Paper interaction with fountain solution during multi-color offset printing

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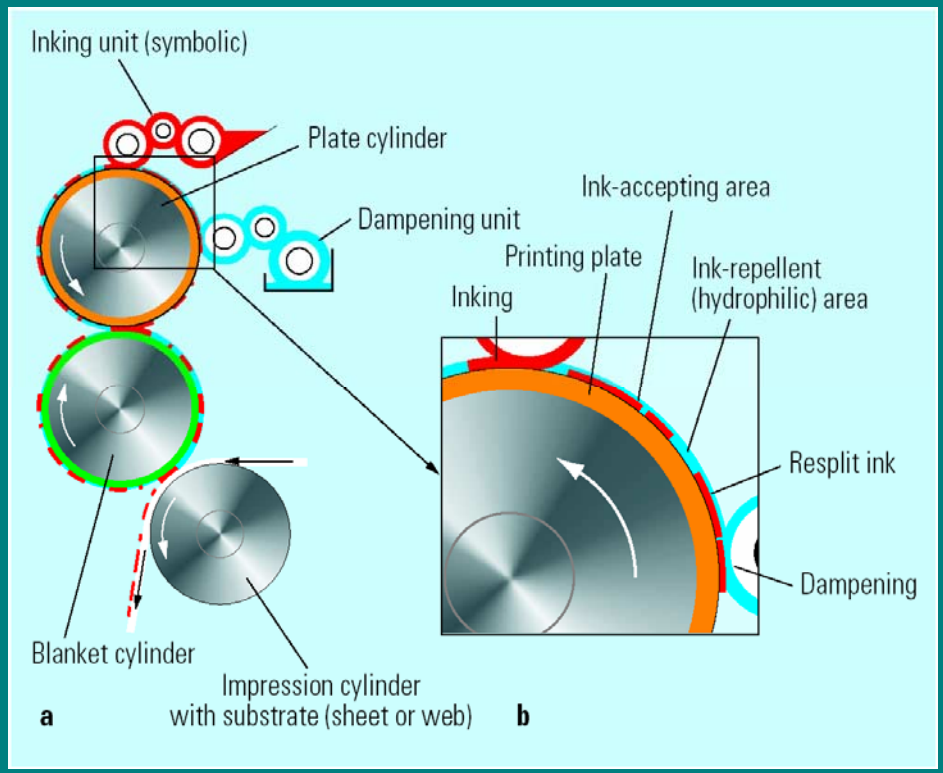
Offset printing

Printing Process	1991	1994	2000	2025
Offset	47	46	42	25-35
Digital, electronic	3	7	13	18-25
Flexography	17	18	19	20-25
Gravure	19	18	17	15-25
Letterpress	11	8	6	4
Silk screen	3	3	3	3

- There are 5 main *traditional* printing processes and also the *recent* digital printing. Their characteristics largely determine the properties of the papers used.
- The offset process has long been the leading print technology for economical production for high-quality medium and long print run.
- *Offset* will remain the dominant production method, and this will be connected with an increasing digitization of the *workflow* and a spread of the *computer to press/direct imaging technology*.

Fountain solution

- A distinctive feature of offset printing plates is the fact that the printing and non-printing areas are on one level.
- To separate these areas a very thin (approximately 2 µm) fountain solution film is applied to the plate by the dampening unit.



- Part of the fountain solution is printed, part emulsifies together with the ink, and part evaporates.

Fountain solutions generally consist of:

A. **Water** - which comprises by far the largest portion of the fountain solution.

B. **Acid** - which reducing the pH, keeping the plate image area sensitive to ink as well as keeping the background areas sensitive to water

C. **Wetting agents** - or surfactants lower the surface tension of the water allowing it to maintain the wetting characteristics of the non-printing areas (non-image areas) of the plate.

D. **Plate conditioners/additives** - minimize the corrosive action of the acid on the aluminum plate.

E. **Gum arabic** (gum substitutes- carboxymethyl cellulose) - serves to protect the plate from humidity and chemical attack during press stops.

Isopropyl alcohol (IPA) was one of the most favorite wetting agents added!!

IPA in fountain solutions:

- **Reduces the surface tension of water, allowing water to wet the dampener form roller more evenly. The result is that less dampening solution is used and the water is spread more evenly to the plate from the rollers.**
- **Increases viscosity to provide a thicker layer of dampening solution to be applied across the rollers, thereby improving the performance of the ink, paper and printing plates. Better, faster ink/water balance reduces waste from start-up.**
- **Allows for less moisture to be carried to the paper, thereby causing less ink drying problems.**

In the past, and in some cases yet today, isopropyl alcohol was used in percentages as high as 20%.

Printing trends

- An important printing trend is volatile organic compounds (VOC) reduction. Today this is required by legislation (VOC Directive on the Limitation of Volatile Organic Compound Emissions)
- The environmental agencies have determined that IPA (isopropyl alcohol) is high in VOC's (volatile organic compounds) and wants it eliminated from the pressroom.

Alcohol substitutes have been developed to replace isopropyl alcohol!

Alcohol substitutes

- **Alcohol substitutes are all proprietary mixture of solvents. Even though alcohol substitutes are proprietary mixtures they do have a couple of common traits that should be considered:**
  - **First, they are very non-volatile and consequently a greater amount of fountain solution will be transferred on the paper surface.**
  - **Second, they are strong ink solvents.**
- **Because of this combination of properties they tend to remain in the fountain solution and, at the same time, can extract some oil portions from the ink.**

General Objective:

To analyze the interaction of paper with fountain solution (free of IPA) during multi-color offset printing

Experimental approach:

- **Simulating and analyzing the transfer of fountain solution free of IPA on paper during multi-color offset printing**
- **Analyzing the influence of softcalendering parameters (roll temperature and nip load) on the printability of offset paper by measuring of print penetration of papers after repeated dampening**

Experimental part
Materials and experimental methods

- Handsheets with basis weight of 80 g/m^2 were obtained on a Rapid-Köthen apparatus, using paperstock with a typical composition for fine printing paper:
  - Bleached hardwood/ softwood kraft pulps 70 /30 (30° SR)
  - 30% $CaCO_3$ (Hydrocarb HO from Omya)
  - 10 kg/t AKD (Aquapel 210 D - Hercules)
- Each handsheet was calendered individually in one nip of a laboratory calender in conditions established by experimental program:

Experimental program:

Series	Pressure, MPa	Steel roll temperature, °C
A	30	60
B	20	150
C	15	140
D	25	125

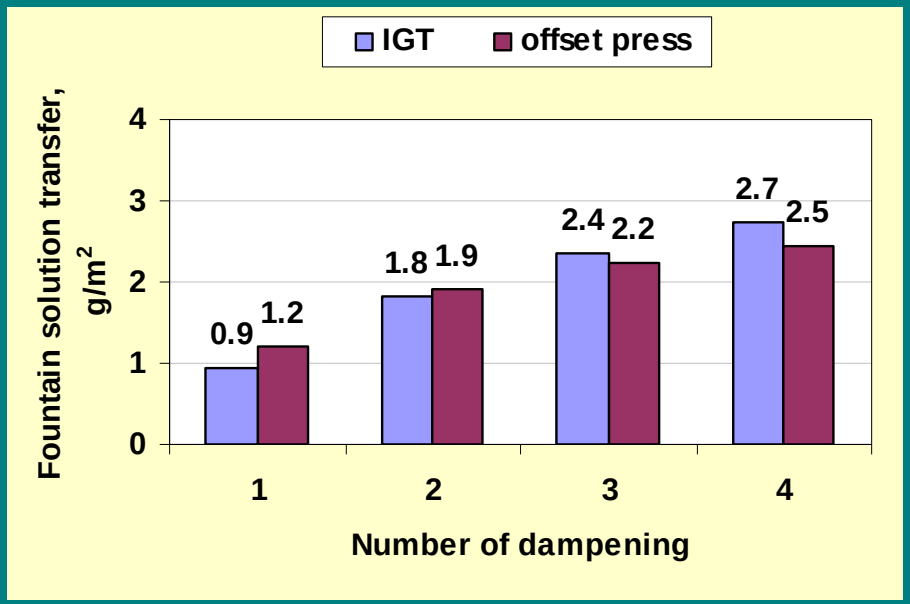
Laboratory calender features

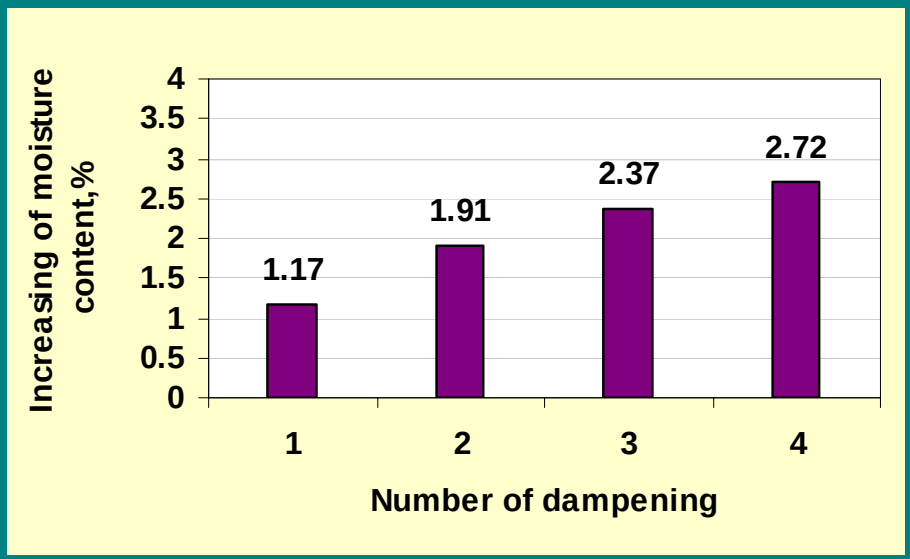
- Rolls: steel/soft-roll/steel
- Roll diameter, mm: 250/195/195
- Width, mm:350
- Number of nips: 2
- Maxim nip load, kN/m:380
- Maxim steel roll temp. °C:200
- Speed, m/min:30-60

Offset printing on IGT press

- There are a multitude of test print presses that find usage in practice.
- With test-print presses special stresses on the paper and characteristics corresponding to the real printing process can be simulated. Under defined and reproducible conditions with low material consumption, test prints can be produced in the laboratory.
- Printability test device IGT A 1-3 offers the possibility to study the interaction between printing ink and paper and to simulate the multitude of influences of an offset printing press, also taking the dampening solution into account.
- A commercial dampening solution “Litho Etch “ containing $Mg(NO_3)_2$ and butyl Cellosove (Ethylene glycol butyl ether) as IPA substitute was used.

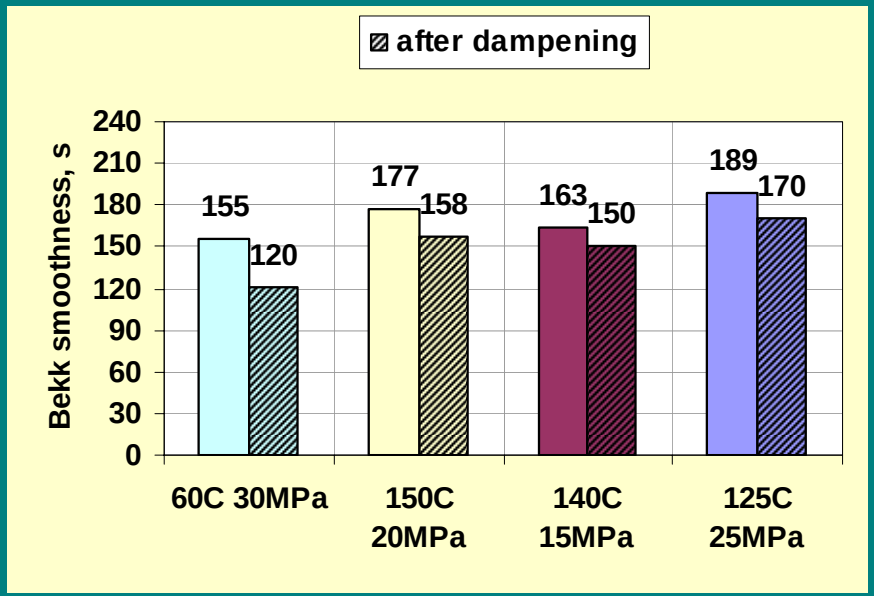
Fountain solution transfer

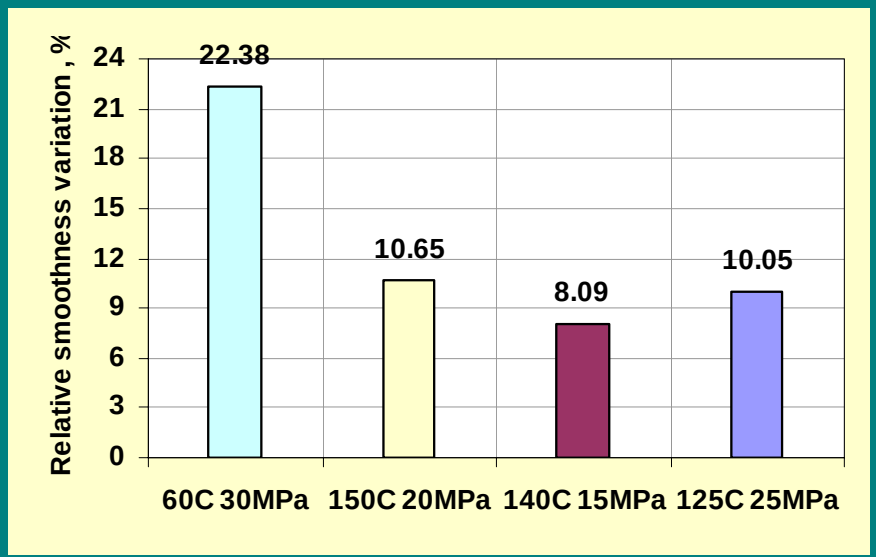




- Dampening process was simulated on a IGT test print press and on a offset press of small format.
- As compared with literature data a unexpected increased values for the fountain solution free of IPA transfer was obtained (0.9-1.2 g/m2 *vs*. 0.7-0.8 for the same conditions)
- Paper moisture content increased with 2.7% (absolute) during simulated offset printing on IGT press by repeating dampening operation four times

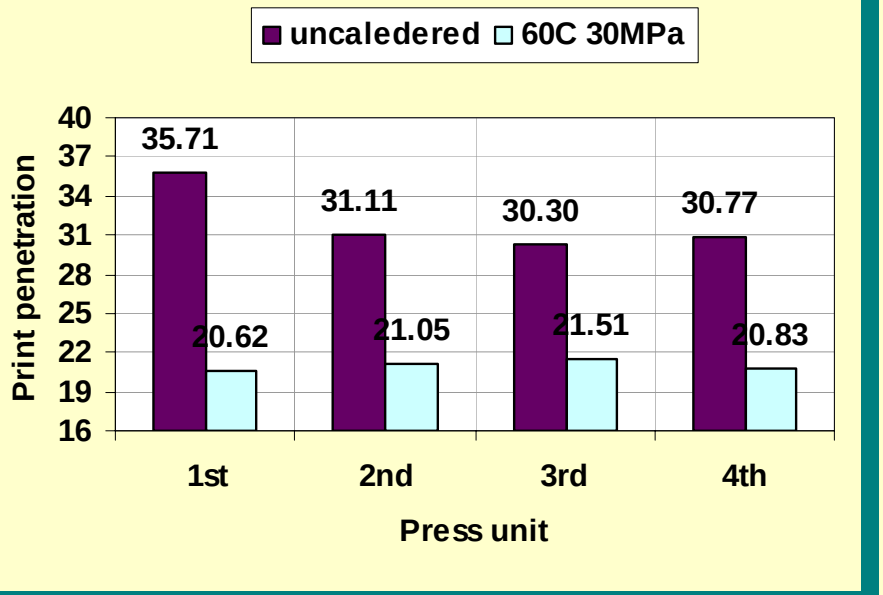
Surface roughening by fountain solution

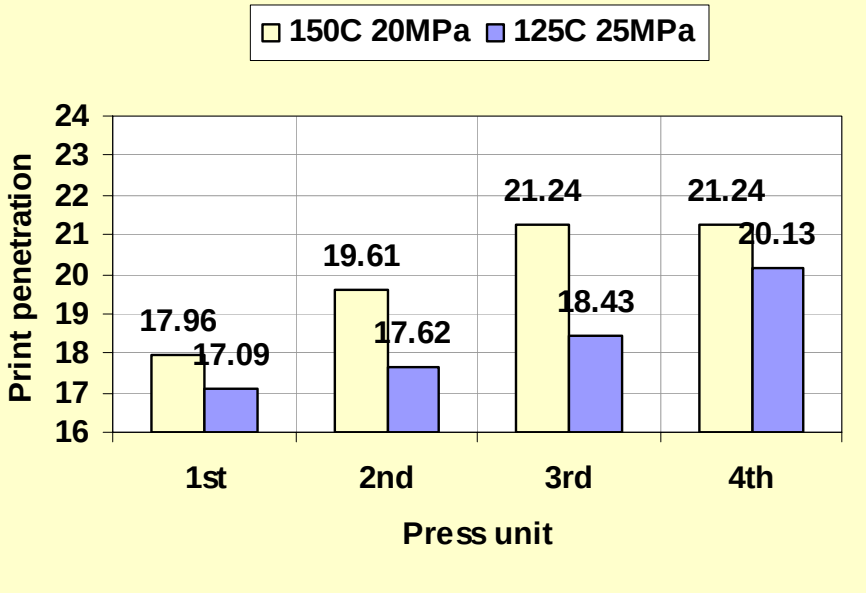


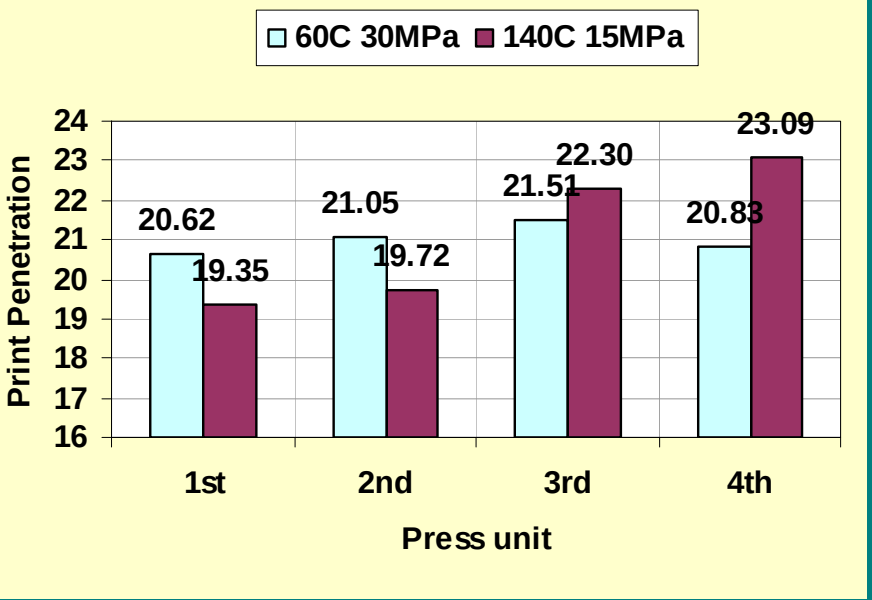


- The effect of fountain solution on the roughening of paper depends of the softcalendering conditions
- Temperature had the largest effect, all samples softcalendered at the higher temperature had a higher smoothness after contact with water than the paper calendered at low temperature.
- The best combination (low roughening) was found with sample C, that is under conditions where the bulk of the sheet would be less affected: high temperature, low load.

Print penetration







- **Paper samples that were calendered at high temperature and low pressure with preserving bulk structure show a better stability on water action.**

Conclusion

- The removal of the isopropyl alcohol from the fountain solution increases the quantity of water that is transferred on the paper.
- The increasing of the fountain solution transferred leads to the amplification of the paper roughening phenomena
- Paper samples that were calendered at high temperature and low pressure with preserving bulk structure show a better stability on water action.