MULTIPOINT SIMULTANEOUS PORE STRUCTURE ANALYZER

Applications

During the manufacturing process, many finished and unfinished sheet products of woven as well as nonwoven materials are produced as rolls. To be able to decide on the suitability of the product for various applications and to control manufacturing parameters for optimizing manufacture of product of desired quality, pore structure characteristics of the product along its width and the length are required. In order to be assured of the quality of the product multi point tests on the width of the product as a function of product length is desirable. Multipoint Simultaneous Pore Structure Analyzer is designed for such applications.

Principle

Capillary flow porometry is used to characterize the pore structure. In this technique flow rate of an inert gas through the sample is measured in dry conditions as a function of differential pressure. The sample is wetted using a wetting liquid and the flow rate of the inert gas through the wet sample is measured as a function of differential gas pressure. Differential pressure yields pore diameter.

$D = 4 \gamma \cos \theta / p$

Dry and wet gas flow rates are used to compute other pore structure characteristics such as pore distribution and mean flow pore diameter. D = pore diameter, γ = surface tension, θ = contact angle, p = differential pressure. Dry flow rate is also used to compute gas permeability after Darcy's law. Liquid flow rate measured as a function of differential pressure yields liquid permeability.

Instrument

All the models of this instrument are similar. In one model the sheet to be tested is made to pass through two flat parallel plates. The top plate has straight through cylindrical holes to accommodate inverted cup shaped sample chambers and about two inch diameter samples. The bottom plate also has through holes aligned with the holes in the top plate. There are five chambers over the product width of about twenty inches. The chamber has gaskets at its bottom rim to make pressure tight seal with the sheet when the chamber goes down the hole in the top plate to make contact with the sheet. The top of the chamber is connected to the pressure transducer to measure pressure just above the sample. The sample chamber is also connected to gas line to supply pressurized gas to the chamber. The outlet of a small valve for discharging specified amount of wetting liquid on the sample in the sample chamber is allowed to pass in to the chamber. The valve is computer controlled to discharge the wetting liquid at the desired time.

The gas permeability test is performed first. During this test gas flow rates through the dry sample and differential pressure are measured. The differential pressure is reduced to zero, a known amount of wetting liquid is discharged on to the sample in the sample chamber so that the sample is completely wet. The pressure of gas is the increased in the chamber. The pressure at which gas starts to flow through the wet sample is measured. This is the bubble point pressure. The computer records all the results and calculates the bubble point pore diameter and gas permeability. If desired tests can be continued at higher pressures after the bubble point has been reached so that mean flow pore diameter and pore distribution can be obtained.

In another model of the instrument, eight chambers are provided over the product width of about fifty inches. This model has the additional ability to measure liquid permeability. An extra chamber is provided with each bubble point test chamber. Liquid flow rate through the sample held within this extra chamber is measured as a function of applied differential pressure. The liquid flow rate is electronically measured by sensing the displacement of a magnetic float on the liquid held in a penetrometer. The samples can be about two to three inches in diameter.

The instrument can have many test heads along the width of the sheet material so that simultaneous tests can be performed at a number of locations along the width. The same tests across the width can be performed in another location when the sheet moves. There are many ways of advancing the material. The sheet product can be mounted on two rolls and can be made to automatically advance from one location along its length to another. Another option is that samples can be cut from the roll after specified length and tests can be performed on the cut piece over its width. The instrument is fully automated. Operator involvement is minimal.

Typical Display of Results

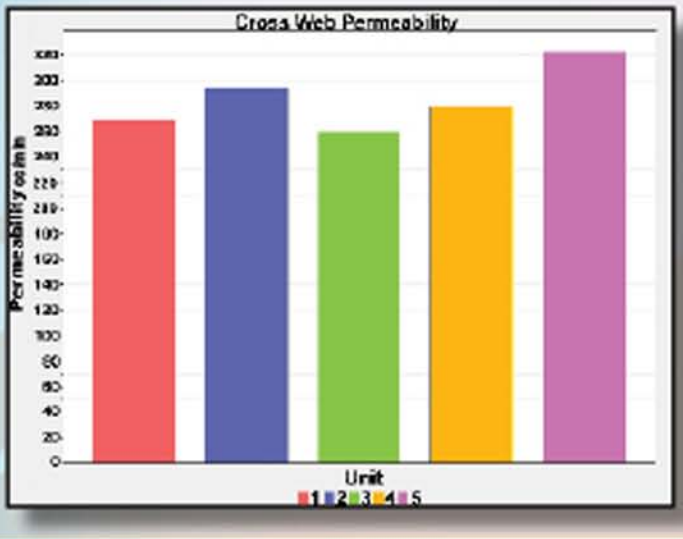
[illegible] 1.0
Date Dec 14 2007
Time 7:22:36 AM
Sample ID A-1
File C:\Documents and Settings\[illegible]\TEST.TXT
[illegible] Pressure 0.1
Surface Tension [illegible]
Date Dec 14 2007
Time 7:22:36 AM

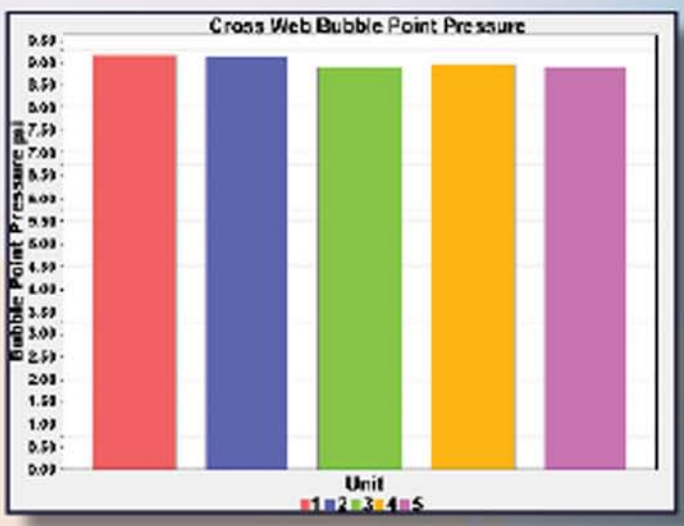
		Test Locations Along the Width of the Rolled Product									
Time	Distance Along the Length of the Rolled Product	#1		#2		#3		#4		#5	
Seconds	Feet	Perm1	BP1	Perm2	BP2	Perm3	BP3	Perm4	BP4	Perm5	BP5
617	1	314.769	9	91.647	3.021	243.319	3.424	275.394	3.031	425.993	0.933
942	2	333.070	3.916	250.745	3.074	242.709	3.429	257.313	3.021	244.609	0.524
1264	3	250.941	3.071	199.358	3.973	249.525	3.752	275.709	3.695	240.795	0.529
1587	4	329.119	3.017	317.951	3.979	249.701	3.407	277.427	3.717	253.915	0.943

Perm - Gas flow in cc/min
BP - Bubble Point Pressure, psi

Display of Cross Web Results

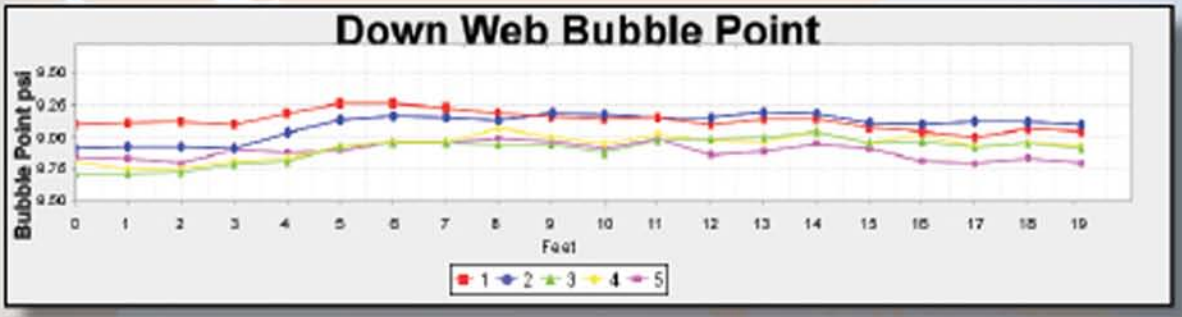
These two graphs show bubble points and permeability values at the five locations. The value at each location is the average of values measured along the length.

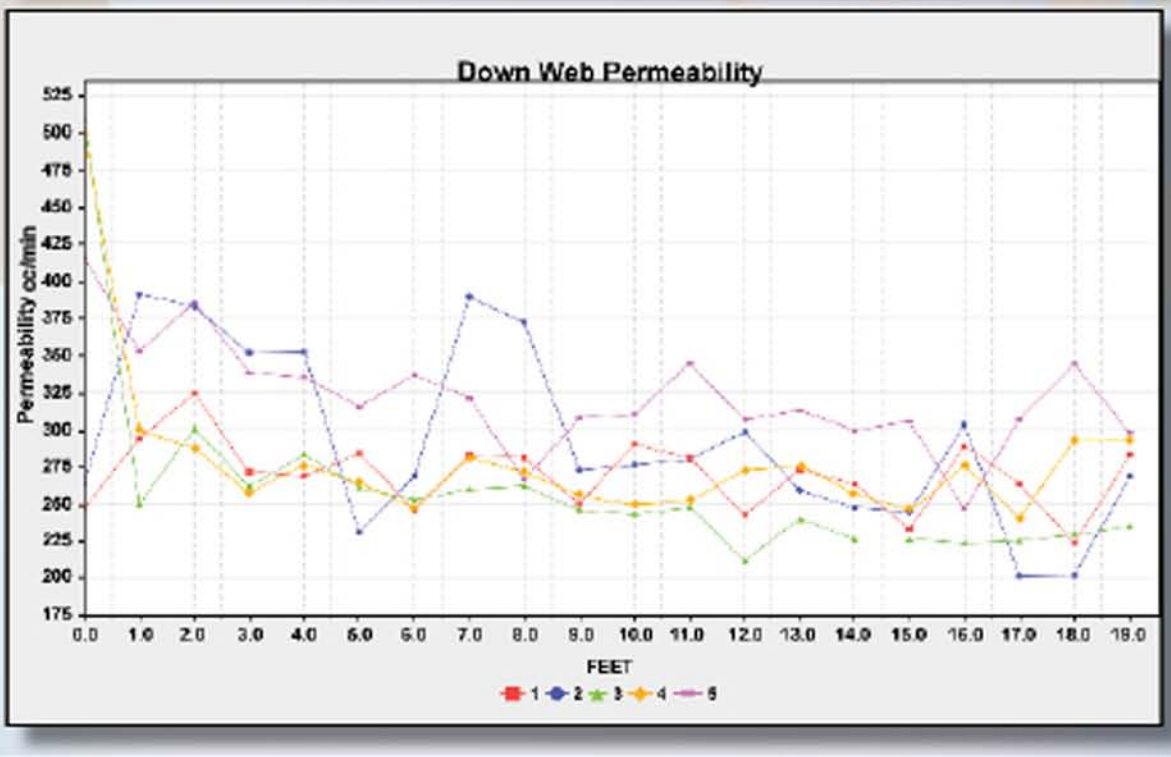




Display of Down Web Results

These two graphs show the results of different bubble points and permeability along the length of a roll at the five locations





Unique Advantages

- Properties are recorded as the sheet is getting rolled. There is a permanent record of pore structure characteristics of the entire roll
- If properties are not within acceptable limits along the width or the length, the unacceptable portions can be discarded rather than supplied to customers creating customer dissatisfaction and increased cost.
- Major faults detected early leads to modification of production control parameters so that more accept able products are manufactured.
- Wastage is minimized, cost is reduced, and production is optimized.

Other Products

Average Fiber Diameter Analyzer
Bubble Point Tester
Capillary Flow Porometer
Complete Filter Cartridge Analyzer
Clamp-On Porometer
Compression Porometer
Cyclic Compression Porometer
Envelope Surface Area Analyzer
Filtration Media Analyzer
High Flow Porometer
Integrity Analyzer
Capillary Condensation Flow Porometer
In-Plane Porometer
Microflow Porometer
Custom Porometer
Nanopore Flow Porometer
QC Porometer
Diffusion Permeameter
Water Intrusion Porosimeter (Aquapore)
Liquid Permeameter
Vapor Permeameter
Water Vapor Transmission Analyzer
Liquid Extrusion Porosimeter
Mercury/Nonmercury Intrusion Porosimeter
Vacuapore
BET Liquisorb
BET Sorptometer
Gas Pycnometer
Mercury Pycnometer
Gas Permeameter

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