.60
Hostmann 49RK505019	8	6.3	6.3	6.5	9.0	10.7	12.2	13.9	16.2	16.7	20.4	2.61
Lorilleux DK-31 standard	9	37.6	44.3	54.2	63.1	69.2	76.8	82.9	87.2	90.9	95.9	15.10
Coates Inks Coldset	10	37.6	41.3	38.2	39.5	42.2	44.3	45.7	47.7	49.1	51.5	4.66
Lorilleux A99318104	11	46.1	55.3	60.3	65.9	62.4	64.3	66.8	69.5	70.8	73.3	8.62

Table 3.5: Results of the emulsification tests.

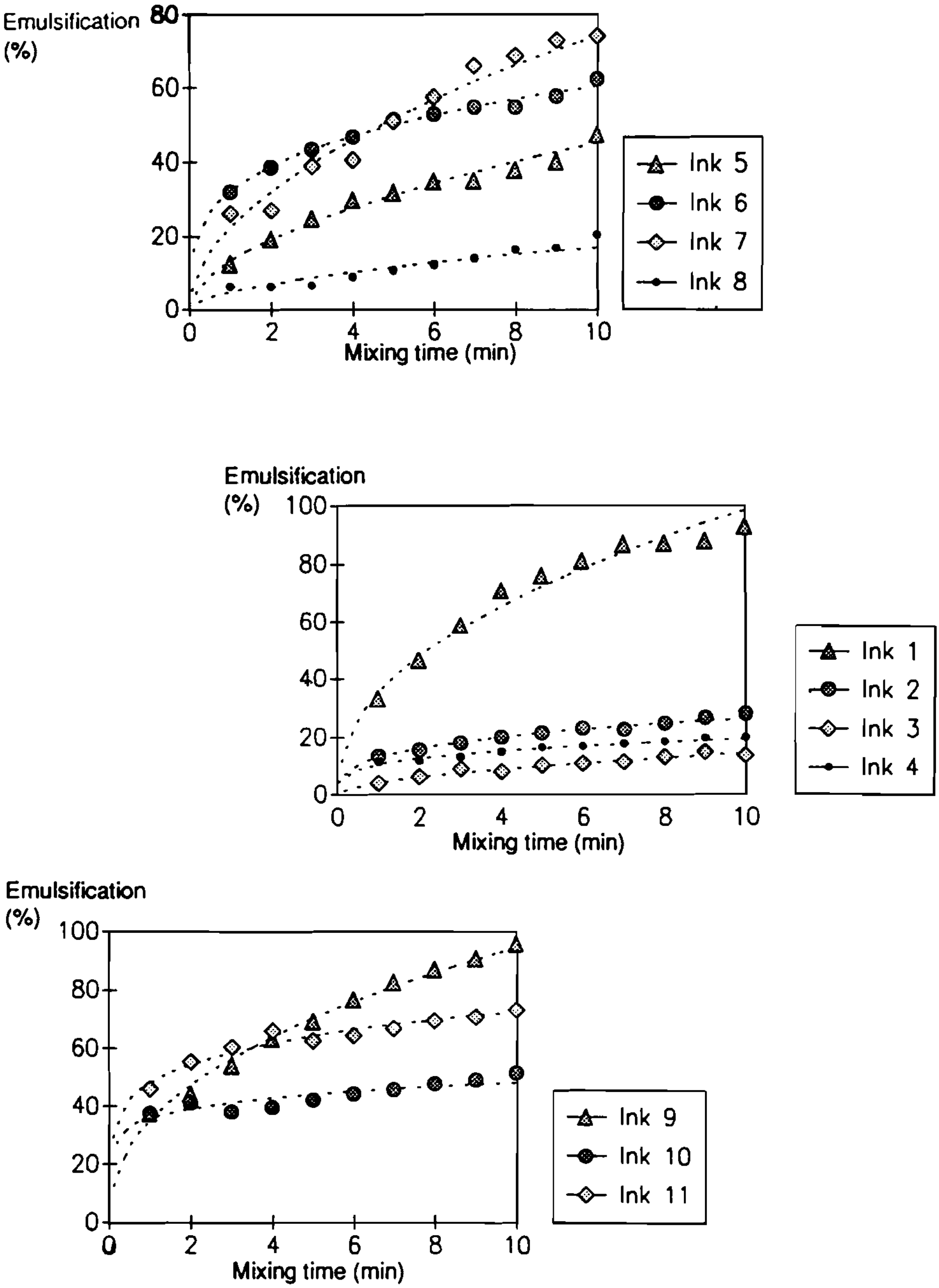

Figure 3.2: The dependence of emulsification on mixing time.

The dependence of water take-up on mixing time is shown in Figure 3.2. As can be seen. the behaviour of inks is different. All the emulsification curves can be considered logarithmic functions of mixing time (formula: y=kxb), and the fitted curves can be seen in the charts.

To describe the rate of emulsification, the derivatives of the curves at x = 1 minute have been calculated, and can be found also in Table 3.5. The strongest emulsification tendency was found with the inks nos. 1, 6 and 7 and the weakest with the inks 3, 4 and 8.

3.4 Surface energy of inks

The surface energy of inks – including its dispersion and polar components – was determined using Kaelble's method. A drop of test liquid is placed on the ink surface and the contact angle of the drop is determined by Lorenzen & Wettre's Contact Angle-instrument. These test liquids range from completely nonpolar (n-hexadecane) to highly polar (water) in surface tension properties. The surface energies of the inks were calculated by a computer program, based on algorithms given by E. Sacher.

Table 3.6 shows the results of the surface energy measurements which have been carried out using the contact angle method. The largest values of surface energy (about 40 mN/m) were obtained with the inks 2, 3 and 8.

Ink code	Film thickness (D=0.95) g/m²	Film thickness (D=1.1) g/m²
1	1.12	1.21
2	0.89	1.26
3	1.11	1.4
4	1.04	1.27
5	1.04	1.35
6	1.00	1.3
7	1.02	1.26
8	0.73	0.96
9	0.82	1.09
10	0.86	1.08
11	0.96	1.27

Table 3.6: The ink film thickness at the density 0.95 and 1.1.

3.5 IGT printing tests

All inks were printed on a standard newsprint, grammage 40 g/m^2, from Yhtyneet Paperitehtaat Oy, Kaipola. The test prints were performed on an IGT tester using 1 m/s, impression 20 N/mm. The ink film thicknesses were chosen to be between 0.7 to 1.3 g/m^2.

The density was measured after at least 48 hours with a Gretag densitometer and the colour measurements were performed on an Elrepho DFC 5 spectrophotometer (C illumination, 2° observer).

3.5.1 Relationship between density and ink film thickness

In table 3.6 the ink film thickness to achieve a density of 0.95 and 1.1 is tabulated.

3.5.2 Relative colour strength

Both the Y-value and CIE-Lab values were measured.

The relative colour strength is defined as the film thickness which is necessary to gain a certain reflection for the print, with blacks only the Y-value is used. This film thickness is reported as a percentage (%) of a standard print reflection.

The colour strength was calculated with the Finnish and the Danish standard newsink as reference at two different reflection levels. Also the average of these two levels is calculated, see table 3.7.

Ink code	Average colour strength relative to Danish standard newsink	Average colour strength relative to Finnish standard newsink
1	0.72	1.00
2	0.79	1.09
3	0.76	1.05
4	0.64	0.88
5	0.75	1.03
6	0.80	1.10
7	0.79	1.09
8	0.78	1.07
9	1.00	1.38
10	0.85	1.17
11	0.79	1.10

Table 3.7: Relative colour strength, an average at Y-value 11.5 and 13.03, against the Danish and the Finnish standard newsink, for the different samples of ink.

3.5.3 IGT printing tests on rub-off

The paper used in these laboratory scale printing tests was a standard newsprint, grammage 40 g/m^2, from Yhtyneet Paperitehtaat Oy, Kaipola. The tests were performed on an IGT tester using the printing speed 4 m/s, impression 20 N/mm and a rubber roller. The set-off paper slip was printed simultaneously. After 4 hours from the printing the rub-off tests were carried out with a Patra device (100 revolutions with a pressure of 0.2 N/cm^2). All the density measurements were done using an Elrepho device equipped with the FMY/C filter.

The results of the IGT printing tests can be seen in Table 3.8. All the properties have been measured at the density level D 0.95 on the standard newsprint.

As can be seen, two inks (nos. 3 and 8) deviate significantly from the others. Their ink requirements at the density level of 0.95 are nearly twice as high as for the other inks. And as a consequence, they also show high set-off values. Despite that the rub-off values of the inks do not correlate with set-off or ink requirement. The reason for the differences in ink requirement compared to results reported in chapter 3.5.1 must be due to variations in colour/hue. The ink requirement curves of the tested inks are shown in Figure 3.3.

Ink	Ink code	Ink requirement (D 0.95) (g/m^2	Print through D	Rub-off D	Set-off D
Magenta 25-76500	1	1.70	0.070	0.070	0.44
Winter 2062-3556	2	1.82	0.080	0.050	0.57
Winter 2062-3557	3	2.99	0.090	0.050	0.74
Winter 2062-3558	4	1.78	0.070	0.030	0.49
Trenal 22535	5	1.65	0.070	0.010	0.44
Hostmann 669708/16	6	1.71	0.060	0.070	0.48
Hostmann 48R336009	7	1.69	0.070	0.050	0.48
Hostmann 49RK505019	8	2.68	0.090	0.030	0.73
Lorilleux DK-31 standard	9	1.41	0.070	0.040	0.41
Coates Coldset	10	1.60	0.070	0.030	0.46
Lorilleux A99318104	11	1.46	0.070	0.050	0.43

Table 3.8: The results from IGT printing tests.

3.6 Discussion of laboratory results

When looking at the results we see that ink no. 8 has an extremely low viscosity compared to all the other inks. Inks nos. 1-4, and no. 6 are of viscosities of the same range. Nos. 1-4 are all Finnish, so this is quite reasonable. Inks 5 and 9-11 show the highest viscosities.

The viscosities measured at Bohlin VOR show that most of the inks are shear thinning, especially ink no. 10. The super-concentrated ink no. 8 shows also a very shear-thinning behaviour and the lowest viscosity.

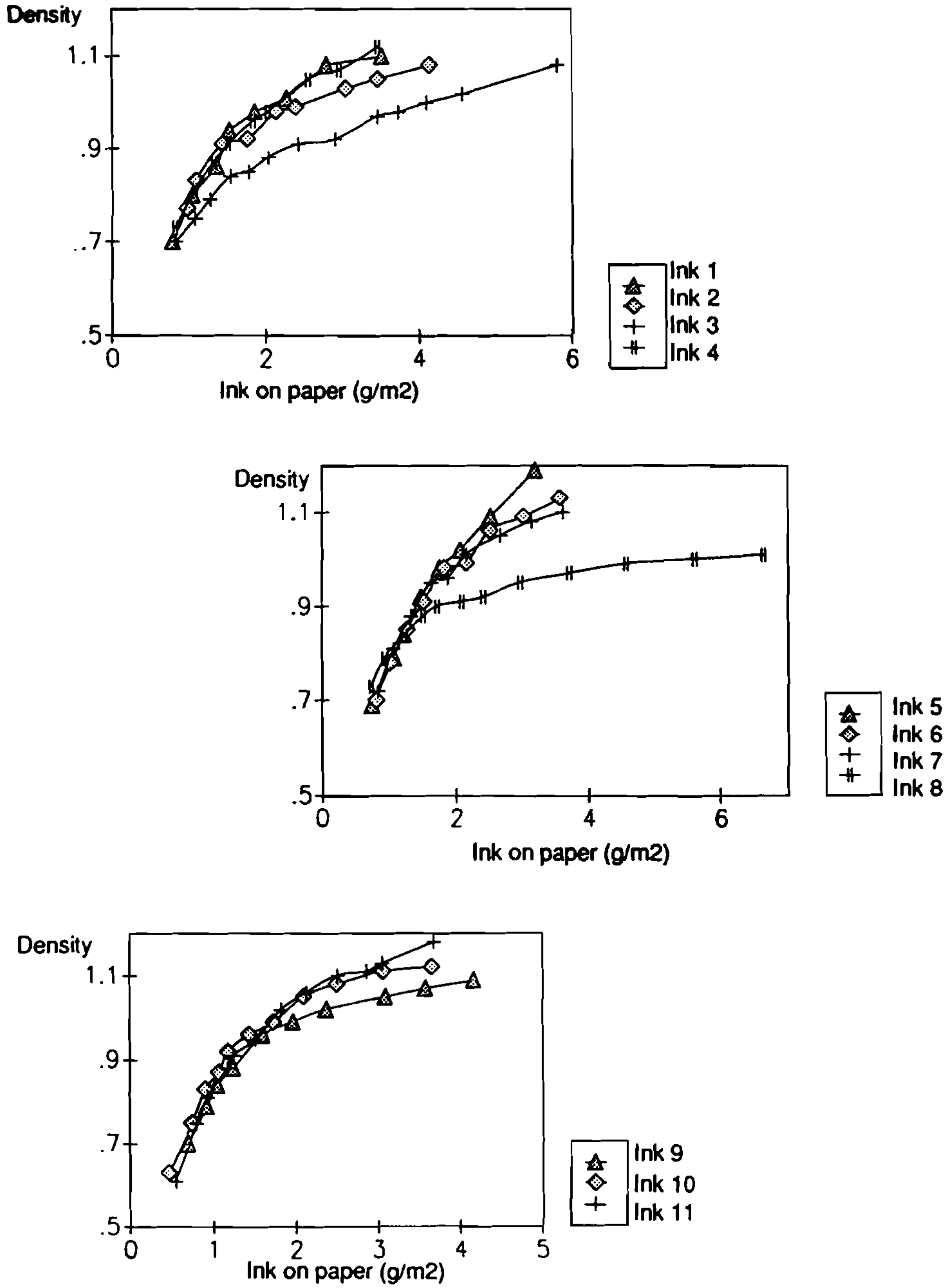

Figure 3.3: The ink requirement curves of the tested newsinks.

Some inks seem to go to an almost constant viscosity at "higher" shear rates. Inks 5 and 9-11 show the highest viscosity with this method too, but ink no. 9 is of the lowest viscosity of these 4 inks, which is differing from the Laray measurements. The Finnish inks are in the same viscosity range. Ink no. 3 gives an almost constant viscosity.

Comparing the tack values it is obvious that ink no. 8 has the lowest tack. The highest tack is measured with ink no. 10, but if all the other inks have to be compared it is evident that the choice of measuring method is important.

The strongest emulsification tendency was found with the inks nos. 1, 6 and 7 and the weakest with the inks 3, 4 and 8. Inks with high relative polarity (>20%) emulsify the fountain solution slowly (and also in smaller amounts) than inks with low polarity.

According to density measurements it was found that inks nos. 8, 9 and 10 give reasonable densities at "low" ink film thicknesses. Ink no. 8, which is super-concentrated, has the lowest ink film thickness generally at all measured densities.

If the relative colour strength is evaluated instead we find a different result. Here ink no. 4 has the lowest colour strength and ink no. 9 the highest.

The deviating results between density and colour strength must be due to variations in colour/hue.

When testing the inks for print-through, rub-off, and set-off, prints with a density level of 0.95 were produced on an IGT-tester, but the density level was measured with an Elrepho device (FMY/C-filter). As the density level was measured with a colour measurement device inks nos. 3 and 8 were printed at higher ink film thickness.

The overall results show that rub-off is the same or less for vegetable oil based newsinks compared to mineral oil based newsinks. Especially the linseed oil based inks and the super-concentrated ink seem to give low rub-off. With regard to set-off all inks, except nos. 3 and 8 due to the ink film thickness, gave about the same result. Nor is it possible to measure any significant difference in print-through between the samples.

4. Field Tests

4.1 Full scale printing trials at Aamulehti, Tampere, SF

Measurements:
Density checks were made throughout the runs. Set-off test was made immediately after printing and after one minute at the printing plant. The rub-off tests were made 24 h after printing. The main densities and print-through were measured as well as the relative contrast of the print. The dot gain was determined in the 50% area. The subjective evaluation of the four-colour picture quality was also evaluated using a ranking order method which is described in IFRA Newsprint and Newsink Guide (Chapter 6.4.4).

Time:	11th December 1989
Press:	Koebau Commander
Press configuration:	Satellite printing 4+0
	Colour sequence: Magenta, Cyan, Black, Yellow
Inks:	Magenta mineral oil based newsink (1)
	Winter tall oil based newsink (3)
	Winter linseed oil based newsink (4)
	Magenta soya-bean oil based newsink (12)
Paper:	Kaipola newsprint 40 g/m^2
Water:	Vadic 2.6%
Blanket:	Reeves 714
Plates:	Kalle N61
Test forme:	VTT Standard test forme
Press speed:	25000 r/h

Density target levels in the printing tests: (Gretag D186)

Cyan, Magenta, Yellow	0.90 D
Black	1.10 D
Tolerance	± 0.10 D

4.1.1 Results

The paper used was Kaipola newsprint 40 g/m^2. The mineral oil based newsink from Magenta was the reference ink, in addition to it three vegetable oil based inks (tall oil based newsinks and linseed oil based ink from Winter, and soyabean oil based ink from Magenta) which were tested. At each point enough copies were printed to reach stable conditions. The results of the printing tests are shown in tables 4.1 and 4.2, as well as in figure 4.1.

Ink	Dens. D	Print-through D	Set-off 0s D	Set-off 60s D	Patra-rub-off D	Rel. contr.	Dot gain %	Subject. conv.	evaluation achrom. separated
1.	1.23	0.094	0.07	0.06	0.103	0.18	33	51	41
3.	1.17	0.076	0.07	0.06	0.108	0.17	29	59	49
4.	1.25	0.078	0.12	0.10	0.080	0.13	37	51	56
12.	1.23	0.080	0.15	0.15	0.046	0.10	32	64	29
Kendall's factor of unanimity									**0.128**

where
1. Mineral oil based newsink
3. Tall oil based newsink
4. Linseed oil based newsink
12. Soya-bean oil based newsink

Table 4.1: Density, print-through, set-off, rub-off, relative contrast, dot gain and results from the subjective evaluation of the samples.

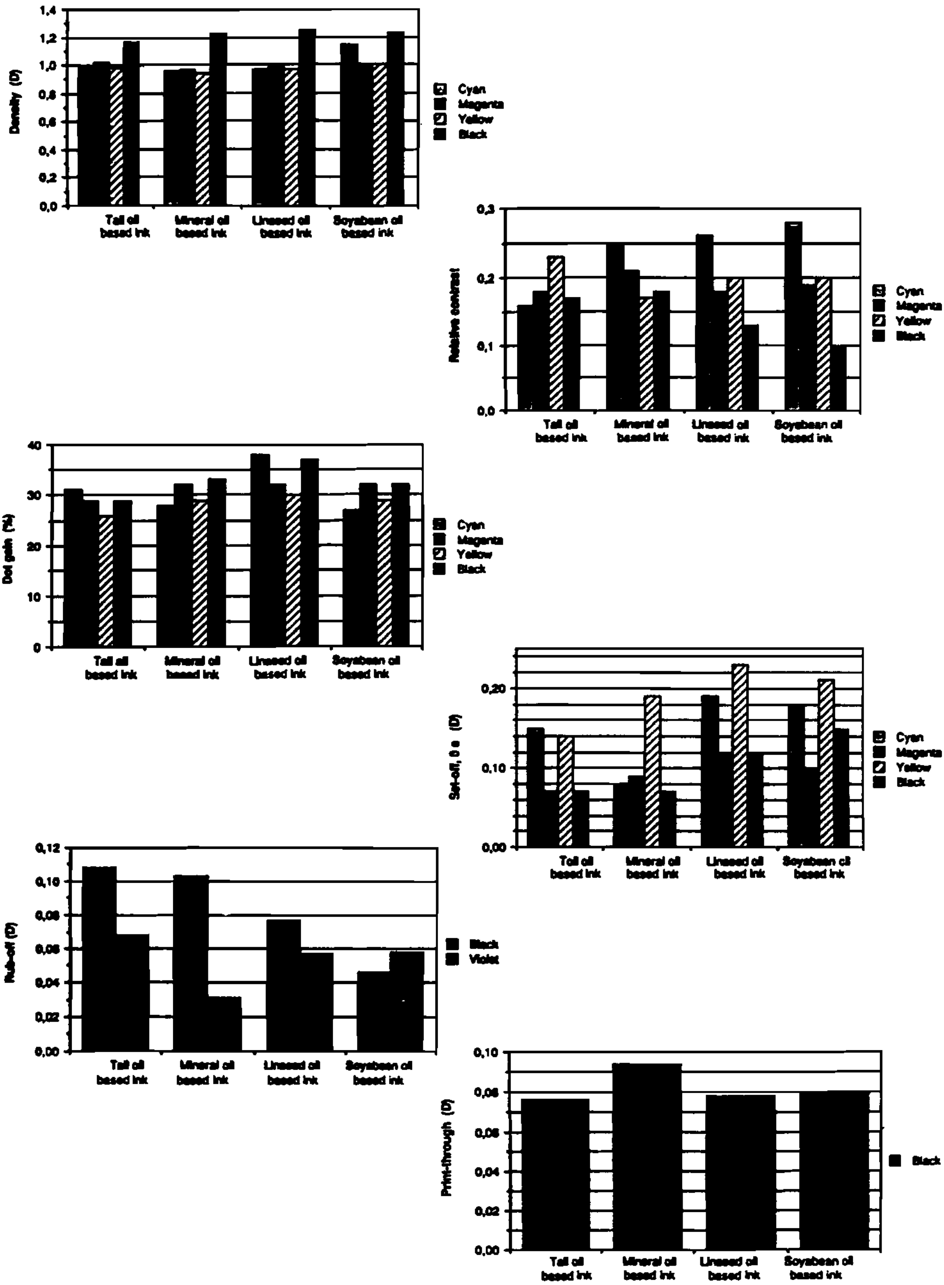

Figure 4.1: Results from printing trials at Aamulehti.

Ink	Density				Contrast				Dot Gain			
	M	C	Y	B	M	C	Y	B	M	C	Y	B
		(D)				(%)				(%)		
1.	0.97	0.96	0.94	1.23	0.21	0.25	0.17	0.18	32	28	29	33
3.	1.02	0.99	0.98	1.17	0.18	0.16	0.23	0.17	29	31	26	29
4.	0.98	0.97	0.97	1.25	0.18	0.26	0.20	0.13	32	38	30	37
12.	1.00	1.14	1.00	1.23	0.19	0.28	0.20	0.10	32	27	29	32

where
1. Mineral oil based newsink
3. Tall oil based newsink
4. Linseed oil based newsink
12. Soya-bean oil based newsink

Table 4.2: Density, contrast and dot gain of magenta, cyan, yellow and black areas of the ink samples.

4.1.2 Density levels

As the density levels of the solid black areas varied in the range of 1.17 (tall oil based newsink)-1.25 D (linseed oil based newsink) and for cyan, magenta and yellow 0.94-1.14 D, they all were near the target values and there were no great differences between the inks excluding the cyan of the sample "soya-bean oil based newsink", which gave the highest (1.14 D) density.

4.1.3 Print-through

The print-through densities did not vary very much (0.076-0.094 D). The mineral oil based newsink gave the highest print-through (table 4.1).

4.1.4 Rub-off

Rub-off densities varied in the range of 0.05-0.11 D in black and 0.03-0.07 D in violet area. The highest rub-off values were measured from sample "tall oil based newsink". The mineral oil based newsink gave the lowest rub-off density in process colours but a high rub-off density in black.

4.1.5 Set-off

The set-off densities of solid black areas varied in the range of 0.07-0.15 D, measured immediately after printing. The set-off densities were somewhat higher for the coloured inks than for black, being the highest for yellow (0.14-0.23 D). Linseed oil based newsink gave more set-off in process colours than other inks.

After 60 seconds the set-off had not reduced very much.

4.1.6 Relative contrast

The relative contrasts of black ranged from 0.10 to 0.18. The lowest value in black was determined from sample "soya-bean oil based newsink". The low relative contrast indicates overinking of the sample in question — e.g. the so-called standard density is too high for this material combination.

4.1.7 Subjective evaluation

Both the conventionally separated and the achromatically separated pictures were judged. The results (table 4.1) show that the Kendall's factor of unanimity is very low, which means that the viewers were not unanimous in their evaluation — e.g. the samples were very close to each other. The achromatically separated picture of sample "soya-bean oil based newsink" was regarded as clearly inferior to the other four-colour pictures.

4.1.8 Conclusions

Some discernible differences, although not major ones, were observed between the tested samples. The print-through of the vegetable oil based newsinks was lower compared to the reference ink (mineral oil based newsink). The set-off values were on the same level or slightly higher for the vegetable oil based newsinks. Linseed oil based newsinks gave the highest set-off in process colours, the highest set-off density in black was measured from the sample "soya-bean oil based newsink". Soyabean oil based newsink gave the smallest rub-off.

Mineral oil based newsink had the largest relative print contrast in black. Linseed oil based newsink had a larger dot gain than the reference ink, whereas tall oil and soyabean oil based newsinks had a slightly smaller dot gain. In subjective evaluation there were no obvious differences between the quality of the four-colour pictures of each ink type.

4.2 Full scale printing trials at Fredriksborg Amts Avis, Denmark

Time:	29th June, and 6th July 1989	
Press:	NOHAB AMPRESS	
Press configuration:	Satellite printing 4+0	
	Colour sequence: Cyan, Magenta, Yellow, Black	
Inks:	Hostmann super-conc. soya-bean oil based newsink	(8)
	Lorilleux Danish standard newsink	(9)
	Rape-seed oil based newsink	(11)
	Blarke & Mahrt soya-bean oil based newsink	(13)
Paper:	Kvarnsveden newsprint 45 g/m^2	
Water:	Lorilleux Aquasol 86 2-3%	
Blanket:	Reeves compressible	
Plates:	Kalle N61	
Test forme:	NATS/VTT standard test forme	
Press speed:	15000 r/h	

Measurements:
Printing trials were performed with ink no. 8 and 11 on the 29th of June and with ink no. 9 and 12 on the 7th of July. Density checks were made throughout the runs. The density was measured after 48 h, where measurements were made at 10 checkpoints on the printed page. The rub-off tests were made 48 h after printing with an "UGRA-Scheuerprüfgerät" (System HUBER). The main densities and print-through were measured as well as the relative contrast (at 75%) of the print. As each second sample was unprinted we got set-off pages automatically, but the set-off on these pages was not measurable. The dot gain was determined for 50% area. The subjective quality of four-colour pictures was also evaluated using the ranking order method described in IFRA Newsprint and Newsink Guide (Chapter 6.4.4).

Density target levels in the printing tests: (Gretag D186):

Cyan, Magenta, Yellow	0.90 D
Black	1.10 D
Tolerance	± 0.10 D

4.2.1 Results

The paper grade used was Kvarnsveden newsprint 45 g/m². The mineral oil based newsink from Lorilleux was the reference ink, in addition to this three vegetable oil based newsinks (super-concentrated soya-bean oil based newsink from Hostmann Steinberg, rape-seed oil based newsink from Lorilleux, France, and soya-bean oil based newsink from Blarke & Mahrt, Denmark) which were tested. The main results of the printing tests are shown in table 4.3 and 4.4, as well as in figure 4.2.

Ink	Dens. D	Print-through D	UGRA rub-off D	Rel. contr.	Dot gain %	Subjective evaluation
8.	1.31	0.07	0.05	0.27	27	62
9.	1.16	0.09	0.06	0.18	32	35
11.	1.11	0.09	0.06	0.16	33	70
13.	0.98	0.09	0.04	0.20	28	32
Kendall's factor of unanimity						**0.118**

where
8. Super-conc. soya-bean oil based newsink
9. Danish standard newsink
11. Rapeseed oil based newsink
13. Soya-bean oil based newsink

Table 4.3: Density, print-through, rub-off, relative contrast, dot gain and results from the subjective evaluation of the samples.

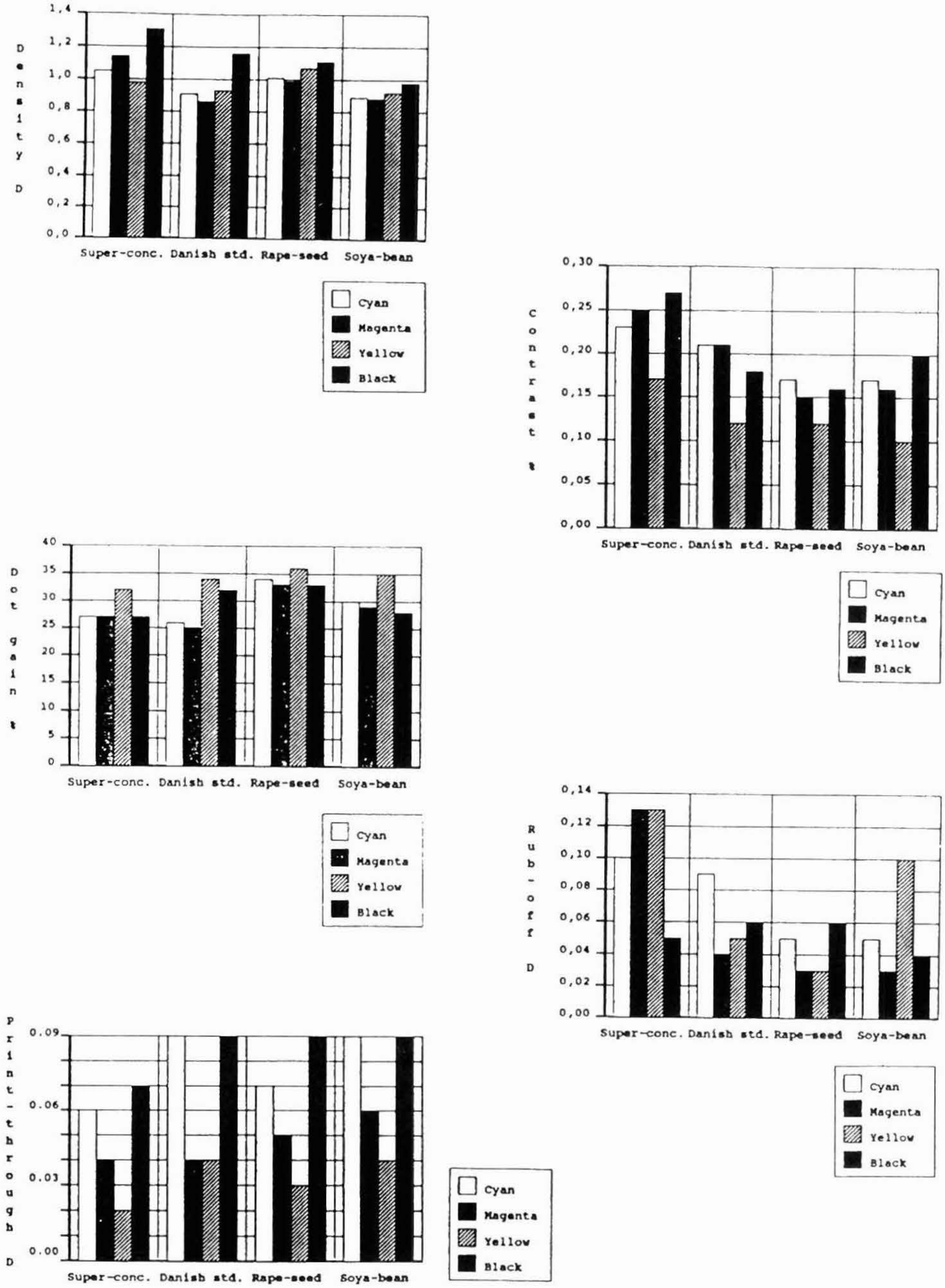

Figure 4.2 Results from printing trials at Fredriksborg Amts Avis.

Ink	Density				Contrast				Dot Gain			
	M	C	Y	B	M	C	Y	B	M	C	Y	B
		(D)				(%)				(%)		
8.	1.14	1.05	0.98	1.31	0.25	0.23	0.17	0.27	27	27	32	27
9.	0.86	0.91	0.93	1.16	0.21	0.21	0.12	0.18	25	26	34	32
11.	0.99	1.01	1.07	1.11	0.15	0.17	0.12	0.16	33	34	36	33
13.	0.88	0.89	0.92	0.98	0.16	0.17	0.10	0.20	29	30	35	28

where 8. Super-conc. soya-bean oil based newsink
9. Danish standard newsink
11. Rapeseed oil based newsink
13. Soya-bean oil based newsink

Table 4.4: Den.:ity, contrast and dot gain of magenta, cyan, yellow and black areas of the ink samples.

4.2.2 Density levels

The density levels of the solid black areas varied in the range of 0.98 (soya-bean oil based newsink) — 1.31 D (super-conc. soya-bean oil based newsink). For cyan, magenta and yellow the density levels were near the target values 0.86-1.14 D, the largest difference encountered with the magenta were of the sample "super-conc. soyabean oil based newsink", which gave the highest (1.14 D) density. It should be noted that it was not possible for the printers to keep the density of the super-conc. newsink on the target values.

The standard deviation for the density, for each colour, was calculated for each type of print. For black areas the standard deviation is close to 0.06. The lowest values for standard deviation was found for the soya-bean oil based newsink (about 0.03 for the colours).

The largest standard deviations were found for magenta and cyan with the super-conc. soya-bean oil based newsink (0.12-0.14). Also the yellow rape-seed oil based newsink showed this higher standard deviation of density.

4.2.3 Relative contrast

The relative contrasts of black ranged from 0.16 to 0.27. The lowest value in black was determined from sample "rape-seed oil based newsink", but the difference compared to the standard newsink is small. The highest values were obtained for the super-conc. soya-bean oil based newsink. The standard deviation on these measurements is about 0.03.

4.2.4 Rub-off

Rub-off densities varied in the range of 0.04-0.06 D (std.dev. 0.01-0.02) in black and 0.03-0.13 D (std. dev. 0.01-0.04) in the coloured areas, see table 4.5. The highest rub-off values for process colours were measured from sample "super-conc. soya-oil based newsink", which also had the highest density values. For the three other inks the rub-off values were very similar.

4.2.5 Print-through

The print-through densities did not vary very much (0.02-0.09 D, std. dev. 0.01-0.02). The super-conc. soya-bean newsink gave the lowest density values for print-through.

Ink	Rub-off (D)				Print-through (D)			
	M	C	Y	B	M	C	Y	B
8.	0.13	0.10	0.13	0.05	0.04	0.06	0.02	0.07
9.	0.04	0.09	0.05	0.06	0.04	0.09	0.04	0.09
11.	0.03	0.05	0.03	0.06	0.05	0.07	0.03	0.09
13.	0.03	0.05	0.10	0.04	0.06	0.09	0.04	0.09

where 8. Super-conc. soya-bean oil based newsink
9. Danish standard newsink
11. Rape-seed oil based newsink
13. Soya-bean oil based newsink

Table 4.5: Rub-off and print-through of magenta, cyan, yellow and black areas of the ink samples.

4.2.6 Subjective evaluation

Only conventional separated pictures were judged. The results (table 4.3) show that the Kendall's factor of unanimity is very low, which means that the viewers (10 persons) were not unanimous in their evaluation – e.g. the samples were very close to each other. The result shows two groups, the prints with the Danish standard newsink and the soya-bean oil based newsink looked very similar, and prints with the rape-seed oil based newsink and the super-concentrated ink were evaluated as very alike. The best scores were given to the rape-seed oil based newsink and the super-conc. soya-bean oil based newsink as no. 2, see table 4.3. This result can only be regarded as a tendency.

4.2.7 Conclusions and comments

The density level was higher for the super-concentrated soya-bean oil newsink than for any other ink. In fact the printers could not keep the density on the target levels in this case. The ink-water balance was also very sensitive for this super-concentrated ink.

The cleaning of the press was problematic with the black super-concentrated ink. A product based on paraffin hydro-carbons was used for cleaning, and if the cleaning was not done immediately after printing the ink got stuck to the cylinders. The cleaning worked reasonably well when done directly.

The print-through of the inks was about the same in all cases. The super-concentrated ink gave more rub-off, especially with the colours, than the other inks.

The print contrast was generally higher for the super-concentrated ink. A comparison between the other inks, shows that for cyan and magenta the print contrast was higher for the standard newsink. The soya-bean oil based newsink had higher contrast in black than the standard newsink.

The rape-seed oil based newsink had a larger dot gain than the reference ink, whereas the soya-bean oil based newsink was quite similar with regard to dot gain. The lowest dot gain was achieved with the super-concentrated soya-bean newsink.

The subjective evaluation was far from being homogeneous, which means that the quality of the prints was very uniform. Still there was a tendency to rank prints with the rape-seed oil based newsink and the super-concentrated soya-bean oil based newsink as better than the others.

As a conclusion it can be said that the super-concentrated soya-bean based newsink differs from the other inks with regard to most of the properties measured.

5. Deinking

5.1 Deinking procedure

Prints from the field test at Aamulehti have been tested for deinkability using the PTS-method (PTS-RH: 010/84 "Prüfung von Altpapier im Flotations-Deinking-Verfahren"). This method is based on three test procedures:

a: The printed matter is split into small parts and treated with chemicals in the flotation cell. After deinking new paper sheets are produced on a SCA-paperformer.

b: The unprinted matter is split into small parts and treated with chemicals in the flotation cell. Laboratory paper sheets are produced on a SCA-paperformer.

c: The printed matter is split into small parts without chemicals. Laboratory paper sheets are produced on a SCA-paperformer.

In the tests, 2 × 12 g of the printed sample are used for each type of ink. The samples were cut into small pieces before treatment.

The printed samples were aged naturally for 3 months before the deinking tests were made. Furthermore, samples were aged at 60°C in 144 hours to obtain an age of about 6 months.

After deinking and paperformation the brightness of the paper sheets was measured, both as ISO-brightness (at 457 nm in accordance with DIN 53 145 – Part 1) and Y-value, on a Elrephomat DFC 5.

The printed samples are coloured, which suggests that the Y-value might be more suitable for measuring brightness than the ISO-brightness, which is mainly used for measurements of paper.

After the brightness measurements, the deinking degree (DEM) was calculated as:

$$\text{DEM}(\%) = \frac{\text{Brightness (a)} - \text{Brightness (c)}}{\text{Brightness (b)} - \text{Brightness (c)}}$$

5.2 Deinking results

When measuring the ISO-brigthness and Y-value of the produced laboratory sheets, the following results were obtained, table 5.1.

Ink	ISO-brigthness b = 52.7 (a)	(c)	DEM (%)	Y-value b = 61.2 (a)	(c)	DEM (%)
1.	51.8	39.1	93.3	59.0	41.9	88.3
3.	50.3	38.2	83.5	58.1	41.9	83.8
4.	48.8	39.0	71.2	54.7	42.7	64.9
12.	49.2	39.8	73.2	55.9	42.6	71.4

where 1. Mineral oil based newsink
3. Tall oil based newsink
4. Linseed oil based newsink
12. Soya-bean oil based newsink

Table 5.1: Deinking results for prints from the field test at Aamulehti after 3 months of natural aging.

The results in table 5.1 show that after 3 months of natural aging the printed samples are quite easy to deink. Ink no. 4, linseed oil based newsink is the most difficult one of the four inks tested. Still the results for all inks are acceptable.

Ink	ISO-brigthness b = 51.9 (a)	(c)	DEM (%)	Y-value b = 60.9 (a)	(c)	DEM (%)
1.	41.0	36.9	27.0	45.6	40.1	26.2
3.	42.0	37.6	31.2	46.7	41.0	28.6
4.	41.4	37.5	27.3	47.8	41.8	31.3
12.	41.3	37.4	27.1	46.2	40.7	27.4

where 1. Mineral oil based newsink
3. Tall oil based newsink
4. Linseed oil based newsink
12. Soya-bean oil based newsink

Table 5.2: Deinking results for prints from the field test at Aamulehti after about 6 months of aging (3 months natural, 3 months artificial according to the PTS method).

After about 6 months of aging, the first 3 months were naturally aged and the last 3 months were artificially aged, all samples show very poor deinkability properties (table 5.2) and to our surprise the standard mineral oil based newsink gave the lowest DEM-value.

As the deinking results fell very dramatically after 6 months of aging, it was decided to repeat the deinking tests by using natural aging only. Hostmann-Steinberg stepped-in to do this after 9 months of natural aging.

Ink	Y-value b = 65.7		DEM
	(a)	(c)	(%)
1.	46.8	40.2	25.9
3.	47.3	34.2	41.6
4.	48.9	37.8	39.8
12.	51.9	40.1	46.1

where 1. Mineral oil based newsink
3. Tall oil based newsink
4. Linseed oil based newsink
12. Soya-bean oil based newsink

Table 5.3: Deinking results for prints from the field test at Aamulehti after about 9 months of natural aging.

From the results it can be seen that the sample printed by mineral oil based newsink gives the same low DEM-value. The vegetable oil based newsinks do not give the same poor results, even though the level of deinkability is not satisfying (table 5.3). A DEM value of at least 60% should be reached according to PTS.

At this time there is no explanation available why DEM values fall so much after around 3 months of aging of the samples and why mineral oil based newsinks are following the same pattern. The only conclusion in this respect which can be drawn is that even mineral oil based inks differ very much from each other in their basic compositions.

In any case it seems to be necessary to screen these results by further investigations and IFRA already decided to do this within its Research Programme for 1991.

6. Summary

An attempt to evaluate vegetable oil based newsinks and their printability properties has been done in this project. Inks based on soya-bean, linseed, tall, and rapeseed oil have been tested and compared with standard mineral oil based newsinks.

Both the production of vegetable oils as well as the technical experiences within the field of vegetable oil based newsinks have been reported in technical literature. The main advantages of soya-bean oil based newsinks are claimed to be good mileage, less rub-off, good colour reproduction, and of course an environmentally acceptable raw material.

Properties like rheology, emulsification rate, colour strength, ink requirement, and rub-off have been tested in the laboratory.

It has been seen that vegetable oil based newsinks can be formulated to achieve the same properties as commercially available mineral oil based newsinks. The major difference discovered was the emulsification behaviour, where the vegetable oil based newsinks show less water pick-up. The vegetable oil based newsinks have a tendency towards high relative polarity, which as a consequence seems to give a slower emulsification of the fountain solution.

A super-concentrated soya-bean oil based newsink was also tested. This ink had a lower ink requirement than any of the other vegetable oil based or mineral oil based newsinks.

At two different sites 4-colour sets have been run and tested in the field. In both cases four different sets have been tested, where one 4-colour set was based on standard newsink, i.e. on mineral oil.

The greatest differences between the vegetable oil based newsinks and mineral oil based newsinks occurred when the super-concentration entered the game. This ink showed the same dot gain, but higher relative contrast, less print through, on the other hand higher rub-off values with process colours at a somewhat higher density level. It was not possible to keep the density constant at the density target levels for the superconcentrated newsinks, especially for the black. This black ink was also more difficult to remove from the cylinders when cleaning the press.

The subjective evaluation of the printed samples showed that the print quality was regarded as about the same for vegetable oil based newsinks compared to mineral oil based newsinks.

With regard to rub-off it was found that black soya-bean and linseed oil based newsinks gave less rub-off at the printing trials in Finland. It was not possible to draw the same conclusion from the second printing trials in Denmark.

In general it can be concluded that the same newspaper print quality can be achieved in 4-colour printing with vegetable oil based newsinks compared to mineral oil based newsinks.

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