

SUMMING UP THE SYMPOSIUM PRESENTATIONS

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Mr. Chairman, Ladies and Gentlemen,

Now that we have a method to systematically relate the Symposium's presentations to the process of papermaking and to the important product attributes of the various paper and board grades, let me sum up this 9th Fundamental Research Symposium:

INTRODUCTION

Dr. D.A. Page mentioned in his review of the beating of chemical pulps: "If a unified simple theoretical treatment can be made from a complex phenomenon, it will then have the following three advantages:

- professors can teach it
- students can learn it,
- engineers can practice it".

Against this statement I feel the Symposium has been successful.

The visionary evaluation of the opportunities and challenges of the future papermaking by Mr. R.C. Williams started the Symposium with high spirits. His call for increased co-operation between paper companies in supporting the development of new technology warrants full attention.

STOCK PREPARATION

Dr. D.H. Page's presentation made everybody, including me, convinced that tensioning of fibers is an important submechanism of low consistency refining. His excellent delivery of the presentation and the complete relevance of its content set a good standard for the symposium. Perhaps

one area that future refining research should address, in addition to the areas recommended by the speaker, would be the interdependence of his listed 9 beating effects, i.e. how many of them are truly orthogonal? The call for using standard pulp fibers in refining research together with the experimental pulp fibers was a good one and deserves a follow up.

Based on the presentations of Ödberg and co-workers and of Noe & Henry it looks as though the refining induced swelling of the cell wall is a "surface layer" phenomenon. The MC fluidization of pulps seems to have a potential for beating and curling plus microcompressioning of fibers as evidenced from the results of Bennington and Seth. I believe that these findings will have practical implications. Our detailed understanding of the structural changes induced by refining and affected by pulp quality is still fairly sporadic as evidenced by the results of Kibbelwhite and of Luner & Abitz. More critical work on refining is needed and this was also encouraged by Dr. Page in his presentation.

FORMING

Dr. B. Norman's review of the physics of sheet forming was excellent and showed us the research opportunities in stratified forming and controlled dewatering.

The report by Tomimasa et al on application of electron beams for quantitative characterization of areal mass distribution was just the type of breakthrough contribution these Symposiums are famous for.

Hopefully the outlined technique will be further developed to separate, for instance, the fiber and filler signals from each other. That would also solve the mathematical problem experienced in separating the areal mass variation of the coating layer from that of the base sheet.

It was good to see new approaches being taken to characterize of the non-uniformity of paper structure and fibre suspension as evidenced by the percolation and scaling contribution of Ritala and Huiku. Their pioneering work warrants further support and guidance to practical applications so that this approach does not become just another hydrogen bonded continuum theory in the history of paper science. Appreciations are also due to the works of Steen and of Niskanen. They are both covering very important areas of papermaking and it is good to see "new blood" entering the science of papermaking.

Dr. Tom Lindström's well structured and critical review of the chemical aspects of the web forming process together with the review type presentations of Van de Ven and of Alinec condensed the various physico-chemical aspects of wet end chemistry of papermaking to a well manageable form. I want to congratulate the FRC for an excellent selection of program for this part of the Symposium. The powerful - albeit yet complicated - flow visualization technique of Onabe and Sakurai should make it possible to check in practice how good the various wet-end chemistry flocculation hypotheses really are. As evidenced by the lively discussions after the presentations by Wågberg, Gill and Tanaka, the absorption phenomenon on pulp fibers and the related electrokinetic activity warrant a lot of further research.

PRESSING

The short wet pressing session was not short in content and in value of information presented. I personally felt that in this session the fundamental information presented by MacGregor, by Szikla and by Bergström had also perhaps the most direct implications to practical papermaking. Future wet pressing research needs to include the role of heterogeneous pressure distribution on the fiber and cell wall level of the structure.

DRYING

In the drying session the thorough review by Dr. C.H. Spragne unified nicely the various water removal regimes and outlined the property and product advantages available if the various thermomechanical subprocesses - now under development - can be reduced to practice. Judging from the level of discussion following Dr. Lindsay's presentation, more experimental results are needed to model the new thermomechanical consolidation processes. I have to confess that Dr. Lindsay's comment about the same type of equation being applicable to nuclear explosion studies for vaporization of cities did not make me feel any more confident into the models used.

The contribution by Douglas and coworkers introduced a clever way to calculate the effective pore size from flow results using the Reynolds-Forheimer formula. Further research is needed to solve the order of magnitude difference between the calculated and measured pore size data. The innovative approach to control CD drying shrinkage (as reported by Hansson and colleagues) clearly showed that innovative

research approaches can remove some of the basic drawbacks of paper structure.

The new, and partially revolutionary results of Nanko and Oshawa of the detailed interfibre bond structure provided an excellent hypothesis for the bond structure. The reported results also seemed to question some of the very foundations of our present understanding of web shrinkage. More TSEM and SLEM research is needed and - I am sure - will be done to verify these new hypo-theses, and its implication to the structural behaviour of paper.

SURFACE APPLICATION

In the surface application session both the review paper by Eklund and the modelling presentation by Kent and Lyne showed that a lot more information is needed to understand the fast dynamic absorption into base paper structure. The great need to know more about the heterogeneity of the coating layer basis weight and thickness was quite evident from the presentations of Gane and Hooper and of Engström and colleagues. This is a pre-requisite for our continued efforts to develop mottle free high quality printing papers with less and less coat weight. The paper by Mangin and Geoffroy cleverly combined the ink transfer information to the compressive surface roughness. I feel that this type of treatment of the surface roughness will become more important in order to better understand the end-use behaviour of printing papers.

CALENDERING

The calendering review by Peel and the review type contribution by Back clearly showed how the response of paper surface and bulk structure to calendering greatly depends on the temperature and moisture domain in which the calendering is carried out. I feel that a lot more research is needed in this area to be able to utilize the new calendering processes to our advantage, i.e. in order to obtain better paper products. And I agree with the concluding remarks of Sprague and Peel that the pressure drying and innovative calendering of the future will have common knowledge base. The presentations of Rodal and of Popil showed the possibilities for modelling the calendering response of paper and using the models for analysis of the role of mechanical properties of paper and roll cover material in this response. As mentioned already, this area of research is important for the future prosperity of papermaking.

In the well structured review of controllability Eriksson pointed out with very practical examples the need for good process control, and for having reliable sensors to monitor the process and to provide the feedback and feedforward control information. The review also dealt with the opportunities and issues of the more advanced integrated control systems for papermaking. The need for co-operation between the papermaking process engineers and scientists and the process control specialists was outlined as a prerequisite for future success in advancing the controllability of papermaking. The presentation by Dumont outlined several good examples of the kind of issues and opportunities that adaptive process control research is working with. Of special interest were the cases, where the environment for process control is continuously changing. And finally, Parker described the importance of understanding the sources of variance or instability in papermaking. He also recommended dealing with good engineering design and sound pulp and papermaking principles with those sources of instability, which are beyond the reach of sound process control.

Closing remarks

In closing, I want to thank the FRC for a truly successful program for this Fundamental Symposium and the speakers for high quality presentations, which have made this Symposium a practical success in the spirit of these Symposiums. I also want to express my satisfaction for the fact that this Symposium has brought "new blood" into the international arena of paper and papermaking research. One of the issues facing the continuous prosperity of the paper industry is to attract talented people into the industry. Please, spend some of your time in recruiting capable young people into the paper industry.

And finally, to all those participants of this Symposium, who can contribute to increased international co-operation in fundamental R & D and in mutually interesting practical R & D, please promote this activity as was called for also by Mr. R.C. Williams in his opening remarks. For instance an international consortium should be organized to sponsor and speed up the impulse drying R & D work.

It is interesting to note the type of organizations that have provided the presentations of this Symposium. As can be seen from Table III, out of the 38 presentations about 70 % originated from "national" research institutes of the paper

industry. About 15 % of the presentations originated from research laboratories of the paper industry or of the supplier industry. Two of the presentations came from university laboratories (four if one calculates those university laboratories as "independent" that are strongly affiliated with the "national" research institutes of the paper industry).

TABLE III.

SOURCES OF THE PRESENTED PAPERS IN THE 9TH FUNDAMENTAL RESEARCH SYMPOSIUM.

<u>"SOURCE" OF PRESENTATION</u>	<u>NUMBER OF PRESENTATIONS</u>
National Research Institute of the Paper Industry	30
Industry Laboratory	6
University Laboratory (If affiliations included)	2 (4)

Finally, Dr. Clyde Sprague gave permission to use his personal conclusions for closing remarks:

- curly fibers are important, but so are straight ones
- curly polymers seem to be important
- there are no right answers to the problems of wet end chemistry.

Thank you for your attention.