(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 514 595 A1**

(12) **EUROPEAN PATENT APPLICATION**

(21) Application number: **91304518.3**

(51) Int. Cl.[5]: **D21G 9/00**, D21H 25/14

(22) Date of filing: **20.05.91**

(43) Date of publication of application:
25.11.92 Bulletin 92/48

(84) Designated Contracting States:
DE FR GB

(71) Applicant: **Union Camp Corporation**
1600 Valley Road
Wayne New Jersey 07470 - 2066(US)

(72) Inventor: **Arnold, Raquiba H.**
48 Darien
New Hope, Pennsylvania 18938(US)

(74) Representative: **Hildyard, Edward Martin et al**
Frank B. Dehn & Co. Imperial House 15-19
Kingsway
London WC2B 6UZ(GB)

(54) **Method of making coated paper and paperboard utilizing impulse drying.**

(57) This invention provides coated paper and paper board and methods of manufacturing these materials by implementing the benefits of impulse drying. The novel methods include providing a moist web of paper-making fibers and impulse drying this web at a temperature of at least about the glass transition temperature of the paper-making fibers to produce an impulse dried sheet having a Parker Print Smoothness of less than about 6.5 microns. Following impulse drying, the impulse dried sheet is surface coated to produce a coated sheet having improved physical properties.

EP 0 514 595 A1

This invention relates to the manufacture of coated paper products, and in particular, to manufacturing coated papers having improved properties and reduced manufacturing costs.

BACKGROUND OF THE INVENTION

The production of high quality printing paper typically includes various finishing operations which include coating the paper with pigments and binder followed by smoothing the paper by passing it through either a series of nips or one nip formed by rolls that may or may not be heated. The coating is generally applied by coaters of conventional designs, such as blade coaters or roll coaters. One or more coating applications can be applied to one or both sides of the paper. Typically, a coated paper is then introduced into equipment which imparts smoothness and gloss to the surface. Such equipment includes supercalenders, machine calenders and gloss calenders.

Coated paper is commonly supercalendered by passing it through a series of nips under high load at elevated temperatures. The paper usually enters the supercalender stacks at a relatively high moisture content of about 7-9%. The nips of the supercalendering equipment provide a shearing action which results in a smooth paper with a high gloss. The high pressure associated with supercalendering compresses and densifies the paper, which typically limits the process to production of low caliper paper. For this reason, paper board for high quality printing is not usually supercalendered. Supercalendering also has the effect of reducing opacity, which is undesirable. The complexity of the supercalendering process also adds significantly to the processing time and the manufacturing cost of the paper.

Most of the final product properties of coated papers, such as smoothness and gloss, are achieved in the finishing section of the paper machine or in a subsequent coating operation off-line from the main paper production equipment. The degree of smoothness of the paper is generally a function of the density. Examples of artisans attempting to improve smoothness while limiting the amount of densification are disclosed in U.S. Patent 4,596,633, to Attwood, June 24, 1986; and U.S. 4,624,744, to Vreeland, November 27, 1986, which are hereby incorporated by reference. These patents refer to methods of producing a smoother paper surface without the densification associated with conventional calendering techniques. However, both disclose processes which are performed after the web is already dried to about 80% solids or more.

Attwood teaches a process that requires rewetting the paper or paper board prior to pressing the moist surface against a smooth polished cylinder, similar to gloss calendering. Vreeland discloses as a finishing step the process of high temperature gloss calendering at low moisture contents to attain high gloss and smoothness. Neither of these disclosures significantly simplifies the paper-making operation so as to produce higher quality papers with less complexity, and, at best, corrects inherent problems concerning lack of smoothness of the base paper as formed.

Another technique for regulating the surface properties and consistency of paper, referred to by those in paper-making arts as "impulse drying", has received considerable attention of late. U.S. 4,324,613, to Wahren, April 13, 1982; U.S. 4,738,752, to Busker et al., April 19, 1988; Burton, et al., "The Instantaneous Measure of Density Profile Development During Web Consolidation," Journal of Pulp and Paper Science, Vol. 13, No. 5, pp. J145-J149, September, 1987, all of which are hereby incorporated by reference. Impulse drying employs high temperatures, high pressures and moderately long residence times to remove water much more efficiently than conventional pressing, with large energy savings. Impulse drying both dries and densifies the fibers of the sheet by compressing a web of fibers between heated nip rollers.

Press drying and/or impulse drying of liner board and paper board has been researched by various organizations for the purpose of taking advantage of the strength increases and water removal efficiency. See U.S. 4,624,744, to Vreeland; and U.S. 4,692,212, to Swenson et al., September 8, 1987, the latter of which is also incorporated by reference.

Most of the work in the area of impulse drying technology has centered around heavy weight packaging grades requiring high strength. However, one artisan has suggested that the increased surface smoothness of impulse dried papers is suitable for writing and printing papers such as newsprint. Lavery, "Impulse Drying of Newsprint," Journal of Pulp and Paper Science, Vol. 13, No. 6, pp. J178-J184, November, 1987, also hereby incorporated by reference. Nevertheless, the effect on coated printing papers has not been investigated and prior speculation about the use of impulse dried paper for coating applications has revealed doubts about whether the coating could adhere to the impulse dried surface because of its low permeability.

Accordingly, there exists a need for paper and paper board with sufficient low permeability and high surface smoothness for producing high quality coated paper products with gloss and smoothness comparable to supercalendered sheets, but with less densification and less applied coating. There is also a need for a base paper having low surface porosity and absorbency, with high surface strength and good optical properties. There is also a need to reduce or simplify the process steps required to make high quality coated paper so as to improve production efficiency.

SUMMARY OF THE INVENTION

This invention provides a method of making coated paper or paper board by providing a web of paper-making fibers, preferably having a consistency of at least about 20% solids, and impulse drying this web at a temperature of at least the glass transition temperature of the paper-making fibers at the level of moisture in the fibers, to produce an impulse dried sheet preferably having a consistency of at least about 50% solids and a Parker Print Smoothness of less than about 6.5 microns upon completion of drying. This novel method further includes surface coating the impulse dried sheet to obtain a coated sheet having improved properties. The surface properties of the impulse dried paper reduce the finishing requirements necessary for producing an improved coated sheet.

Accordingly, a new process for the manufacture of coated paper and paper board is provided which permits the high gloss and smoothness of supercalendered coated papers without the loss in bulk or opacity associated with supercalendering. This invention makes use of the properties imparted to a base sheet during impulse drying and uses these properties to make high quality coated paper in an unexpected and improved manner. Preferably the invention includes calendering, such as gloss calendering, the coated sheet to provide a product with high gloss and better smoothness at a lower average density than a supercalendered sheet. The process enables a relatively thin coating of about 3-5 lbs/3000 ft^2 and moderate gloss calendering conditions to produce a coated paper product similar to a No. 3 coated offset paper, but with higher bulk and better smoothness. The process also results in substantial savings in manufacturing costs through the reduction of energy usage, materials and time required to produce the product.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings illustrate comparative test data for paper produced pursuant to this invention under laboratory conditions.

FIG. 1: is a graphical depiction of Gurley porosity versus bulk, comparing a standard sheet to samples prepared with impulse drying techniques;

FIG. 2: is a graphical depiction of Parker Print surface smoothness versus bulk for a standard sheet versus various impulse dried sheets; and

FIG. 3: is a graphical depiction of Letterpress Smoothness versus bulk for a standard sheet versus various impulse dried sheets.

DETAILED DESCRIPTION OF THE INVENTION

The preferred operable embodiments of this invention will now be discussed. In the preferred method, a coated paper or paper board is manufactured by first providing a web of paper-making fibers having a consistency of at least about 20% solids. This web is then impulse dried at a temperature of at least about the glass transition temperature of the paper-making fibers to produce an impulse dried sheet having a consistency of at least about 50% solids and a Parker Print Smoothness of less than about 6.5 microns upon completion of drying. Following impulse drying, the impulse dried sheet is surface coated to obtain a coated sheet. As used herein, the term "glass transition temperature" of the paper-making fibers refers to the temperature at which the cellulose fibers begin to form an amorphous, glass-like substance and bond to one another. If more than one type of furnish is employed, the "glass transition temperature" would constitute a weighted average of the individual glass transition temperatures for each type of furnish. The glass transition temperature of the furnish is lowered as the moisture content is increased, so the glass transition temperature at the furnish consistency is the preferred temperature of the fibers during impulse drying.

In another method embodiment of this invention, a web of paper-making fibers is provided having a consistency of about 20-30% solids. This web is then impulse dried at a temperature of at least about the glass transition temperature of the paper-making fibers to produce an impulse dried sheet having a consistency of about 65-99% solids and a Parker Print Smoothness of about 3.0-5.5 microns. The impulse dried sheet is then surface coated with a coating of about 3-5 lbs. per 3000 sq ft. to obtain a wet coated sheet. The wet coated sheet is then dried to produce a substantially dry coated sheet, and the dry coated sheet is then gloss calendered at a temperature of about 250-350 °F and a nip pressure of about 300-700 pli.

This invention also provides coated paper and paper board comprising an impulse dried surface having a coating of about 3-12 lbs. per 3000 sq. ft. The coating comprises a gloss calendered finish having a gloss of about 64-68%, a Parker Print Smoothness of less than about 1.5 microns, a bulk of greater than about .9 cm^3/g, and a caliper of above about 3 mils.

This invention also provides fine coated paper comprising an impulse dried surface having a coating of about 3-5 lbs/3000 ft^2. This coating comprises a gloss calendered finish having a gloss of about 64-68%, a Parker Print Smoothness of less than about 1.0 microns, and bulk of about 1.07-1.19 cm^3/g, a caliper of about 3.2-3.8 mils, and a basis weight of above about 30 lbs/3000 sq. ft.

The preferred processing techniques for operating the method of this invention will now be described. As a preliminary step, the paper-making fibers of this invention are formed into a paper web of at least about 20% solids, and more preferably 20-30% solids. The moisture level is typical of paper webs formed on a fourdrinier paper machine just before conventional pressing. The sheets are then carried to the impulse drying apparatus using drier felts for absorbing some of the water from the web during the impulse drying step.

The apparatus for the impulse drying step of this invention can include a heated drier drum capable of reaching temperatures up to about 700°F. Preferably the impulse drying step dries the web at a temperature of about 300-900°F, and more preferably about 400-600°F. The heated drier drum is preferably in contact with another drum for forming a nip capable of reaching nip pressures of about 0.3-7 MPa. Exposure times generally can run from about 15-100 milliseconds, although about 20-60 milliseconds is preferred. Reference is made to U.S. 4,324,613, which describes impulse drying techniques more fully.

In accordance with the present invention, using the above procedure, the sheets were impulse dried using one nip at 600°F and two different pressures, 287 and 445 psi, and two different dwell times, 98 and 50 milliseconds. Specific conditions for each of the samples are listed in Table I below.

Upon impulse drying, the solids content increased to over 69% for each of the samples. In contrast, pressing conditions of conventional processes increase the solids content only slightly from about 25% to about 31%. During impulse drying, the fibers in the web consolidate more completely than in conventional processing, and the structure is effectively locked in. The increased solids level after impulse drying further reduces deformation of the fibers from additional process steps.

During web formation and drying, the fibers of the web shrink and deform much more in conventional pressing and drying than in impulse drying, since they are relatively unrestrained. With impulse drying, the web is preferably held against a heated steel roll at high temperature and pressure and for a relatively short time, making the fibers highly constrained as they dry. This permits the fibers to consolidate and the structure is locked in.

TABLE I

Impulse Drying Parameters:

Sample	Temperature (°F)	Pressure (PSI)	Residence Time (msec.)	Ingoing Consistency (% solids)	Outgoing Consistency (% solids)
1	600	287	98	26	89
2	600	287	98	26	85
3	600	287	98	25	77
4	600	287	98	24	99
5	600	445	50	26	69
6	600	445	50	24	74
7	600	445	50	24	83

Cross-section micrographs comparing conventional unrestrained drying to impulse drying established that the impulse dried fibers are well bonded, more dense, and exhibit a very flat and smooth surface where the web has been heated. This difference in structure affects the physical properties to a great extent. These benefits include greater surface strength, better smoothness, and higher density than conventionally pressed papers. For board grades, the density of the fibers towards the heated surface during impulse drying is greater than the underlying fibers.

Although the density of the sheet is higher, the fibers of the sheet are less deformable. Upon final calendering after the cooling step, the impulse dried sheet is less dense than a conventional pressed, coated and calendered paper.

The smoothness of an uncalendered impulse dried sheet as measured by conventional Parker Print

Smoothness ("PPS") analysis was found to be smoother than an uncoated machine calendered conventional sheet, "Jamestown Xerographic" manufactured by Union Camp Corporation, as revealed by the data in Table II.

TABLE II

Parker Print Smoothness of Impulse Dried Sheet vs. Commercial Uncoated Paper:		
Sample	Parker Print Smoothness in microns	
	Impulse Dried Side	Untreated Side
1	4.4	8.2
2	4.3	8.2
3	4.3	7.7
Jamestown Xerographic	N/A	5.6

The impulse dried side of the sample sheet was also much smoother than the untreated side of these sheets. Generally speaking, the uncalendered impulse dried sheets of this invention will have a Parker Print Smoothness of less than about 6.0 microns, and preferably about 3-5.5 microns.

The surface coating step of the preferred method can include conventional apparatuses such as air knife coating or blade coating. Preferably, about 1-12 lbs/3000 ft^2, and more preferably 3-5 lbs/3000 ft^2 of coating material is employed for coating a single side of the paper or paper board of this invention. Both sides may also be coated. The coatings can contain standard pigments and binders typically used in coating paper. A typical composition is about 80 wt.% No. 1 kaolin clay and about 20 wt.% fine ground calcium carbonate as a pigment with styrene butadiene as a binder. This coating was not optimized for properties but will provide a glossy, smooth product. The coating solids should be relatively high to minimize the amount of water applied to the sheet. The coating may be applied at e.g. 5 lbs/3000 sq. ft. to the impulse dried side of the sheets. This amount of coating is less than the usual amount applied in standard coating practices for high quality papers.

To get a smooth coated surface, blade coaters are typically employed by manufacturers of coated paper. Blade coaters can compensate for the roughness of a base sheet and can cover irregularities if enough coating is applied. An air knife coater, on the other hand, follows the contours of the substrate surface. Air knife coaters are commonly used as a top coat after a smooth surface has already been laid down by a blade coater for coated board grades. Since the surface of such impulse dried sheets is already smooth, a smooth coated surface can be obtained even using an air knife coater with a single coating application. Even better quality is obtained if a blade coater is used on an impulse dried base sheet.

Following coating, the coated sheet will be wet and thereafter dried. The coating drying operation preferably employs hot air blown onto the coated surface. Alternatively, infrared driers can be used to quickly set the coating. Infrared is usually used under special circumstances, and generally results in better qualities since it reduces the penetration of coating into the sheet by shortening the time the coating is wet. However, the low surface porosity of an impulse dried sheet already minimizes coating penetration, and thus the need for infrared drying can be reduced or eliminated. Furthermore, drying the coating on an impulse dried sheet is easier since the coating is held out on the surface, rather than absorbed. Less energy and/or less time is used to dry the coatings since rewetting of the underlying base sheet is minimized. The efficiency of coating driers decreases dramatically if the underlying base sheet is too wet. The base sheet can become too wet if a high amount of coating is required needed to cover a rough base sheet to obtain high quality. These inefficiencies can be reduced or eliminated if the base sheet is impulse dried.

The most preferred method of this invention further includes gloss calendering the substantially dry coated sheet to produce a fine paper. Gloss calendering is a common finishing operation which produces high gloss surface finishes without the densification associated with supercalendering. The technique uses heated rolls preferably having a temperature of at least about 225°F and more preferably about 250-350°F with moderated nip pressures of about 250-1000 pli, more preferably 300-700 pli, and primarily affects only the uppermost surface of the paper, which is usually coated. Because there is less densification, better opacity results, but the sheet is generally not as smooth as supercalendered products. Gloss calendering equipment, however, can be used in-line with the main paper production equipment, while supercalendering generally is not. Coated impulse dried sheets that were tested pursuant to this invention were gloss calendered using a soft rubber covered backing roll at about 300°F and about 300 pli. The calendering conditions were thus relatively mild for producing glossy coated paper. These conditions were typical of coated board produced on-machine. As a result, while the caliper of the coated impulse dried sheets was not reduced very much at all, a very glossy smooth surface similar to a supercalendered sheet was unexpectedly obtained.

Alternatively, the preferred calendering step of this invention can be accomplished with machine calendering. The coated paper passes through a nip between two hard rolls at high pressure and moderate temperature. The machine calender densifies the web and is used to control the caliper of the sheet. Machine calendering also produces smoothness but generally with little gloss. The equipment is fairly standard for finishing operations for paper and paper board and is usually used in-line with the main paper production equipment.

The properties of three experimental sheets made in accordance with this invention were compared to a commercially available No. 3 coated paper which was supercalendered and blade coated on two sides with approximately 7-8 lbs/3000 sq. ft. of coating per side. A summary of the properties of the experimental impulse dried sample sheets and the commercial product are listed in Table III below. The experimental samples were as glossy, much smoother, and were less dense than the commercial sample. The experimental samples also possessed excellent ink holdout. Because these properties are better, and different, the coated impulse dried sheet proved to be higher in quality than the more expensive No. 3 coated paper.

Further experiments were conducted employing more conventional techniques and consistencies. A 12" wide web was formed on a web former using 40 dry pounds of bleached chemical pulp containing high amounts of southern hardwood, 25-30% solids. Specifically, the furnish contained 85% hardwood and 15% pine; 80 pulp brightness; and 370 S/R freeness. The pulp was reslushed in a laboratory beater and delivered directly to the head box. The web former used was basically a head box, a Fourdrinier wire with vacuum-assisted drainage, a small one nip press roll and a spindle for winding up the wet web The targeted basis weight was about 75 lbs/3000 ft^2.

After forming, the wet web was impulse dried using consistencies, dwell times and temperatures which were chosen by considering the limitations of impulse dryers and the technical feasibility of these parameters in practical applications. The samples employed impulse drying parameters which included nip temperatures of 400, 500, and 600°F; nip dwell times of 20 and 50 milliseconds; and an average nip pressure of 400 pli. These experiments used one nip on one side of the web surface. Additionally, experiments were run which included, in the first instance, the use of 400°F for two nips on both sides of the web surface, and, in the second instance, a first nip of 600°F and a second nip of 400°F. A control

TABLE III

Property Comparison:

	Gloss (%)	Parker Print Smoothness (microns)	Bulk (cm^3/g)	Caliper (mils)	Basis Wt. lb/3000 ft^2
Test Sample*	66.5	0.91	1.07-1.19	3.5	51
No. 3	66.2	2.19	0.86	3.0	54.5

* Average of the data for three samples.

was run at 100 ° F, 20 milliseconds, and 400 pli average nip pressure.

The nip pressure was held constant throughout the trial at an average pressure of about 400 pli. This pressure is not unlike conventional pressing. Experiments showed that higher nip pressures do not significantly improve smoothness and may interfere with runability.

After impulse drying, it was noted that the impulse dried web was significantly drier, but because the dwell times were shorter and the basis weight was higher, the same degree of drying found with handsheets was not observed in this experiment. Drying the webs was completed on a laboratory drum dryer. The ingoing consistency for impulse drying generally was between about 32-34% and the outgoing consistency varied with the conditions listed in Table IV below.

For the one nip experiments, the wire side of the web was toward the heated roll and the felt was on the top side. A liner board felt was used in these experiments so the felt side of the sheet was much rougher than ideal, which was subsequently reflected in the smoothness parameters for this side. For the two nip experiments, the wire side was toward the first heated nip and the top side was toward the second heated nip. In these experiments, felt marking was observed on both sides of the sheet because the sheet was in contact with a felt at some point. Felt marking was more severe on the wire side of the sheet since it was the last side to have a felt on it.

The uncoated impulse dried webs were subjected to both physical and print lab testing. Scattering coefficients were determined and used as a measure of how well bonded the fibers in the sheet became with impulse

TABLE IV

CHANGE IN MOISTURE DURING IMPULSE DRYING

Temp. °F.	NRT msec	Peak psi	Ingoing Consistency	Outgoing Consistency
100	20	400	32.1	38.6 control
400	20	400	"	40.1
400	50	400	"	47.3
500	20	400	"	49.3
500	50	400	" sheet break	43.3
600	20	400	33.8	53.1
600	50	400	"	45.4

drying. The scattering coefficient for the impulse dried sheets increased about linearly with bulk. It was determined, therefore, that better bonding is usually found for denser sheets and the scattering coefficient decreases with increases in bonded area. Unexpectedly, however, the average bulk of the impulse dried sheet was found to be lower than for conventional pressed and dried sheets. Impulse drying, therefore, increases the flexibility for obtaining different properties which depend on bulk.

Sheet porosity was found to change significantly with impulse drying compared to standard pressing and drying as described in FIG. 1. Gurley porosity was shown to increase as the sheet is densified. The increase was different but not as high with two nip impulse drying. With two heated nips in subsequent operations, water is probably forced through the first impulse dried side causing it to be more open. The impulse dried sheets were found to be much less open than the control and standard pressed sheets made from this type of furnish. The data for the standard conditions was obtained from pressed and calendered handsheets.

The change in Gurley porosity with bulk for impulse dried sheets suggests that the paper is unique and would be suitable base stock for coating. Because of the lower porosity, the coating penetration into the sheet should be much less and this property has many advantages.

Surface smoothness, as measured by Parker Print Smoothness, was determined to be much better for the impulse dried sheets than for conventionally pressed and dried sheets, as illustrated in FIG. 2. See J. R. Parker, TAPPI Journal, Vl.64, No. 12, pp. 56-58 (1981) which further describes this procedure and which is herein incorporated by reference. This curve shows that the impulse dried conditions produce products which were all smoother than the control. Typical machine calendered xerographic paper has a PPS of about 5.6. The impulse dried base stock is nearly as smooth as a finished sheet but retains a higher bulk. Increasing the temperature and dwell time of the nip helps smoothness. Therefore, it is further noted that smoothness development with the impulse dryer responds similarly to gloss calendering. The process can be considered as a one-step process for pressing, drying, surfacizing, and finishing.

When smoothness is measured by Letter Press Smoothness ("LSS"), the same conclusions about smoothness development with impulse drying were reached, see FIG. 3. Letter Press Smoothness is the measure of a depth of black ink, in microns, sufficient to obtain complete coverage of the paper surface. This standard was compared to the conventionally wet pressed, dried and machine calendered sheets of similar furnish. Compared to the control estimations, the bulk-smoothness relationship of the impulse dried sheets was much improved over the standard methods of producing base stock. These samples were coated by an air knife coated with 5 lbs/3,000 ft^2 of coating.

The impulse dried base sheets of this invention are not limited to fine paper production and can be used as a starting material for a multitude of paper products. The base sheet can be treated with a pigmented size press application to produce machine finished pigment grades or treated with a light blade coating to produce light weight coated paper. The base sheet could alternatively be coated using any formulation or coating equipment to achieve the quality of any supercalendered coating grade of paper, such as No. 2, or No. 1, etc. Additionally, the base sheet can be treated by more than one coating application to produce, for example, double coated and triple coated grades. The base sheet can alternatively be coated and finished by other art recognized processes for achieving smoothness and/or gloss. In sum, this invention can be used to manufacture products which typically use coating to impart a specialized surface finish in which keeping the coating on the surface and keeping that surface as smooth as possible is a desired effect.

Claims

1. A method of making coated paper or paper board, comprising:
(a) providing a web of paper-making fibers having a consistency of at least about 20% solids;
(b) impulse drying said web at a temperature of at least about the glass transition temperature of the paper-making fibers to produce an impulse dried sheet having a consistency of at least about 50% solids and a Parker Print Smoothness of less than about 6.5 microns; and
(c) surface coating said impulse dried sheet to obtain a coated sheet.

2. The method of claim 1 wherein said providing step (a) provides a web of paper-making fibers having a consistency of about 20-30% solids.

3. The method of claim 1 or claim 2 wherein the impulse drying step (b) comprises producing an impulse dried sheet having a consistency of about 65-99% solids.

4. The method of any preceding claim wherein the impulse drying step (b) comprises drying said web at a temperature of about 300-900 °F (149-482 °C).

5. The method of claim 4 wherein said impulse drying step comprises drying said web at a temperature of about 400-600°F (204-316°C).

6. The method of any preceding claim wherein the impulse drying step (b) comprises employing a nip exposure time of about 15-100 milliseconds.

7. The method of claim 6 wherein said impulse drying step (b) comprises employing a nip exposure time of about 20-60 milliseconds.

8. The method of any preceding claim wherein the impulse drying step (b) comprises applying a pressure of about 0.3-7 MPa.

9. The method of any preceding claim wherein in step (b) the impulse dried sheet has a Parker Print Smoothness of less than about 6.0 microns.

10. The method of claim 9 wherein said impulse dried sheet has a Parker Print Smoothness of about 3.0-5.5 microns.

11. The method of any preceding claim wherein the surface coating step (c) comprises applying a coating of about 1-12 lb/3000 ft^2 (1.631-19.57 g/m^2).

12. The method of claim 11 wherein said surface coating step (c) comprises applying a coating of about 3-5 lb/3000 ft^2 (4.893-8.154 g/m^2).

13. The method of any preceding claim wherein the surface coating step (c) comprises air knife coating.

14. The method of any of claims 1-12 wherein the surface coating step (c) comprises blade coating.

15. The method of claim 13 wherein said air knife coating step comprises coating said impulse dried sheet with a coating composition comprising about 80% Kaolin clay, about 20% ground calcium carbonate and a styrene butadiene binder.

16. The method of any preceding claim further comprising the step of gloss calendering said coated sheet.

17. The method of claim 16 wherein said gloss calendering step comprises gloss calendering at at least about 225°F (107°C) and at least about 300 pounds pli (528 N/cm).

18. A method of making coated paper or paper board comprising:
(a) providing a web of paper-making fibers having a consistency of about 20-30% solids;
(b) impulse drying said web at a temperature of at least about the glass transition temperature of the paper-making fibers to produce an impulse dried sheet having a consistency of about 65-99% solids and a Parker Print Smoothness of about 3.0-5.5 microns;
(c) surface coating said impulse dried sheet with a coating of about 3-5 lbs. per 3000 sq. ft. (4.893-8.154 g/m^2) to obtain a wet coated sheet;
(d) drying said wet coated sheet to produce a substantially dry coated sheet; and
(e) gloss calendering said dry coated sheet at a temperature of about 250-350°F (121-177°C) and a nip pressure of about 300-700 pounds pli (528-1232 N/cm).

19. A coated paper or paper board comprising: an impulse dried surface having a coating of about 3-12 pounds per 3000 sq. ft. (4.893-19.57 g/m^2), said coating comprising a calendered finish having a gloss of about 64-68%, a Parker Print Smoothness of less than about 1.5 microns, a bulk of greater than about .9 cm^3/g, and a caliper of above about 3 mils.

20. A fine coated paper comprising an impulse dried surface having a coating of about 3-5 pounds/3000 sq. ft. (4.893-8.154 g/m^2), said coating comprising a gloss calendered finish having a gloss of about 64-68%, a Parker Print Smoothness of less than about 1.0 microns, a bulk of about 1.07-1.19 cm^3/g, a caliper of about 3.2-3.8 mils, and a basis weight of above about 30 lbs/3000 ft^2 (48.93 g/m^2).

21. A coated fine paper manufactured by the process of any of claims 1 to 18.

22. A method of making coated paper or paper board, comprising:
(a) providing a moist web of paper-making fibers;
(b) impulse drying said web at a temperature of at least about the glass transition temperature of the paper-making fibers to produce an impulse dried sheet having a Parker Print Smoothness of less than 6.5 microns;
(c) surface coating said impulse dried sheet to obtain a wet coated sheet; and
(d) drying said wet coated sheet to produce a substantially dry coated sheet.

23. The method of claim 22 further comprising gloss or machine calendering said substantially dry coated sheet.

Fig. 1

POROSITY OF THE SHEET WITH IMPULSE DRYING

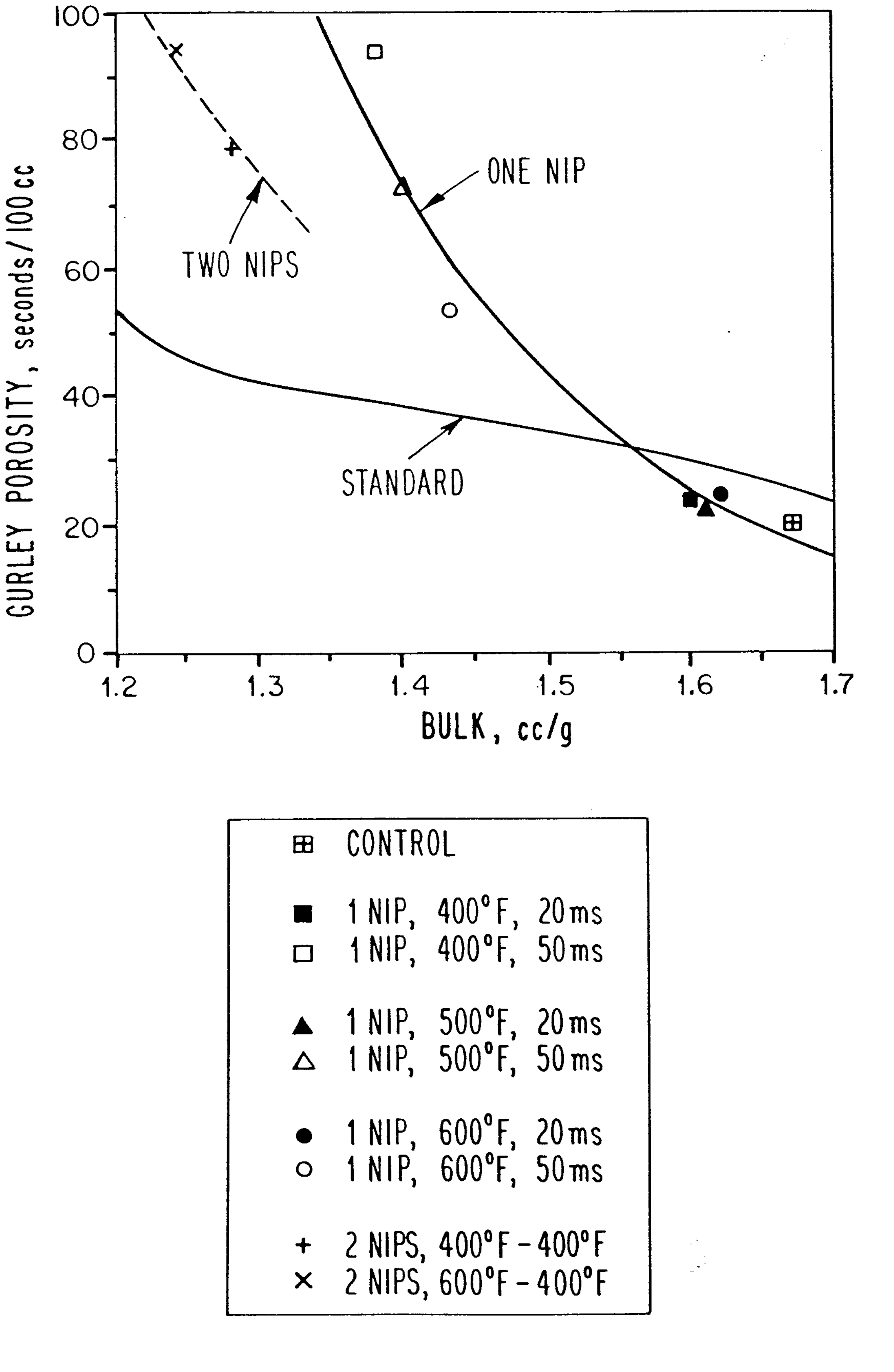


Fig. 2

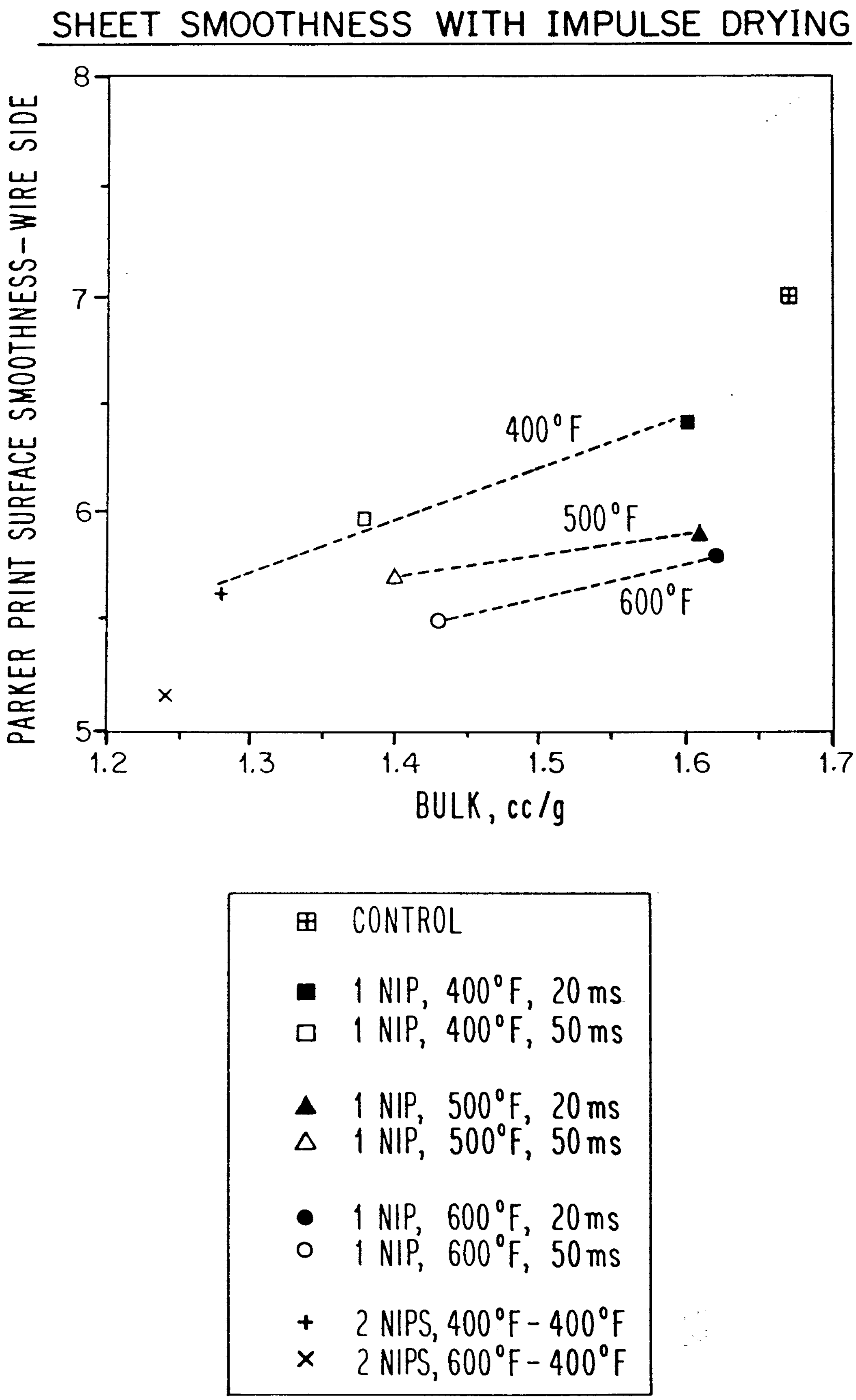
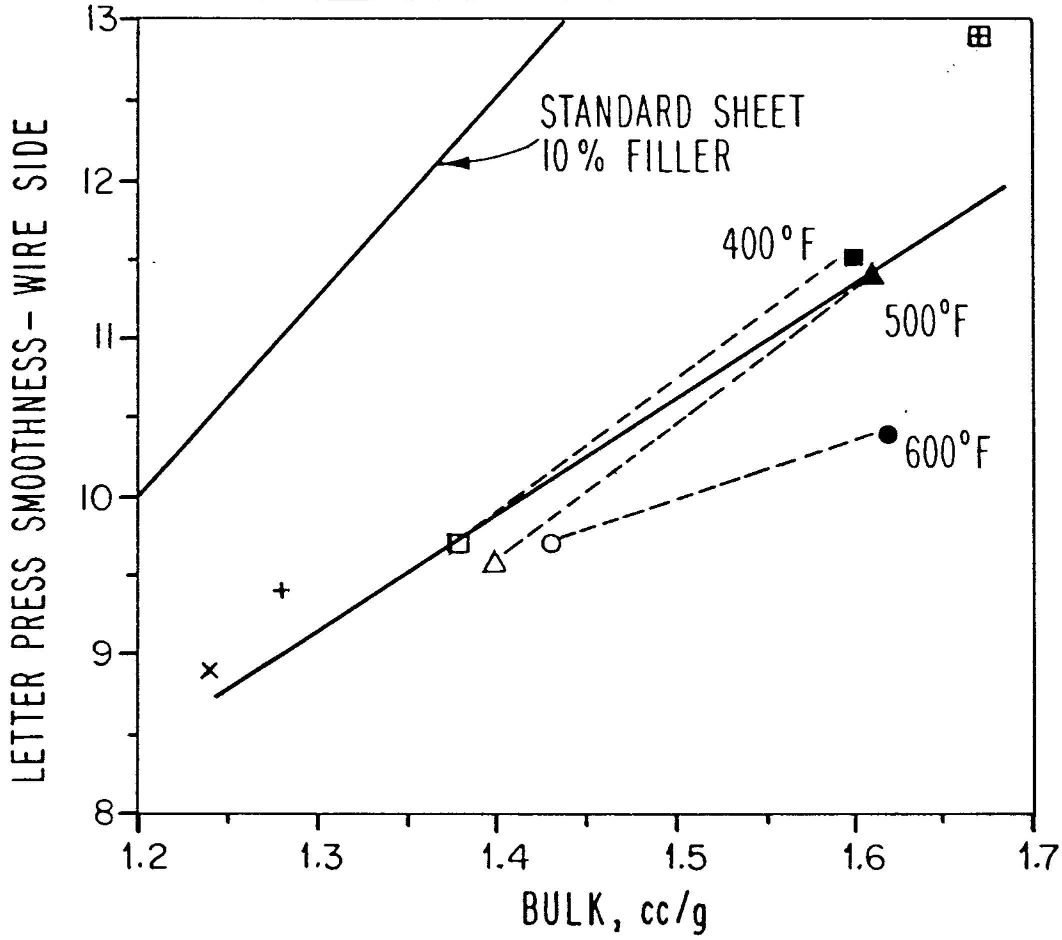
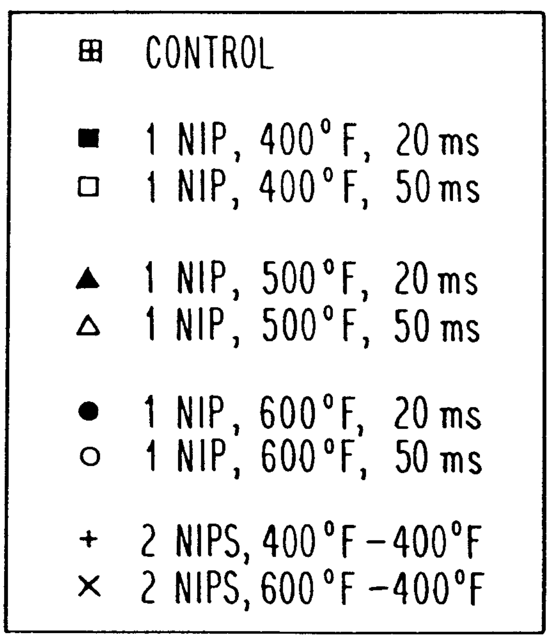

SHEET SMOOTHNESS WITH IMPULSE DRYING
PARKER PRINT SURFACE SMOOTHNESS–WIRE SIDE
8
7
6
5
1.2
1.3
1.4
1.5
1.6
1.7
BULK, cc/g
400°F
500°F
600°F
CONTROL
1 NIP, 400°F, 20 ms
1 NIP, 400°F, 50 ms
1 NIP, 500°F, 20 ms
1 NIP, 500°F, 50 ms
1 NIP, 600°F, 20 ms
1 NIP, 600°F, 50 ms
2 NIPS, 400°F - 400°F
2 NIPS, 600°F - 400°F

Fig. 3

SMOOTHNESS DEVELOPMENT MEASURED BY LSS FOR IMPULSE DRIED SHEETS





European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 91 30 4518

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
D,A	US-A-4 624 744 (VREELAND) * the whole document * ---	1,18-22	D21G9/00 D21H25/14
D,A	US-A-4 596 633 (ATTWOOD) * the whole document * ---	1,18-22	
A	DE-A-3 535 685 (BILLHÖFER MASCHINENFABRIK GMBH) -----		

TECHNICAL FIELDS SEARCHED (Int. Cl.5)
D21G D21H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	16 DECEMBER 1991	ELMEROS C.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons
....
& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P0401)