# Supercalendering and its Effect in Printability

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*The study of influence of supercalendering on printability is a complex affair. The most important task will be to dissolve the flat conceptions such as printability and supercalendering. The special relevance of the various printing processes in connection with the operations in a supercalender should be reserved to futher examinations. The breaking-up into various fields may in future lead to a clear determination of all factors of influence and their evaluation with regard to the respective paper, the finishing process and the printing process. Such specification will reveal that well known conceptions such as smoothness, compressibility, resiliency etc. which are used today i.e. a more generalizing manner, have their specific value for each single printing process.*

A. In expert publications dealing with the printability of papers smoothness of the paper is mentioned as a factor of the first order. For most kinds of paper, especially improved and high grade printing papers this smoothness is obtained by supercalendering.

While the constructive design of the supercalender and its technical data can be described precisely, a clear metrological defintion of the calendering effect obtained is similarly complex as the conception of "printability".

The meaning of this term is a compendium of all those characteristics of this kind of paper influencing the quality of the printed product i. e. its appearance in illustration and type. An extensive description of the compendium of printability of paper was given on the occasion of a conference of the Graphic Research Institute held in Sweden in 1953. It was later described in more detail by Albrecht and Falter.

A pointed improvement of the printability and the printing results can only be obtained by analysing the coherent details. W. Klipper points out the difficulty of improving a whole bunch of characteristics simultaneously to an optimum.

However this is generally speaking possible and the high standard of printed products on the market proves that this is so, but all endeavours to raise special qualities of printing papers an absolute optimum will always be subject to limitations of other characteristics.

An abundance of demands is still confronted with the absence of a common effective basis for all partners viz. printers–paper makers–machine and apparatus builders and colour producers. If a machine builder is called upon to incorporate the printed product into his conception all partners concerned, and this includes also the printer, must give objectively and metrologically clear definitions of their demands of general validity.

In the future it may perhaps be possible to establish calculations with regard to printability, printing conditions and the characteristics of paper permitting the production of good prints without any difficulty and reducing the art chiefly to a combination of figures and programs.

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## B. Machine calender or supercalender–a confrontation.

The supercalender must warrant the largest possible variation of factors permitting a most favourable influencing of the glazing effect (and the smoothness) during the calendering process. Contrary to the machine caelnder at the end of the paper machine with its stack of chilled cast iron rolls to glaze the paper arriving from the paper machine, the supercalender is equipped with an alternating stack of chilled cast iron and resilient bowls Fig. 1. On a machine calender, the rough surface of the paper is equalized and smoothed by an unresilient compression of the structure of the paper with a simultaneous calibrating effect. The uneven distribution of the stock produces variation in the compression of the sheet. As a result, the printing colour is absorbed unevenly during the printing process. This, however, would not be considered a disadvantage if it were not for the negative

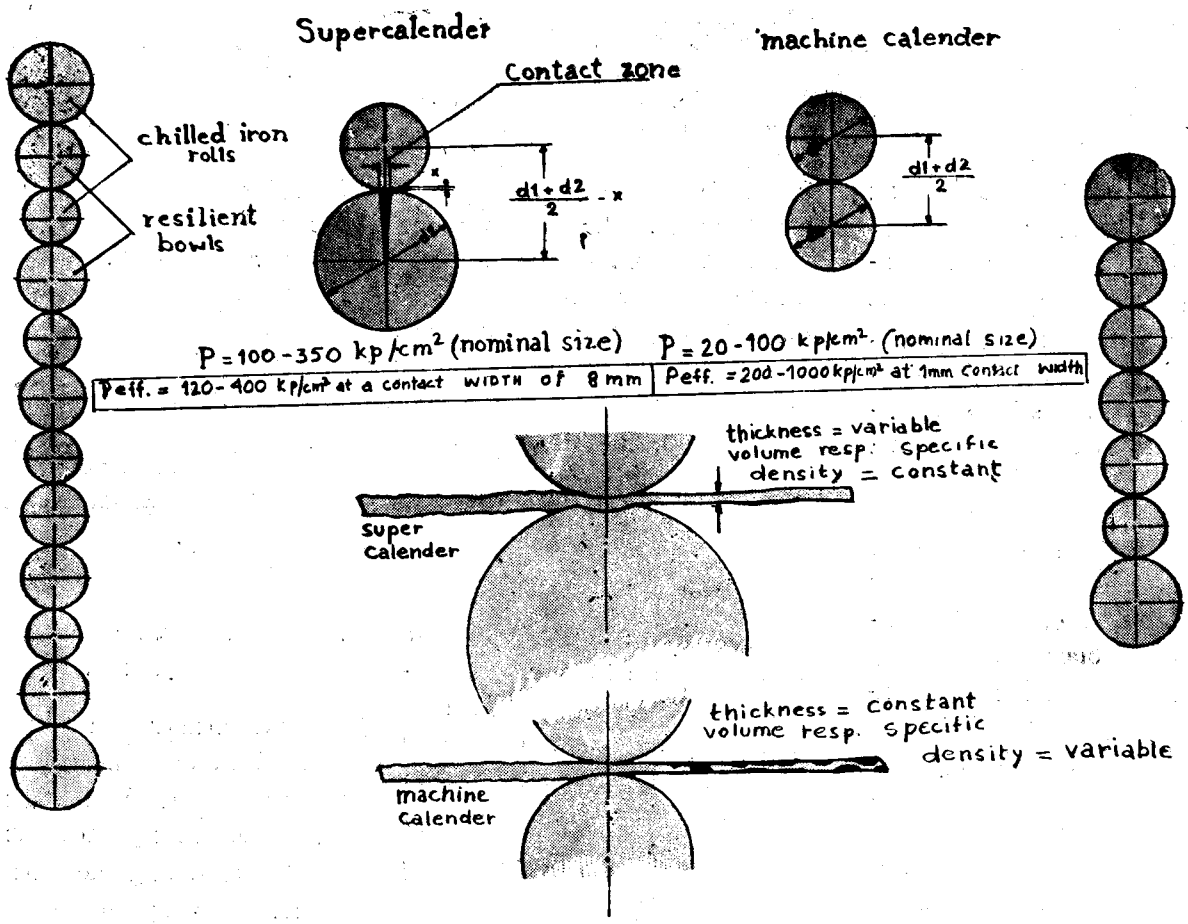


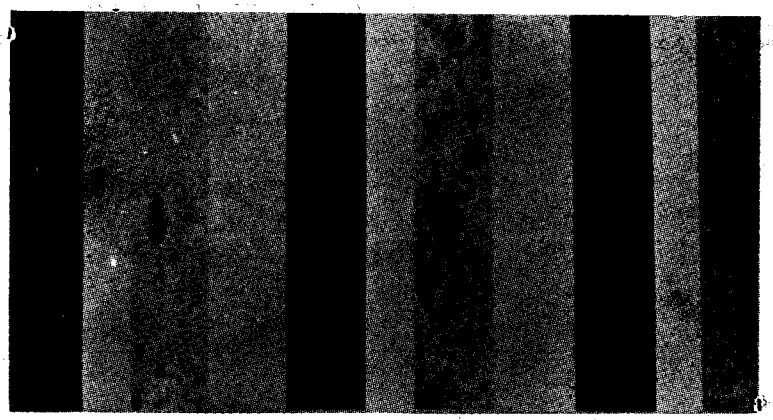

**Fig. 1.**

effect on the printed product. On a supercalender however, the variations in the compression of the paper are avoided by the resilient bowls to a far reaching extent. These calender bowls adapt themselves to the uneveness of the paper surface. They give way to local accumulation of stock and produce almost the same amount of linear resp. surface pressure. Though the supercalender operates with a higher nominal load than the machine calender, the real and effective surface pressure on the paper is less. Fig. 2.

Proof strips of pressure tests of machine calendered and supercalendered paper of equal make show quite distinctly the typical difference in these operations Fig. 2. The Figures Nos. 3–5 are sectional views. They show the effect of supercalendering and machine calendering respectively on the structure of the paper.

Figs. 3 and 4 show a machine calendered paper. Fig. 3 shows a highly compressed local area whereas Fig. 4 shows a less compressed local area. Fig. 5 shows the same paper after supercalendering operation. Such differences in compression did hereby not appear as was to be expected from the pressure test strips. The paper used for this trial was newsprint which generally is not supercalendered. The results obtained with supercalendered newsprint justify the question whether supercalendered news print will not gain a larger portion of the market in the future.

Figs. 6–8 show a comparison



machine calendered | machine calendered | super-calendered

**PRESSURE TESTS–NEWSPRINT PAPER**
**Comparison : machine calendered–supercalendered**

**Fig. 2.**

**Fig. 3.**

of uncalendered and supercalendered coated paper. Fig. 6 shows an optical sectional view; Fig. 7 presents a sectional view of uncalendered paper and Fig. 8 the same paper after supercalendering operation.

The paper maker will therefore concentrate his efforts to the production of a paper with the highest possible degree of uniformity of sheet structure with the view to eliminate the machine calender completely for supercalendered papers.

With the production of smoothness in the roll nips of a supercalender a number of other factors are by necessity influenced at the same time. This has partly positive and partly negative consequences. Gloss formation may for instance have a positive effect on certain paper grades. Reduced compressibility and elasticity resulting from supercalendering have been considered negative in some publications. However, in other publications it is pointed out that this general assertion does not apply to all paper grades and printing processes. Changes in properties cannot always be considered negative or positive. Lustre e. g. is a decisive hall mark of quality for most coated paper grades whereas it is undesirable for mat papers. Which of the two is desirable can only be judged by their intended use. It is also not possible to draw a distinct sharp line between so–called positive and negative properties and the trial to find the absolute optimum will always end in a compromise.

### C. The supercalendring process

The characteristic feature of super-

Fig. 4.

Fig. 5.

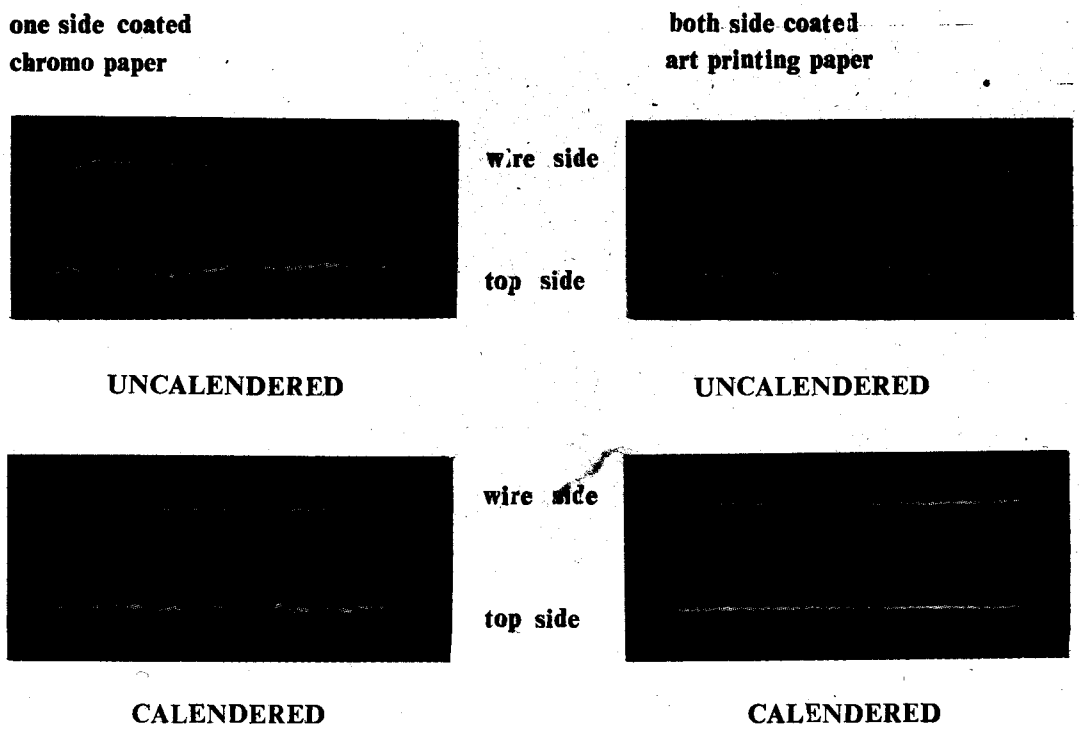
calendering is the use of resilient bowls. According to load and speed a trough shaped glazing zone is formed in the nips. As a result a horizontally working power, so-called "microfriction" is produced. This friction power intensified by the generated heat polishes the surface; it is increased by the degree of resiliency of the paper bowls. Without going into details in this report it should only be mentioned that there are developments in progress both in the machine-and the processing field aiming at bringing certain characteristics of the glazing process separately to optimum (gloss calender, friction calenders and so on).

### D. Points of influence in a supercalender

Fig. 9 shows the most important points of influence in a supercalender. Their gradual effect on the degree of smoothness to be obtained is not the same for all kinds of paper and their sequence of importance varies according to the grade of paper and the desired effect. For instance, the influence of surface moistening which is of increasing importance in supercalendering is in certain cases much more effective for optimizing the printing smoothness than the increase of linear pressure.

In a supercalender all factors are effective, such as

1. the resilient bowls
2. the initial moisture content
3. the additional moisture
4. the temperature
5. the surface condition of the rolls
6. roll dimensions
7. number of rolls
8. speed




**Light-section-photo scale 200 : 1**
**Coated papers (calendered and uncalendered)**

**Fig. 6.**

9. linear pressure
10. paper guiding

Some of these factors are limited by the constructive design of the machine and do not offer a variable influence. For certain paper grades, however, some of these factors can be varied and optimized. For coated art print papers e. g. the influence of temperature, surface moisture and surface quality of the rolls and bowls are of special importance. For mat effects, the same factors apply but in this case the temperatures should be pretty low, the chilled iron rolls should have a dull finish, surface moistening drops out completely and it is tried to obtain the desired result with the least possible linear pressure.

**Fig. 7.**

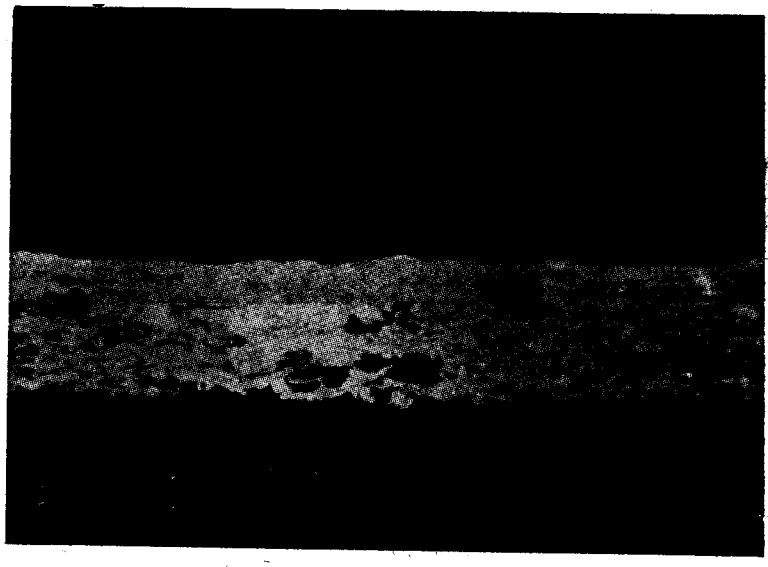
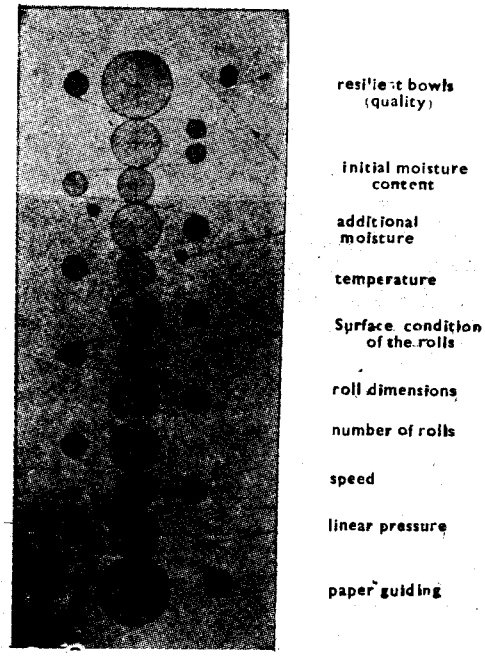


Fig. 8.




**Supercalender influences on smoothness and gloss**

Fig. 9.

### E. The resilient calender bowls

The development of raw materials used for the filling of resilient calender bowls have lead to a large number of combinations of fibres of various kinds, chiefly wool and cotton. But also combinations of synthetic fibre with others or bowls with pure synthetic fibre fillings are being used in practice or are being developed. The decisive quality mark of resilient bowls is their resiliency and their indifference to markings. These markings should be avoided in order to prevent the marking of the paper. These markings especially bias the printing results of coated papers. The obtaining of the absolute optimum of resiliency of the resilient bowls is limited by the high speeds which are generally demanded today.

The synthetic fibre or plastic bowl is being discussed increasingly during these last years. In spite of the high costs invested for the development of these bowls the results so far obtained have not come up to expectations. Trials carried out in laboratories did not furnish the same results in the field. The increasing number of new synthetic fibre products may furnish one day a new material for plastic bowls rendering their use in the paper industries more efficient and practicable.

The few plastic bowls so far in use in a limited number of special calenders have furnished good and very good results and particularly with regard to the uniformity of effect and their indifference to markings. These plastic bowls offer no difficulty in machining, i. e. dressing and grindings, similar to resilient paper bowls.

Other typical properties of material of to-day's plastic rolls are preventing their use in supercalenders. Their high sensibility io temperature variations and to high and sudden loads, are drawbacks which can only be overcome by further modifications of the plastic material.

Another disadvantage is the fact that some of the well known plastic bowls furnish decreasing degrees of smoothness with temperature exceeding 40°C. (Hockle). The plastic bowl absorbs lustre and is, therefore, very useful for mat finishing.

F. **Number of rolls**

An interesting criterion mentioned in the latest works about printing approaches and printability is the number of nips which the paper has to pass when running through the supercalender. It is put on record that the maximum smoothness is already obtained after passing 5 nips (acc. to Bekk measures) and no measurable increace of smothness is obtained by additional nips.

It is pointed out in other publications that the smoothness increases fast up to the 5th nip and then solwly. Such statements can only be fully evaluated in their importance when the printing results are also being taken into consideration. If optimum printing results are obtained with a certain paper grade even after having less nips, this would mean a starting point for consequences to the machine conditions and for the future design and construction. Such singular statements, however, generally refer only to a certain paper and for a definite printed product obtained under definite conditions of manufacture and printing.

The production of large quantities of paper a standard uniform quality and for exactly the same printing product may warrant the abandonment of the standard calender in favour of the single purpose calender, especially with regard to number of bowls and linear pressure.

Until then, the supercalender has on the average 10–12 bowls and permits the paper to be guided through 1 to 9 or 11 nips according to the degree of smoothness wanted for the various paper grades.

The greater number of bowls essentially contributes to obtaining more even effect and permits the supercalendering operation to be made under lower linear pressures due to the sucessively repeated compression.