npt2™ Putting education to work.

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The Advanced Technology Education (ATE) program endeavors to strengthen the skills of technicians whose work is vitally important to the nation's prosperity. In ATE centers and projects, two-year colleges have a leadership role, and work in partnership with universities, secondary schools, business and industry, and government agencies to design and carry out model workforce development initiatives.

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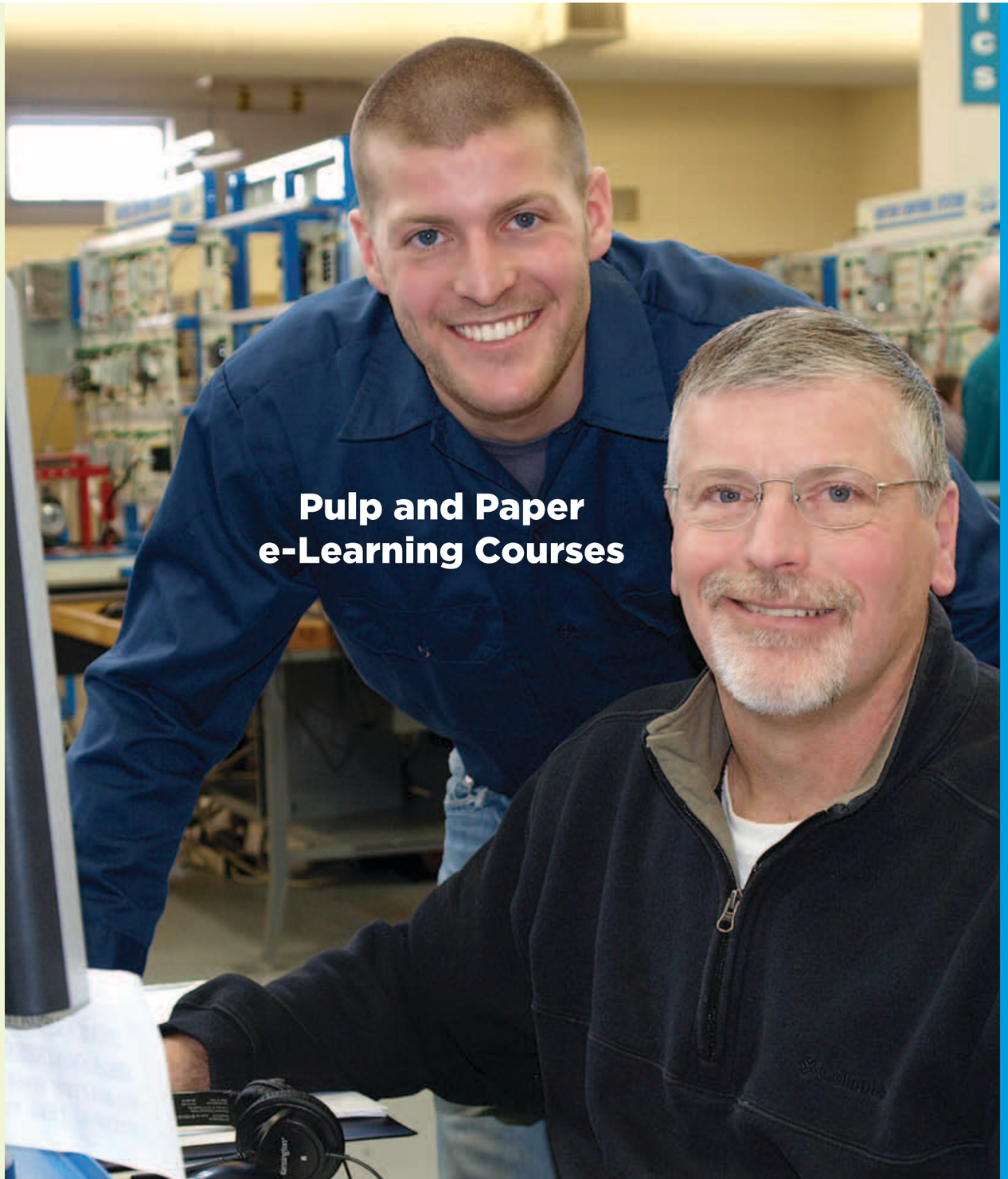

Our network of community colleges and other partners has enabled us to develop and deliver the curriculum that works.

Today, the opportunities for careers in the pulp and paper industry are significant. Due to the move to more automated technologies and intelligent production systems, combined with the impending retirement of a generation of seasoned workers, there are jobs open in mills across the country. And an extremely efficient and effective way to prepare for these jobs is through the training provided by NPT2.

NPT2 is a nationally recognized leader in pulp & paper training, educating future and current process & maintenance technicians in a broad array of subjects. Here are just a few of the reasons NPT2 works:

- NPT2, along with our network of community colleges, offers a full curriculum to make certain employees receive a well-rounded education. Program participants can progress toward accredited certificates, diplomas, and degrees.
- You can select from a number of training options, from classroom to e-learning, providing flexibility to meet your needs.
- NPT2 e-learning courses are led by renowned experts in the area of pulp & paper science.
- We can also customize material from our course portfolio for your specific organizational needs, including integration of our educational material with your in-house training.

The following classes offered by NPT2 have been developed in cooperation with the following distinguished faculty:

Dr. Martin A. Hubbe
Professor, Department of Forest Biomaterials
North Carolina State University

Dr. Margaret Joyce
Professor, Department of Paper Engineering, Chemical Engineering, and Imaging
Western Michigan University

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Pulp Manufacturing Technology

Course Description:

The overall objectives of this course are to provide participants with the following:

1) an improved understanding of pulping processes,

2) the ability to interact more knowledgeably with process engineers, operators, and technicians, and

3) the skill and ability to optimize mill performance.

Upon successful completion of this course, participants will have gained:

- A comprehensive overview of pulping, pulp processing & bleaching technology, process variables, equipment, and terminology.
- Increased knowledge of how one part of the mill affects another, and an increased awareness of thinking on a mill-wide basis.
- Increased knowledge of how the pulp mill processes affect pulp properties, thereby increasing the ability to maintain product quality metrics, and how to troubleshoot variations in quality.
- Increased awareness of the complex environmental challenges associated with pulp manufacturing.

Textbook:

NPT2. **The Pulp and Paper Technology Advanced Workforce Training and Education Series, Volume 1: Pulp Manufacturing**. Tappi Press, 2006. ISBN: 1-59510-133-0

Smook, G.A. **Handbook for Pulp & Paper Technologist**, 3rd Edition, 2002. ISBN: 0969462859

Module	Title	Objectives	Subject
1	Introduction and Overview of Course	Course Introduction	Course Introduction • Learning Objectives • Overview of Pulp Mill Operations • Overview of Paper Operations • Technical Resources
2	Overview of U.S. and Global Pulp & Paper Industry	A review of the U.S. and global pulp & paper industry, and the factors that drive industry trends. • Awareness of global supply and demand factors and the variables associated with cost and competitiveness.	U.S. Paper and Paperboard Production • CFS Markets • UFS Trade • Global Paper and Paper Board Consumption • Forces that Drive Industry Trends • Raw Material Influences • Paper Machines • Major Production Expense Categories • Cost Curves • Global Implications • Pulp & Paper Mill Strategy
3	Wood and Fiber Supply	An understanding of: • U.S., Canadian, and global wood & fiber sources. • Non-wood fiber sources.	Papermaking Fibers • Global Forest • Wood Requirements • Wood Supply Trends • Fiber Lengths • Fiber Comparisons • BSKP Wood Costs
4	Wood and Fiber Structure and Properties	Recognize the characteristics of Hardwoods and Softwoods. • An understanding of important wood and fiber properties that affect pulp & paper quality.	Wood Chips • Softwood and Hardwood • Softwood Fiber • Hardwood Fiber • Fiber Coarseness • Strength Comparisons • Wood Structure • Cell Wall • Cell Wall Microfibrils • Fiber Properties That Affect Paper Structure and Properties
5	Wood and Fiber Chemistry	To learn about the chemistry of wood fibers, including cellulose, hemicelluloses, lignin, and the extractives in order to assimilate the reactions that occur in pulping and the effect of chemicals on pulp properties.	Wood Chemistry Components • Hemicelluloses • Lignin Structure • Wood Terpenes • Wood Phenols • Wood Resins and Fatty Acids • Pitch Deposits • Properties of Extractives • Wood & Fiber Quality and Control • Softwood Compression Wood • Comparison of Mature and Juvenile Wood • Fiber Characteristics of Juvenile Wood • Paper Characteristics of Juvenile Wood
6	Fiber Bonding in Paper	To learn about hydrogen bonding and how it is achieved; the concept of inter-fiber relative bonded area and variables that influence bonding. • An understanding of how fiber properties and bonding predict tensile strength as shown by the Page Equation.	Fibers in Paper Structure • Interfiber Bonding • Bonded Area • Page Equation • Troubleshooting Strength Variations • Mill Overview
7	Wood Preparation	An understanding of the function and importance of a pulp & paper mill Woodyard operation. The examination of the Woodyard includes how wood arrives and is stored; bark removal equipment, and variables that affect debarking.	Harvesting • Wood Delivery • Woodyard Overview • Woodyard Equipment • Wood Handling • Wood Storage • Quality Control • Bark • Bark Organics • Wood and Chip Preparation
8	Chip Preparation	Attain an increased knowledge of the chipping process, chip screening, chip storage & recovery, and to learn about variables that comprise a chip quality program.	Chipping • Chip Screening • Chip Characteristics • Chip Quality • Chip Storage • Chip Degradation • Chip Reclaim
9	Overview of Pulping	Describe the categories of pulping, including chemical and cooking conditions. • An understanding of terminology used in pulping operations. • Analyze the most common pulp properties and tests.	Overview • Pulping Processes • Pulp Grades • Pulp Production • Pulp Testing • Yield vs. Kappa • Shive Rejects • Brightness • Pulp Cleanliness • Pulp Viscosity • Tensile Strength • Product Properties
10	Kraft Pulping Equipment	To become familiar with the major types and functions of equipment utilized in pulping operations. • Examine and gain an increased understanding of batch and continuous digesters.	Pulping Equipment • Digesters • Batch Digesters • Continuous Digesters • Batch Cooking • Chip Filling • Heating Options • Heating and Cooking • Blowtank • Blowheat Condensate Accumulator • KAMYR Continuous Digester • Chip Bins • Chip Meter and Steaming Vessel • High Pressure Feeder • KAMYR Top Section • Standard Top Separator • Steamphase Digester • High Pressure Impregnation of Chips • Cooking Zone • Extraction Zone • High Heat Washing • Low Temperature Blowing • M&D Continuous Digester • Horizontal Tube Digester

11	Kraft Pulping Chemistry	Delineate the primary reactions occurring in the digester between wood and the pulping chemicals. • Demonstrate the relationship between %AA, Sulphidity, and %EA.	Kraft Pulping Chemicals • A, B, & C Test • Concept of Expressing all Chemicals as Na2O • Simplified Kraft Pulping Reaction • Lignin Molecule Reaction • Carbohydrate Peeling and Stopping Reactions • Consumption of Chemicals during the Kraft Pulping • Phases of Lignin Removal • Total Yield
12	Kraft Pulping Variable and Trends	Identify and discern the most common and important variables in the pulping process, including the impact these variables have on pulp quality. • Understand significant trends that have occurred in Kraft pulping.	Kraft Pulping Variables • Chip Dimensions • Effects of Lignin on Rejects • Effect of Chip Thickness • H-Factor • Kappa vs. H-Factor • G-Factor • Sequence of Events in Pulping • Pulp Yield vs. Pulp Strength • High Kappa vs. Low Kappa • AQ Reactions • Polysulphide Pulping • Low-Solids Pulping • Effects of Dissolved Organics on Pulp Strength • Four Commandments of Extended Delignification • Low-Level Heat Recovery • Isothermal Cooking • Control Capabilities • Distributed Control System • Kappa Control • Reduced Reject Levels
13	Sulfite and Bisulfite Pulping	Knowledge of sulfite liquor chemistry, chemical reactions in the digester, and chemical recovery.	Chemical Pulping Processes • Woodpulp Production • Chemicals • Pulping Liquor Preparation • Reactions in the Gas Absorption Towers • Sulfite Liquor Analysis • Decomposition of Sulfite • Quality Control Testing • Simplified Sulfite Pulping Mechanisms • Lignin Reactions • Hydrolysis • Sulphonation • Carbohydrate Reactions • Chemical Reaction Goals • pH Effect on Chemicals • Sulfite Liquor Recovery • Fluidized Bed Recovery
14	Mechanical and Hybrid Pulping	An understanding of mechanical and hybrid processes. • Discuss the primary variables affecting stone groundwood and thermo-mechanical pulping. • The differences in mechanical vs. chemical and hybrid pulp properties.	Mechanical and Hybrid Pulping Overview • Family of Mechanical and Hybrid Pulps • Groundwood Mechanical Pulp • Groundwood System • Types of Grinders • Grinding Variables • Thermo-Mechanical Pulp (TMP) • TMP Variables • Pressurized Groundwood Pulp (PGW) • Semi-Mechanical Pulping Processes • Major Chemical and Semi-Chemical Methods • CTMP and Semi-Chemical Hybrid Pulping
15	Pulp Processing: Washing	Examine the different operations in fiberline pulp processing, including fiberizing, washing, screening, and cleaning. • An overview of major equipment types and key operating variables in Brown Stock washing.	Pulp Processing Overview • Pulp Processing Operations • Pulp Processing: Market Pulps • Pulp Processing: Linerboards • Pulp Processing: Kraft • Pulp Processing with Oxygen • Brown Stock Washing • Washing Pulp Samples • Pulp Water Mixtures • Counter-Current Washing • Vacuum Washing • Cylinder Washing • Internal Structure of Rotary Cylinder • Factors Affecting Brown Stock Washing and Displacement • Showers • Atmospheric Diffusion Washer • Horizontal Belt Washer • Pressure Washer • Compaction Baffle Filter Washer
16	Pulp Processing: Cleaning and Screening	To increase knowledge about the equipment and operating variables associated with screening and centrifugal cleaning.	Shives • Pressure Screen • Rotating Foil Action • Design of Pressure Screens • Cascade Screening System • Variables Affecting Screening Performance • Screen Designs • Screening Accepts and Rejects • Centrifugal Cleaner • Theory of Operation • Forward and Reverse Cleaning • Horizontal Cleaners in Canister Housing • Primary and Secondary Canisters • High Density Pulp Storage
17	Overview of Bleaching	Distinguish and recognize the most common terminology related to the bleaching process. • Analyze bleaching sequences. • Review and evaluate recent trends.	Bleaching Overview • Bleaching Sequence Symbols • Multi-Stage Bleaching • Bleach Plant • Bleaching Objectives • Simplified Bleaching Reactions • Damaged Low Viscosity Pulp Fiber • Process Conditions • Bleaching Costs • Oxidizing Equivalents • Bleach Plant Effluents • Major Path for TCSS/TCDF • Dioxin in Pulp • Cl2 Reaction with Lignin • Absorbable Organic Halide (AOX) • Impact of ClO2 Substitution on Effluent • Final Treated Effluent AOX • Bleach Plant Effluent 2378-TCDF • Bleach Plant Effluent Chloroform • TCF or ECF • TCF Sequences • Final Bleach Plant Washer • Decker for Pulp Thickening • Disc Thickening • HD Pulp Storage
18	Chlorine Dioxide Bleaching	Identify and evaluate the chemical reactions between chlorine dioxide and the wood components, including side reactions of chlorine dioxide that determine effectiveness of ClO2.	Bleaching Sequence • ClO2 Plant • ClO2 Generation • ClO2 Generation Reactions • Oxidizing Equivalents • Kappa Factor • Lignin Reactions • Kinetics of Brightening • End pH in the D1 Stage • ClO2 Bleaching • Caustic Extraction • Brightness Development

19	Oxygen, Peroxide, and Ozone Bleaching	An understanding of the technology, equipment, and operating variables in oxygen, peroxide, and ozone bleaching. • Assess the chemical reactions between the chemicals and wood.	Bleach Sequence • Oxygen Delignification • Oxygen Decomposition • Oxygen Conditions • Lignin Reactions • Typical Operating Conditions • System Aspects • Effects on Recovery System • The High Consistency Process • OÐ Reactor • The Medium Consistency Process • Two-Stage System • Process Variables • Effect of Temperature • Effect of Caustic • Viscosity Reduction • Factors Affecting Selectivity • Peroxide Bleaching • Peroxy Forms • Peroxide Variables • Pressurized Peroxide Bleaching • Mechanical Pulp Brightening • Peroxide Bleaching System • Ozone Bleaching
20	Chemical Recovery: Black Liquor Evaporation	An overview of chemical recovery operations. • Gain knowledge with regard to the composition and properties of black liquor. • Analyze the technologies associated with evaporators. • Examine environmental aspects of the chemical recovery process.	• Chemical Recovery Overview • Black Liquor Recovery • Black Liquor Compounds • Black Liquor Composition • Heating Values • Recovery Definitions • Evaporators • Black Liquor Evaporation • Black Liquor Evaporator Scaling • Falling Film Evaporator • Tube-type Falling Film Evaporator • Plate-type Falling Film Evaporator • Forced Circulation Crystallizer • Tall Oil Recovery • Concentrated NGC Typical Analysis • Total Reduced Sulfur (TRS) • Types of NCG Systems • NCG Collection • Thermal Oxidizer • Condensed Condensate Segregation • Blowheat Condensate Accumulator • Recovery Furnace
21	Chemical Recovery: Combustion	Familiarization with Recovery process equipment and operating variables. • An understanding of the path of hot gases to create steam and electricity. • Knowledge of reactions in the base of the furnace to create smelt, and safety considerations in dealing with water and smelt in the furnace.	Recovery Furnace • Water Treatment • Black Liquor Combustion • Black Liquor Spraying • Black Liquor Droplets • Generation of Steam • Turbine • Tube Bank • Tube Wall Construction • Gas Flow • Cascade Evaporator • Recovery Boiler Emissions • Nitrogen Oxides •Electrostatic Precipitator • Char Bed • Smelt • Control Room • Dissolving Tank
22	Chemical Recovery: Recausticizing	An understanding of how pulping liquor is generated in Recausticizing. • Discuss and discern the technology of Recausticizing and lime kiln operations, variables, and environmental considerations.	Recausticizing Overview • Causticizing Reactions • Slaker • Slaker and Dissolving Tank • Causticizing Tank • Mud Washer • Lime Kiln • Calcining Reaction • Lime Reburning Kiln • Rings, Ball, and Refractory Coating • Lime Energy Balance • TRS Resulting from Poor Mud Washing • Main Sources of TRS
23	Recycling: Overview and Raw Materials	Knowledge of recycled paper and board categories. • Awareness of contaminates and related issues associated with recycled paper.	Recycling Overview • Secondary Fiber Source and Use • Secondary Fiber Grades • Recycled Fibers • Effect of Repeated Recycling on Strength Properties of Unbleached Kraft Pulp • Effect of Recycling • Optical Properties • Contaminants
24	Recycling	Evaluate and assess the factors, considerations, variables, equipment, and processes associated with removing contaminants from recycled paper.	Recycling Operations • Recycling Sequence • Pulper • Contaminate Removal • Pulp Conditions • Cooking Formulas • Deinking Aids • Dispersion • Medium Density Cleaner • Reverse Cleaner • Theory of Operation • Sidehill Washer • Screw Extractor • Cylinder Washer Thickness • OCC Quality • Flotation
25	Summary of Pulp Mill	Applied knowledge of pulp mill operations.	Course Review

Paper Manufacturing Technology

Course Description:

The overall objectives of this course are to provide participants with the following:

1) an understanding of papermaking processes,

2) the ability to interact more knowledgeably with process engineers, operators, and technicians, and

3) the skill and ability to optimize mill performance.

Upon successful completion of this course, participants will have gained:

- A comprehensive overview of papermaking technology, process variables, equipment, and terminology.
- Increased knowledge of paper and board structure, properties, and tests.
- Increased knowledge of how paper mill processes affect paper and board properties; the ability to maintain product quality metrics, and how to troubleshoot variations in quality.
- Ability to apply analytical concepts and systems-approach thinking on a mill-wide basis.

Textbook:

NPT2. **The Pulp and Paper Technology Advanced Workforce Training and Education Series, Volume 2: Paper Manufacturing**. Tappi Press, 2006. ISBN: 1-59510-157-8

Smook, G.A. **Handbook for Pulp & Paper Technologist**, 3rd Edition, 2002. ISBN: 0969462859

Module	Title	Objectives	Subject
1	Introduction and Course Overview	Introduction	Learning Objectives • Paper Mill Overview • Technical Resources
2	Overview of U.S. & Global Industry	An understanding of the factors that drive industry trends. • A review of U.S. and global industry statistics regarding the major grades of paper and board. • Increase awareness of industry information and resources.	U.S. & Global Paper and Paperboard Consumption • U.S. & Global Paper and Paperboard Production • Paper Machines • Manufacturing Expense Categories • Cost Curves • Paper Mill Strategy
3	Paper & Board Structure: Part 1	An understanding of paper and paperboard structure and properties.	Paper Properties • Structure of Paper • Fiber Orientation • Basis Weight • Caliper • Density • Formation • Retention
4	Paper & Board Structure: Part 2	Knowledge of tissue and multiply paper structure, properties, and tests.	Tissue • Tissue Properties • Corrugated Containerboard • Paperboard Grades
5	Paper & Board Properties and Tests: Part 1	An understanding of printing processes and properties influencing printability, including smoothness, rate of liquid penetration, and optical properties.	Printing Papers • Printing Papers Nomenclature • Paper Grade Properties • Printing Processes • Ink Penetration • Lucas Washburn Equation • Cobb Size Test • Hercules Size Test • Paper Properties Affecting Print Quality
6	Paper & Board Properties and Test: Part 2	To increase knowledge of mechanical strength properties.	Tensile • Stiffness • Stretch • Tear • Burst • Compression Test • Ring Crush • Short Span Test
7	Wood and Fiber Properties	Examine the distinctions between hardwoods and softwoods. • Learn how the wood and fiber characteristics of hardwoods and softwoods affect pulp and paper properties.	Softwoods • Hardwoods • Oak Vessels • Bark Fibers • Fiber Lengths • Fiber Coarseness • Juvenile Wood • Softwood Compression Wood • Hierarchical Wood Structure • Cell Wall Structure
8	Bonding in Paper	Understand hydrogen bonding and related bonded area in paper. • Analyze the importance of cellulose and hemicelluloses in bonding	Fibers in Paper Structure • Hemicelluloses • Interfiber Bonding • Surface Tension • Page Equation • Troubleshooting Strength Variations.
9	Stock Preparation: Refining	An intermediate level understanding of the refining process, equipment used in the refining process, and the effects of refining on paper properties.	Stock Preparation • Mechanism of Refining • Effects of Refining • Fibrillation • Refining Control • Optimization of Refining
10	Optimization of Refining	Understand the key variables related to optimizing the refining process.	Optimization Goals • Process Variables • Refining Variables • Refiner Maintenance • Energy Use • Net Refining Power • Refining Theories • Specific Edge Load (SEL) • Rate of Bar Edge Crossings • Strength Variation
11	Additives Overview	Examine the primary additives used in paper and board production.	Dry Strength Additives • Wet Strength Additives • Pigments • Dyes • Sizing • Retention • Foam Control
12	Additives: Adhesives	Fundamental and applied knowledge of dry strength adhesives, the chemicals used in wet strength and how these chemicals function.	Fiber Bonding • Strength Additives • Adhesive Bonding • Latex Adhesives • Starch • Amylose • Amylopectin • Polyacrylamide • Epichlorohydrin • Wet Strength Requirements • Strength Resins • Covalent Bridges • Stabilization
14	Additives: Pigments, Fillers, and Dyes	An understanding of pigments and fillers. • To learn about the properties of pigments. • Knowledge of the categories and function of dyes.	Concept of Pigments and Fillers • Effects of Filler/Pigments • Concept of Opacity • Effect of TiOÐ • Clay • PCC • Alumina Trihydrate • Talc • Brightness • Refractive Index (RI) of Fillers and Pigments • Properties of Dyes • Factors Affecting Dyeing Results • Optical Brightening Agents (OBA) • Process Control
15	Additives: Retention	To increase knowledge of • Wet-End chemistry and retention mechanisms • Zeta potential and cationic demand • The chemicals used to achieve retention.	Retention • First Pass Retention • Mechanism of Retention • Zeta Potential • Cationic Demand • Properties • Cationic Polymer • Retention Aid – Large Flocs • Retention Aid – Small Flocs
16	Additives: Deposits, Foam Control	Describe the categories, sources, and control of mill deposits and foam.	Deposits • Deposit Analyses • Consequences of Deposits • Bacteria • Fungi • Yeast • Application Points for Biocides • Pitch Control Agents • Air Entrainment and Foam • Cause of Foam • Antifoam Classes

17	Overview of Paper Machine and Approach System	To identify the major parts and operation of paper machines, and to increase understanding of the approach system, including basis weight control, dilution, air removal, and cleaning & screening prior to the Headbox.	Paper Machine Overview • Fourdrinier vs. Twin Wire Forming • Simplified Approach System • Approach System with Deculator • Basis Weight • Stuff Box • Dilution • Approach System Detail • Headbox Screen • Centrifugal Cleaner Canisters
18	Headbox Operation	Discuss the types of Headboxes. Demonstrate the internal operations of Headboxes.	Headbox Overview • Types of Headboxes • Headbox Assembly • Inside the Headbox • Formation • Formation Variables • Process and Design Variables • Process Variables Affecting Machine Performance & Sheet Quality
19	Sheet Forming	Examine Headbox slice operations and the initial forming of the sheet, including jet/wire velocity ratio and its effect on fiber orientation and formation. • Analyze basis weight CD profile control strategies, including dilution Headbox operation.	Slice • Forming Board Drainage and Sheet Forming • Mechanisms of Fiber Deposition on Wire • Velocity Formation • Pressure Formation • Jet Impingement Position • Microturbulence • Jet Streaks • Jet Wakes • Slice Basis Weight Control • CD Basis Weight Control • Ultrasonic Measurement of Modulus (TSI) • Dilution Headbox • Effects of Stock Jet Velocity/Wire Ratio • Effects of Headbox Pressure
20	Wet-End Operations: Drainage	Distinguish dewatering elements used to remove water from the sheet, including foils and tables.	Wire Drainage • Table Rolls vs. Foils Vacuum Profiles • Foil Mechanism of Dewatering • Effect of Angle
21	Formation: Microturbulence Control	Discuss and analyze the ways microturbulence is generated to create and/or maintain good sheet formation, and the strategy of optimizing scale and intensity of microturbulence.	Microturbulence • Scale of Microturbulence • Coarse Microturbulence • Medium Microturbulence • Fine Microturbulence • Intensity Scale • Microturbulence Profile • Activity Profile • Dandy Roll, Suction Boxes, Couch • C-Former • Sheet Transfer
22	Twin Wire Gap and Hybrid Machines	Define the varieties of twin wire gap machines, and the differences in dewatering mechanisms, sheet forming operations, and paper properties of Fourdriniers, Twin Wire Gap, and Hybrid formers.	Two Wire Gap Overview • Twin Wire Machine “Gap Formers” • Gap Blade Former • Blade Shape • Forming Elements • Twin Wire Dewatering • Hybrid Machine • Top Wire Former
23	Linerboard and Multiply Machine	Describe and recognized the varieties of board, and configurations of linerboard and multiply machines.	Multiply Forming • Brown Linerboard • White Top Linerboard • Solid Bleached Board • Folding Boxboard • Liquid Packaging Board • White Line Chipboard • Cylinder Machine Vat • Roto Former • Linerboard • Primary/Secondary Headbox • Multiple Former Top Fourdrinier • Linerboard Machine • 3-ply Machine • Comparison of Forming Methods
24	Forming Fabrics, Wet Press, and Dryer Felts	Explain the importance and design of forming fabrics (wires), wet press fabrics (felts), and dryer fabrics (felts).	Paper Machine Clothing Materials • Forming Fabric Design Parameters • Metal Wire – 4 Shed Single Layer • Plastic Wire Weaves • Single Layer Designs • Two Layer Designs • Triple Layer Fabric Designs • Weaving Components • Finishing • Seamed Fabrics • Shower System • Saveall Operation • Needled Wet Press Felt • Felt Design Parameters • Felt Conditioning • Dryer Felt • Dryer Fabric Design and Materials
25	Pressing	Gain an overview of the different types of press section configurations, and what happens in the nip press. • Visualize what happens to the sheet during pressing. • Examine several pressing variables and trends.	Pressing Overview • Straight Through Press • Two Nip Press • Three Nip Press • Press Configuration • Mechanism of Pressing • Double Felted Press • Pressing Variables • Roll Defection • Crowning • Controlled Crown Roll • Controlled Crown Nipco Roll • Nipco Roll • Effect of Pressing on Smoothness • Shoe Press • Conventional Press • Press Conparisons
26	Drying: Part 1	Discuss the fundamentals of drying operations, and describe variables that affect the rate of drying.	Overview of Drying • Dryer Details • Temperature Profile • Drying Cycle • Moisture Removal • Condensate • Air Handling • Dryer Fabric • Effect of Felt • Top and Bottom Felt Run • Unirun or Serpentine

27	Drying: Part 2	Increase understanding of how drying and sheet shrinkage affect paper and board properties. • The role of felts, draw, and sheet restraint. • An overview of Tissue Machine Yankee Drying and Creeping Operation.	Effect on Drying on Sheet • Source of Paper Strength • Surface Tension • Mechanism of Bonding • Sheet Shrinkage • Two Tier Drying Restraint • Single Tier Dryers • Dryer Section • Moisture Profile • Moisture Profile Control • Steam Shower • Sectionalized Drive Control • Tissue Machine with Yankee • Yankee Condensate Removal • Through Air Drying (TAD) • Creping • Calendering
28	Calendering and Winding	Increase understanding of the different types of calenders. • Examine what happens to sheet properties by reviewing major calendering variables. • Briefly describe Winding and roll finishing operations.	Calendering & Winding Overview • Machine Calendering • Effects of Calendering Smoothness • Effect of Temperature • Calendering Application Areas • Calender Types • Soft Nip Press • Soft Nip Calender Configurations •Supercalender • Supercalender and Soft Nip • Gloss Calender • Wet Stack • Calendering Variables • Effect of Dwell Time • Effect of Moisture • Caliber Control • Air Cooling • Backtender Caliber Control • On Line Control • Reel • Winder • Slitting • Breaks • Roll Handling • Roll Wrapping • Roll Shipment
29	Size Press Operations	Evaluate size press operations, including equipment, types, and variables that affect starch pickup in the press size.	Size Press Overview • Surface Sizing • Surface Sizing Chemicals • Starch during Cooking • Starch Sources • Properties of Modified Starch • Synthetic Surface Sizes • Size Press Operations • Inclined Size Press • Puddle Size Press • Metering Blade Size Press • Metering Head • Size Press Variables • Starch Penetration
30	Coating: Part 1	Increase understanding of the categories of coated papers and board, their primary components, and the processes of coating operations.	Coating Overview • Off Machine Paper Blade Coater • Coated Publication Grades • Coated Boards • Coating Components • Adhesives • Pigments • Dispersion • Coated Free Sheet • Light Weight Coated Paper • Coating Preparation
31	Coating: Part 2	Increase awareness of the differences between Roll, Air Knife, and Blade Coaters. • Describe the various methods of drying coating.	Comparison of Coaters • Air Knife/Blade and Air Knife • Roll Coater • Film Splitting • Air Knife Coater • Blade Coater • Short Dwell Blade Coater • Blade Dynamics • Roll Coating • Cast Coater • Drying Coater • Hot Air Impingement • Shrinkage of Coating • Supercalendar • Finished Roll Storage
32	Corrugating and Converting	Increase knowledge of various converting operations. • A general understanding of what occurs in the corrugating process. • Examine the types of flutes. • Examine quality issues associated with liner and medium.	Corrugating and Converting Overview • Converting • Corrugated Medium • Quality Characteristics • Corrugated Board Defects
33	Effluent and Air Treatment	Increase awareness of the materials present in pulp & paper mill effluents and to increase understanding of primary and secondary effluent treatment. • Increase awareness of materials present in pulp & paper mill emissions, and examine various collection and elimination methods.	Characterization of Mill Effluents • Water Usage • Waste Discharge Amounts • Overview of Primary and Secondary Treatment • Activated Sludge • Aerated Lagoons Water Permitting Criteria • Characterization of Air Emissions • TRS Compounds • Air Treatment Methods • Lime Kiln • Recovery Boiler • Thermal Oxidizer • Air Quality Permit Criteria

Chemical Recovery & Environmental Control

Course Description:

The overall objectives of this course are to provide participants with the following:

1) an improved understanding of Chemical Recovery Operations,
2) an improved understanding of Environmental Control Operations,
3) the ability to interact more knowledgeably with process engineers, operators, and technicians, and
4) the skill and ability to optimize mill performance.

Upon successful completion of this course, participants will have gained a comprehensive overview of:

- Chemical recovery operations and terminology
- Equipment and process variables
- By-product recovery
- U.S. Environmental laws and regulations
- Water treatment options
- Activated sludge and aerated lagoon operation
- Air emission compounds and sources
- Air treatment options

Textbook:

NPT2. **The Pulp and Paper Technology Advanced Workforce Training and Education Series, Volume 1: Pulp Manufacturing**. Tappi Press, 2006. ISBN: 1-59510-133-0

Smook, G.A. **Handbook for Pulp & Paper Technologist**, 3rd Edition, 2002. ISBN: 0969462859

Module	Title	Objectives	Subject
1	Introduction and Course Overview	Introduction	Recovery Overview
2	Evaporation I	Increase understanding of overall evaporation operations, including types of evaporators, what occurs in an evaporator, multi-effect evaporator, tall oil recovery, and environmental challenges.	Simple Six-Effect Evaporator Set • Long Tube Evaporator • Black Liquor Evaporation • Black Liquor Evaporator Scaling • Falling Film Evaporator • Plate Type Film Evaporator • Tube Type Falling Film Evaporator • Forced Circulation Crystallizer • Tall Oil Recovery • Total Reduced Sulfur • Types of NCG Systems • NCG Collection • Thermal Oxidizer (Direct Fired) • Condenser Condensate Segregation • Blowheat Accumulator • Recovery Furnace
3	Evaporation II	Gain a more in-depth awareness of the advantages and disadvantages of evaporator types and operations, performance factors, equipment, black liquor properties affecting performance, causes and prevention of scales, fundamentals of heat transfer, and operating efficiency calculations.	Falling Film Multi-Effect Evaporators • Rising Film Evaporators • Evaporator/Condensator Combination • Direct Contact Evaporators • Falling Film Lamella Evaporator • High Solids Technology • Reynolds Enhanced Crystallizer (REX) • Forced Performance Factors • Black Liquor Evaporation • Performance Factors • Surface Condenser & Vacuum System • Two-Stage Condenser Systems • Condenser and Vacuum Problems • Liquor Preheating • Mist Elimination • Evaporator Scaling and Fouling • Basics of Heat Transfer • Impacts of Viscosity • Concept of Evaporator Economy • Steam Economy
4	Recovery Boiler I	Increase understanding of recovery boiler operations, including equipment and terminology; what occurs in combustion of black liquor; environmental challenges; and smelt interactions.	Recovery Furnace • Water Treatment • Black Liquor Combustion • Generation of Steam • Turbine • Tube Bank • Gas Flow • Cascade Evaporator • Recovery Boiler Emissions • Nitrogen Oxides • Electrostatic Precipitator • Char Bed • Smelt Reduction • Smelt Water Explosions • Dissolving Tank
5	Recovery Boiler II	Gain a more in-depth look at modern recovery boiler equipment and operations, including black liquor spray and droplet variables, air distribution, flue gas flow, modern electrostatic precipitator operations, and variables affecting char bed.	Recovery Boiler Designs • Black Liquor Guns and Spray Variables • Spray and Droplet Characteristics • Black Liquor Spray Nozzle Designs • Effect on Droplet Size • Effect of Firing Temperature • Droplet Swelling • Effect of Gas Velocity and Droplet Size on Burning • Air Distribution • Primary Air • Secondary Air • Tertiary Air • Air System Variables • Flue Gas and Water/Steam Flow • Screen, Superheater, Boiler, Economizer • Low Odor Recovery Boiler • Electrostatic Precipitator Components • Sodium Balance in Kraft Recovery Boiler.

6	Recovery Boiler III	Gain a more in-depth look at safety and maintenance operations, including case studies from the Black Liquor Recovery Advisory Committee; tube bank designs, deposits, corrosion, and cracking.	Black Liquor Recovery Boiler Terminology • Case Studies • Deposits and Plugging • Deposit Chemistry • Deposit Composition • Superheater Deposits • Boiler Section Deposits • Economizer Deposits and Plugging • Sootblowers • Steam Sootblowers • Recovery Tube Construction • Risk of Critical Leaks • Tube Leak Causes • Types of Corrosion • Boiler Tube Corrosion, Pitting, and Cracking • Reducing Tube Cracking • Thermal Efficiency
7	Recausticizing Overview	Learn about the conversion of green liquor into white liquor. • Examine Caustisizing equipment and reaction. • Understand environmental and energy challenges.	Recausticizing Overview • Causticizing Reaction • Slaker • Slaker and Dissolving Tank • Causticizing Tank • Mud Washer • Typical Lime Mud Composition • Lime Mud Composition • Lime Mud Washer and Kiln • Lime Kiln • Calcining Reaction • Lime Kiln Energy Balance
8	Recausticizing II	Gain a more in-depth look at Recausticizing operations, including green liquor clarification equipment types; slaker equipment and operation; causticizers and causticizing efficiency, white liquor clarification and filtering equipment; lime mud washing equipment and composition.	Causticizing Reaction • Recausticizing Cycle Recausticizing Equipment Loading • Green Liquor Preparation • Raw Green Liquor Stabilization Tank • Green Liquor Clarification Options • Clarifier Problems • White Liquor Preparation • Slaker • White Clarification Efficiency • Recausticizing Process Control • Density Control
9	Lime Kiln	Gain a more in-depth view of lime kiln operation, including internal construction; lime quality characteristics and variables, kiln operating variables; and kiln operating problems.	Lime Kiln Equipment • Kiln Refractory Brick • Kiln Internal Operations • Cooling of Reburned Lime • Chain Systems • Lime Quality Characteristics • Lime Kiln Operating Problems • Reburned Lime Chemistry • Ring Formation • Lime Balls • Recarbonation • Hard Ring • Lime Ball Prevention • Dusting • Forms of Total Sodium • Sodium Build-up in Kiln and Lime • Lime Kiln Fuels • Air Supply • Heat Rate • Optimized Energy Efficiency
10	Sulfite Recovery Systems	Increase awareness of sulfite pulping chemical recovery, including NSSC and bisulfite/acid sulfite spent pulping liquor; the different approaches to dealing with sodium, magnesium, calcium, and ammonium bases; and what occurs in a SOÐ gas absorption system.	Major Chemical and SemiChemical Pulping Methods • NSSC Spent Liquor Properties • NSSC Recovery Boiler • Magnesium Bisulfite Chemical Recovery • Magnesium Base Chemical Recovery • Ammonium Bisulfite Chemical Recovery • Sodium Base Recovery Systems • Tampella Sulfite Recovery Systems • NSSC Liquor Recovery from Green Liquor • Rauma Process Sodium Base Chemical Recovery • Fluidized Bed Reactor • Bisulfite/Acid Sulfite Pulping Starting Chemicals • Bisulfite Pulping Liquor Preparation • Reactions in the Gas Absorption Tower • Sulfite Recovery
11	By-product Recovery	Gain a more in-depth understanding of tall oil soap recovery and processing; turpentine recovery and processing, and lignin recovery and processing.	Wood Chemistry Components • Wood Resin & Fatty Acids • Tall Oil Soap • Tall Oil Soap Yields • Loss of Extractives • Tall Oil Soap Recovery • Evaporator Tall Oil Skimmers • Weak Liquor Soap Skimmers • Soap Separation and Skimming Variables • Conversion of Soap to Raw Tall • Crude Tall Oil Distillation • Turpentine Recovery • Lignin Recovery • Lignin Recovery from Black Liquor • Kraft and Sulfite Lignin Processes and Products • Lignin Product Applications
12	The Forest Biorefinery	Increase awareness of the biorefinery, including biomass sources, composition and scope of biofuels and bioproducts; thermochemical platforms; biochemical platforms, and pulp mill conversion options.	The Forest Biorefinery • Biorefinery Concept • Pulp & Paper Mill Biomass Utilization • Biofuels Legislation • Biorefinery Roadmap • Biomass Sources • Biomass Chemical Composition • Cellulosic Biomass to Biofuels • Biofuels Classifications • Fischer-Tropsch (FT) Process • Biorefinery Technology Pathways • Gasification • Thermochemical Platform Gasification • Bioconversion Platform • Biochemical Platform • Biochemical Platform Enzymatic Hydrolysis • Hemicellulose Structure and Enzymes • Value Prior to Pulping • Biorefinery Potential Impact on Value of Wood
13	Environmental Overview	Introduction	Environmental Control Overview

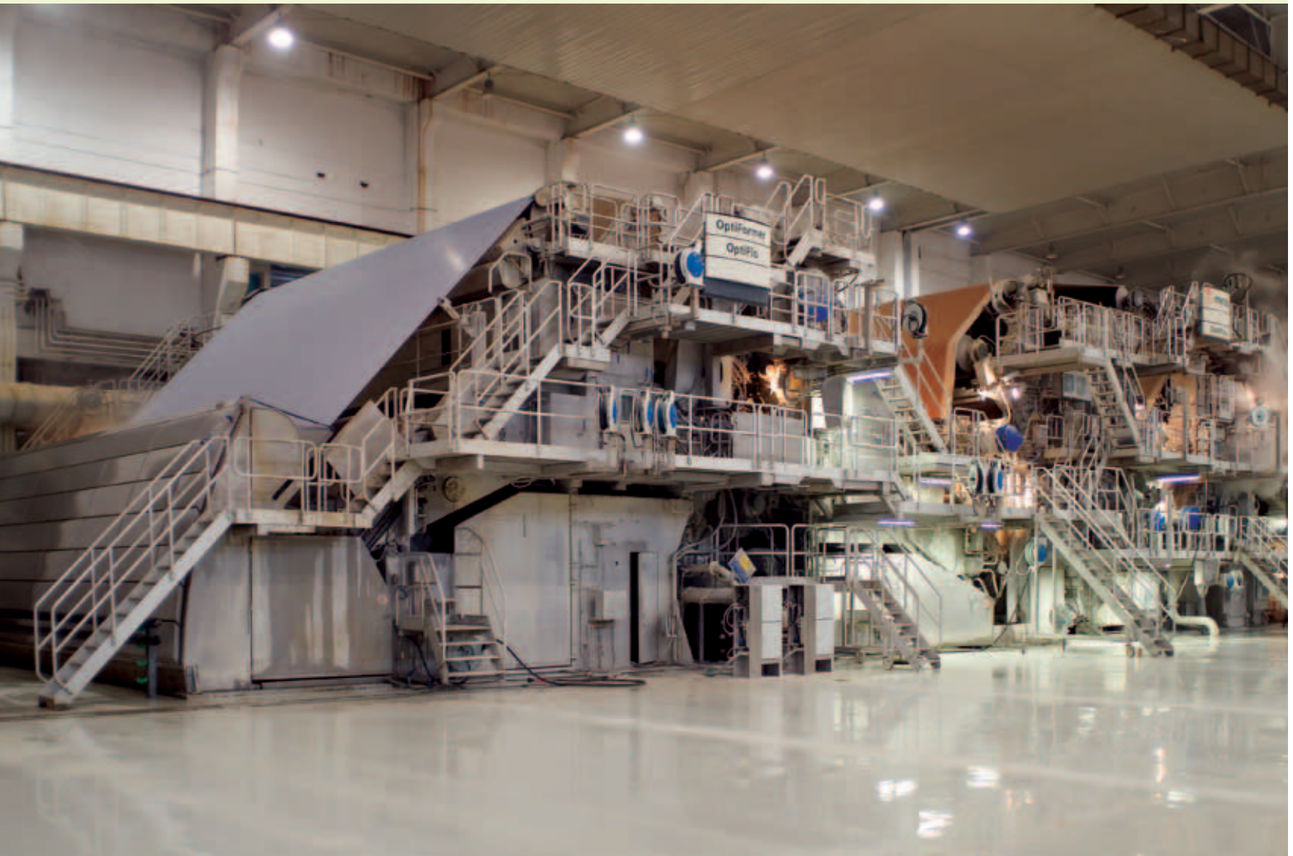
14	U.S. Laws & Regulations	Increase understanding of U.S. environmental laws and regulations by reviewing the history of environmental legislation in the U.S.; summaries of air and water discharge regulations; and the permitting process.	Laws and Regulations • Clean Water Act Pollutants • Terminology • Effluent Regulation Summary • Boiler MACT • Air Regulations Summary • NPDES • Permit Writing Criteria • TMDL's Under NPDES Permits • Permit Case Study • BACT Review Process
15	Pulp & Paper Process Review I	Increase awareness of Pulp & Paper process effects on air and water emissions. This module will provide an overview of: Wood chemical components that are at the core of understanding the source of emissions; Woodyard operations; pulping; and pulping processing.	Wood Chemistry Components • Cell Wall • Lignin • Hemicelluloses • Properties of Extractives • Wood Resin & Fatty Acids • Wood Terpenes • Wood Phenols • Woodyard Overview • Pulp & Paper Mill Overview • Chemical Kraft Pulping Chemistry • Air Emission Composition • Odor Compounds
16	Pulp & Paper Process Review II	Increase awareness of pulp & paper process effects on air and water emissions. This module will focus on an overview of pulp processing and bleaching.	Brown Stock Washing • Screening and Cleaning • Bleach Plant • Bleaching Stages • Bleaching Reactions • Bleach Plant Effluent
17	Pulp & Paper Process Review III	Increase awareness of pulp & paper process effects on air and water emissions. This module will focus on an overview of chemical recovery.	Recovery Overview • Black Liquor Combustion • Evaporators • Black Liquor Oxidation • Tall Oil Recovery • Wood Terpenes • Non Condensable Gases • Total Reduced Sulfur • Recovery Furnace • Black Liquor Combustion • Recovery Chemical Reactions • Recovery Boiler Emissions • Lime Kiln
18	Pulp & Paper Process Review IV	Increase awareness of pulp & paper process effects on air and water emissions. This module will focus on stock preparation wet end additives, recycling, and coating.	Papermaking Additives • Strength Adhesives • Dyestuffs and Pigments • Deposits • Bacteria • Fungi • Biocide Additives • Air Entrainment and Control • Deinking • Flotation Chemicals • Water Recovery • Coating
19	Air Emissions Control I	Increase understanding of the categories and sources of gaseous emissions: gas collection methods and standards; monitoring requirements; and disposal methods.	Categories of Air Pollutants • Dust Explosion Particulate Characteristics • Process Sources of Air Emissions • Process Sources of TRS • Source Sampling Protocols • Gas Stream Source Sampling • Particulate Sampling • Volatile Organic Compound (VOC) Sampling • Visible Emission Detector • Air Pollution Control Equipment • Gas, Vapor, and Particulate Removal Equipment • Continuous Monitoring System • Dilute Gas Collection and Control • Thermal Oxidation.
20	Air Emissions Control II	Increase awareness of air pollution control equipment, including varieties of wet and dry scrubbers, cyclone separators, fabric filters, dust settling collectors, and electrostatic precipitators.	Categories of Scrubbers • SOÐ Scrubbers • Dry Absorption Particulate Scrubber • Wet Scrubbers • Impingement & Venturi Scrubbers • Combination Scrubber • Particulate Cyclone Separator • Baghouse Fabric Filter • Dust Collection Tubes • Dust Settling Chamber • Recovery Boiler and Electrostatic Precipitators
21	Effluent Treatment I	Increase awareness of the compounds present in effluents, definitions, discharge limitations, and treatment options including an overview of clarification, flotation, and filtration.	Effluent Definitions and Measurements • Oxygen Depletion Tests • Dissolved Oxygen • BPT Effluent Restrictions • Effluent Limitation Guidelines • Regulated Compounds • Dissolved Solids vs. BOD • Water Quality • Effluent Treatment Methods • Solids Screening • Clarifier Components • Flocculation Clarifier •Flux • Loading of Clarifiers • Overflow Weir • Clarifier Sludge Collection • Arm and Scrapper Design • Flotation Treatment of Effluent • Aerobic Treatment Reactions • Anaerobic Treatment Reactions • Activated Sludge • Terminology
22	Effluent Treatment II	Increase understanding of activated sludge operations and variables; bacteria growth factors; nutrient management: anaerobic treatment options, and sludge solids management and disposal.	Activated Sludge Effluent Treatment • Primary and Secondary (Activated Sludge) Treatment • Activated Sludge Flocs • Terminology • Nitrification and Denitrification • Aerobic Biological Treatment • Activated Sludge Treatment/Operational Control Variables • Aerator Flow Patterns • Secondary Clarifier Performance Factors • Ammonia/Urea Ammonium Nitrite Addition • Anaerobic Treatment Plant • Anaerobic Pretreatment Reactor • Biofiltration • Sludge Drying • Sludge Disposal and Uses

Tissue Manufacturing Technology

Course Description:

The overall objective of this course is to increase a participant's understanding of tissue properties and manufacturing performance. The course is designed for participants who desire an introductory to intermediate level, comprehensive, and structured course on tissue manufacturing technology, including performance properties, manufacturing technology, raw materials, equipment, and processes. Upon successful completion of this course, participants will have gained a comprehensive overview of:

- Tissue properties, including softness, absorbency, and strength.
- Fiber properties and effects on tissue.
- Stock preparation, including refining & refining variables, and the effects of refining on tissue properties.
- Tissue chemicals—dry & wet strength, debonders, retention aids, deposits, and foam control.
- Tissue machine technology, including headboxes, forming, drying, molding, creping, calendering & converting.
- Tissue machine technology including approach systems, modern tissue machine headboxes, types of tissue formers, forming variables, machine forming and press fabrics, pressing, Yankee dryer, Through Air Drying (TAD), Yankee coating, creping, calendering, and converting.



Module	Title	Objectives	Subject
1	Introduction & Overview	Course Introduction	Tissue manufacturing terminology • Industry trends and statistics • Technical resources
2	Tissue Structure	Increase awareness of the tissue properties consumers evaluate in their selection of a specific tissue products. • Examine the basic differences in sheet structure and manufacturing processes that influence tissue properties.	Product properties • Tissue Structure manufacturing processes • Commercial tissue structure • Creped tissue • Dry crepe technology • Through Air Dying (TAD) • Wet Molding technology • Toweling • Fibers and Bonding in tissue • Formation • Formation Analysis • Formation variables
3	Tissue Properties – Softness	Increase understanding of the factors that define "Softness." • Provide an overview of how Panel Softness Tests are performed. • Gain an overview of other tests conducted to measure and predict "softness."	Tissue Properties • Softness Panel Exercise • Softness and Physical Property Correlations • Handle-O-Meter • Tissue Softness Analyzer • Stylus Profilometer •Softness Modeling & Analysis Techniques
4	Tissue Properties – Absorbency	Increase understanding of factors that influence the rate of absorption of liquids by tissue and toweling products.	Liquid Penetration • Rate of Liquid Penetration • Contact Angle • Surface Tension • Absorbency • Absorbency Aids
5	Tissue Properties – Strength	Increase understanding of the properties of Tensile, Stretch, Stiffness, & Elastic Modulus.	Product Properties • Tensile Failure Strength of Paper • Page Equation • Tensile Measurement • Tensile & Stiffness Terminology • Tensile & Stretch • Physical Properties Correlated to Softness • Manufacturing Processes to Increase Strength
6	Fiber Properties and Effects on Tissue	Increase understanding of fiber properties, including length, coarseness, and flexibility. This module will also examine the various sources of fiber, and analyze variances in wood and non-wood fibers	Fibers & Pulps for Tissue Grades • Softwoods • Hardwoods • Fiber Lengths • Fiber Coarseness • Fiber for Premium Grade Tissue • Non-wood Fibers • Fiber Comparison • Fiber Properties • Wood and Fiber Quality Variation
7	Chemical and Mechanical Pulps	Increase knowledge of the differences between chemical pulp and mechanical pulp properties. This module will also examine the effect of pulp processing (washing, screening, bleaching) on pulp properties and quality.	Wood Components • Lignin & Hemicellulose • Chemical Pulping Processes • Pulping Yield vs. Pulp Strength • High Lignin vs. Low Lignin Kraft • Chemical Kraft Pulp • Groundwood Mechanical Pulp • Pulp Processing • Washing • Screening • Bleaching
8	Recycled Pulps: Part I	Increase understanding of the properties of recycles pulps; the major contaminants present in recycled pulps, and the processes utilized to remove these contaminants.	Recovered Paper • Recovered Paper Grades • Contaminants—Sources and Problems • Recycled Operations
9	Recycled Pulps: Part II	Increase understanding of the properties of recycled pulps; the major contaminants present in recycled pulps, and the processes utilized to remove these contaminants.	Screening Processes • Variables Affecting Screening Performance • Screen Designs • Cleaners—Theory of Operation • Deinking • Dispersion • Deinking Processing Aids • Flotation • Pulp Testing
10	Stock Prep Refining for Tissue	Increase understanding of the mechanism of refining, refining variables, and the effects of refining on fibers and tissue properties.	Effects of Refining on Tissues • Pathways to Optimizing Refining • Fibrillation and Hydration • Enzymatic Treatment in Tissue • Influence of Refining on Tissue Properties • Principal Refiner Factors
11	Overview of Tissue Chemicals	Gain an overview of the various chemicals used in the manufacture of tissue.	Chemicals—Pulping and Pulp Preparation • Chemicals—Fiber Modification and Pulp Preparation • Chemicals—Tissue Manufacturing • Coating & Creping Chemicals
12	Dry & Wet Strength / Debonders	Increase understanding of dry and wet strength additives, including their categories and function.	Dry & Wet Strength Definitions • Dry Strength Additives • Sheet Bonding and Strength from Additives • Adhesive Bonding • Latex Adhesive • Chemistry of Additives • GPAM • SPAM • PVAM • Liquid Starch • Wet Strength Additives • Categories of Wet Strength • Debonders • Softeners

13	Chemicals – Retention Aids	Increase awareness of the terminology, categories, and mechanisms of retention aid chemicals.	Mechanism of Retention • Methods of Absorption • Polymer/Fiber Surface Interactions • Classes of Retention Aid Polymers • Wet-end Optimization—On Machine Testing
14	Deposits and Foam Control	Increase awareness of the categories, sources, and control of mill deposits and foam.	Types of Deposits • Chemical Deposits • Biological Deposits • Controls of Deposits • Microbiological Control • Biocides • Defoamers • Defoamer Chemistry •
15	Overview of Tissue Machines	Increase awareness of the four major types of tissue/toweling machines and technologies.	Creping Technology • Through Air Drying (TAD) Technology • Wet Molding Technology • Dry Forming Technology • Tissue & Toweling Forming Configurations
16	Tissue Machine Headboxes	Increase understanding of the types and internal operations of Headboxes, including balanced pressure/flow to maintain uniform basis weight and fiber orientation, and microturbulence for improving sheet formation.	Approach System • Influence of Air Content on Sheet Formation • Deculator • Headbox Designs • Headbox Performance • Tissue Formation • Formation Analysis • Formation Variables • Microturbulence • Optimizing Headbox Turbulence
17	Sheet Forming and Wet-End Operations	Increase awareness of 1) Headbox slice operations and the initial forming of the sheet, including jet/wire velocity ratio and its effect on fiber orientation and formation, 2) basis weight CD profile strategies, including dilution Headbox operation, and 3) the mechanisms of dewatering with twin wires.	Phases and Mechanisms of Forming Roll Drainage on Twin Wire Gap Former • Mechanism of Fiber Disposition on Wire • MD/CD Fiber Orientation Ratio • Effect of Stock Jet Velocity/Wire Velocity Ratio • Challenges to Optimizing Jet/Wire Velocity Ratio • Variations in Jet Velocity • Controlling Edge Flow Effects • Fabric Effect on Fiber Orientation • Tissue Machine Forming Configurations • Tissue Machine Forming Variables
18	Tissue Machine Forming Fabrics	Increase understanding of the importance and design of forming fabrics.	Role of Forming Fabrics • Fabric Selection • Forming/TAD Fabric Terminology • Forming Fabric Design Construction • Fiber Support • Fiber Support Index • Caliper/Void Volume • Drainage – Air Permeability • Draining Index • Surface Open Area (SOA %) • Machine Design Considerations
19	Pressing and Press Fabrics: Part I	Gain an overview of what occurs in a press nip and to the sheet during pressing, and increase understanding of the importance and design of press fabrics. In addition, this module examines several pressing variables and trends.	Mechanism of Pressing • Pressing Variables • Effect of Roll Cover • Roll Deflection • Controlled Crown Roll • Nipco Roll •Shoe Press • Yankee Pressure/Press Rolls • Yankee Dryer Pressure Roll Shoe Press • Hydrodynamic Shoe
20	Pressing and Press Fabrics: Part II	Gain an overview of what occurs in a press nip and to the sheet during pressing, and increase understanding of the importance and design of press fabrics. In addition, this module examines several pressing variables and trends.	Requirements of a Press Fabric • Press Felt • Press Felt Impact on Tissue Properties and Runability • Needled Felt • Seamed Felt • Basic Structure of a Press Fabric • Tissue Machine Considerations • Base Fabric Comparison • Press Felt Cleaning & Conditioning
21	Through Air Drying (TAD)	Increase familiarity with the basic concept of Through Air Drying (TAD), and the importance and design of TAD fabrics in creating structured tissue.	Through Air Drying (TAD) Process Flow • TAD Operating Variables • TAD Modeling • Sheet and Exit Air Temperature During Drying • Effort of Air Flow and Basis Weight on Drying Rate • Drying Rate Variables • TAD Fabrics • TAD Product Properties • TAD Machine Configurations • TAD Fabric Designs • Fabric Design Optimization
22	Wet Molding	Provide an overview of the wet molding technology used to create structured tissue.	Wet Molding Technology • Dimensionally Shaped Product (DSP) Weaves • DSP Weave Variables • Forming
23	Yankee Drying	Increase understanding of Yankee dryer operations, and examine the effects of drying on the sheet.	Machine Dryer Configurations • Yankee Dryer Design • Temperature Profile • Air Cap/Hood • Yankee Steam Profiles • Tissue Yankee Pressure Roll • Sheet Adhesion and Creping
24	Creping Chemicals	Increase understanding of the chemical coatings and their purpose in protecting the Yankee dryer, and how these coatings affect the creping process.	Adhesion and Crepe Structure • Yankee Coating Feed System • Coating Chemistry • Yankee Dryer Coatings • Crepe Adhesive Chemistries and Characteristics • Crepe Releases • Calculation of Creping Aids Add-On Value • Evaporative Load • Spray Boom Water Parameters

25	Creping Operations	Increase understanding of creping operations on the Yankee, including creping blade variables that affect the type of crepe produced.	Creping Process • Creped Sheet Characteristics • Blade Geometry • Creping Blade Wear • Effect of Blades on Softness • Blade Change Analysis • Properties Affected by the Creping Process
26	Calendering & Converting	Increase understanding of the operations of calendering, embossing, and finishing.	Finishing and Converting • Finishing Processes • Creping Shoe Calender • Calender Pressure and Nip Widths • Reel • Parent Roll Handling • Winders • Slitting •Roll Defects • Embossing and Engraving • Folders • Die Cutters • Lotion Applicators • Packing Lines, Bundlers, and Wrappers

Wet-End Chemistry

Course Description:

The overall objectives of this course are to provide participants with the following:

1) an understanding of papermaking wet-end chemistry,
2) the ability to interact more knowledgeably with process engineers, operators, and technicians, and
3) the skill and ability to optimize paper mill performance.

Upon successful completion of this course, participants will have gained a comprehensive overview of:

- Papermaking materials, including fillers and chemical additives
- How some chemicals are used to control product attributes
- How some chemicals are used to improve process efficiency
- Case studies and practical examples
- Wet-end chemistry applications in a variety of paper mill situations

Textbook:

Hubbe, M.A., and King, K. **Cost Saving Strategies in Papermaking Chemistry**, TAPPI Press, 2009,
Product code: 0101R325, ISBN: 15951018374, Source: www.tappi.org.

Module	Title	Objectives	Subject
1	Introduction and Course Overview	Introduction to course	Why wet-end chemistry matters • Brief introduction to fixed and variable costs • Brief introduction to the materials used to make paper • Course goals
2	Paper Properties Affected by Wet-End Chemistry	Increase understandings of how paper properties can be modified using chemical additives. • Introduce the subject of sizing.	Functional additives • Hercules size test • Cobb size test • Hydrogen & covalent bonds • Cellulose fiber surface • Hydrophobic sizing agents • pH ranges of sizing agents
3	Keeping Properties within Specification	Increase understanding of paper properties. • Focus on one type of property: paper's brightness.	This module will use a case study to examine the problem-solving approach to brightness quality issues. Topics include: • Brightness • Fixatives • Quantifying variability • Sources of variability
4	Water – Some Key Concepts	Increase understanding of water usage and chemical additives. • Examine the effect of chemical additives on papermaking optimization.	Geometry of the water molecule • Hydrogen bonding in water • High surface tension • Chemical equilibrium in water • Acidity • Alkalinity • Conductivity • Hardness
5	Fibers and their Surfaces	Increase understanding of cellulose fibers & fiber surfaces, and their effect of papermaking processes.	Paper structure • Fiber wall sublayers • Wall thickness vs. species • Lignin breakdown • Bleaching • Fiber shearing & compression in refining • Recovered fibers
6	BBC Boxboard and their Urgent Sizing Needs	Increase understanding of internal sizing.	This module will use a case study to examine a customer complaint regarding "soggy boxes," and evaluate problem solving solutions. Topics include: • Alkaline sizing • ASA sizing • Factors that affect sizing performance
7	From Lab Results to the Paper Machines—Calculating Addition Amounts	Increase knowledge of planning lab tests, utilizing lab results, defining "basis," calculation chemical additive amounts, and calculating a flow rate to the machine.	Equipment used to make a test sheet • Running a lab test to estimate an addition rate • Canceling units to check your work • Calculating flow rates for commercial-scale addition
8	More Ways to Make Paper Resist Water and Other Fluids	Increase understanding of different sizing agents and their applications.	The most common lab tests for sizing • Rosin sizing • Rosin soap vs. rosin emulsion products • Surface sizing • Case study for a TMP mill • Case study for an ONP mill
9	FPC Fine Paper Co. Wants to Reduce the Costs of Materials	Examine expense categories of material used in papermaking. • Consider the proportional balance of materials used in papermaking to lower costs. • Understand the consequences of material proportion and its affect on product quality. • Analyze results of material proportion adjustments.	How filler use can affect variable costs to the mill • How fillers affect paper's strength • How the choice of filler can affect paper's apparent density • Case study involving the cost of materials, brightness goals, smoothness goals, and caliper specifications in a printing grade
10	What Mineral Products (Filler) Should Be Chosen For What Product	Gain a greater understanding of strategies for selecting the most effective mineral product (filler) for a given grade of paper.	Clay (kaolinite) • Calcium carbonate (calcite) • Titanium dioxide • Bonding • Tensile strength • Air penetration • Bulk • Brightness • Opacity • Smoothness • Costs • Particle size distribution • Particle shape • Blend ratio
11	Retention Efficiency—Why it Matters and How it's Determined	Increase understanding of the concept of retention of fine particles during the manufacture of paper. • Explain how retention efficiency is related to yield losses. • Show how retention efficiency can affect the structure of the sheet.	How fine materials can be lost from the paper machine system • Definitions of "fines" • How fines can run "around and around" in the paper machine system • The distribution of fines in paper's thickness dimension • Function and use of a save-all system
12	Selecting and Evaluating a Retention Aid System	Increase understanding of retention aid use, including process control on a paper machine.	Lab evaluation of a retention aid • Alum • Cationic starch • Acrylamide retention aid • Calibration and metering • Dosage-response tests • Online control of retention
13	How Retention Aids Work	Increase understanding of how retention aids work. • Gain insight into the relationship between retention aids and drainage.	Retention aid mechanisms • Polymer bridging • Charge patch mechanism • How retention aids can affect drainage • Why fiber flocs often increase initial drainage, but they often result in a wetter sheet at the couch
14	Balancing the Wet-End Charge	Increase understanding of concepts related to charge and zeta potential, which can be the key to optimizing the performance of a range of chemical additives.	Origin of the surface charge of fiber • Effect of pH on fiber's charge • The positive or negative charges of different additives • Zeta potential • The role of high-charge cationic additives • Alum's charge • Titration test to determine charge demand • Balancing the charge to improve the efficiency of other chemical additives

15	Dry Strength is Low on the FPC Paper Machine #2	Understand various options that a papermaker has to increase the dry strength of the product.	Refining and dry strength • Dry strength additives • Why wet-end starch typically has a positive charge • How flocculation of the fibers can hurt paper strength • Using the size press to improve strength and stiffness • Case study: saving costs at the size press
16	ONP Old News Paper Co. Can't Get Quality Product to the Reel	Illustrate how papermakers and lab technicians can work to overcome various causes of lost production on paper machines.	The relationship between downtime and paper mill productivity • Causes of spots & web breaks (Pareto chart) • Wet-web strength • Troubleshooting (two brief case studies dealing with deposits)
17	Making the Paper Machine Run Cleaner	Illustrate some strategies that papermakers can employ to make the machine run cleaner, which can mean fewer process interruptions.	Incorrect addition of a chemical additive • Ways to successfully inject chemical agents • Ways to combat scale formation • Ways to combat tacky and sticky substances • Talc use • Slime and holes • Felt cleaning • Case study
18	Making Paper with Less Water	Introduce the concept of "paper machine water system closure" and outline some strategies of coping with the consequences in terms of wet-end chemistry.	Strategies to reduce the amount of fresh water used on a paper machine • Enrichment of non-retained substances when water reuse is increased • Kidney strategies • De-aeration equipment • Dealing with high electrolyte (salt) levels
19	Dealing with Wastewater Issues	Introduce the most common unit operations in the treatment of wastewater from a paper mill.	Total suspended solids (TSS) • Biological oxygen demand (BOD) • Color • Turbidity • Primary wastewater clarifiers • Activated sludge secondary treatment • Sludge thickening • Alternative uses for sludge from paper mills
20	"Please Match this Pastel-Colored Sample"	Introduce the basics about what determines paper's color, how to evaluate color, and how to control it with dyes and whiteners.	Brightness test equipment • Brief introduction to theory of color • The function of dye additives • Classes and behavior of different dyes • Color matching • Fluorescent whitening agents or "OBAs" • Mottle issues
21	Minimizing Waste When Making Multiple Grades on a Paper Machine	Introduce some issues related to efficient operation of a paper machine making several grades of paper, using a wet strength grade as an example.	Transition time between paper grades • Adsorption, a key requirement for an additive to be effective • Selection of an addition point • Process control delay • Case study: using a high-charge cationic additive to make a wet-strength additive work more efficiently
22	"If It Ain't Broke… It Must Be our Product"	Illustrate a problem-solving approach as papermakers work to figure out what is causing low sizing test values, which turn out to have an unexpected cause.	Case study: low size test results on a fine paper machine, including: • Causes of moisture streaks on paper machines • Dewatering on the Fourdrinier • Pressing • Drying • Additional causes of web breaks
23	Rita Book Paper needs Higher Smoothness and Higher Caliper	Illustrate how papermakers can use a variety of approaches to achieve product specifications in an economical way.	Calendering • Refining and smoothness • Fiber selection to increase bulk • Filler shape relative to paper's bulk and smoothness • Using cationic starch to maintain strength of filled paper • Starches used at the size press
24	Bringing Value to your Company by Addressing the Needs of Your Customers	Introduce some basic concepts that can help a papermaking professional succeed both for themself and for their company.	Building your skill base • Team effectiveness • Customer focus • Commodity vs. specialty manufacturing • Supply-demand effects and market entry • Use of statistics to gain credibility • Example of a confidence interval calculation
25	PB Paper Bag Co. has Wet-End Tolerance Problem	Work through a case study with a surprise ending: In this case to make paper bags stronger when wet; the key was to keep them from really getting wet.	Case study: how to meet customer expectations for paper bags under challenging conditions • Wet-strength agents and their strategies of use • How wet-end sizing can be used to help meet wet-strength test requirements
26	The Optimization of Multi-Ply Board Products	Illustrate some concepts related to paperboard development and manufacture by considering a case study.	Multi-ply paperboard • The folding of boxboard • Optimizing the choice of fiber type • Strategies to achieve strength and stiffness in paperboard • Coating
27	Recycled Pulp: Getting the Ink Count Down	Understand the basics of a fiber recovery operations. • Understand how and why recovered fibers are often different from virgin fibers.	Quality attributes of recovered fiber • Key challenges to overcome in paper recycling • Loss of fiber strength • Embrittlement due to drying • Some hidden advantages of recovered fibers • Some unit operations in deinking
28	Acidic Papermaking	Review basic concepts of acidic papermaking, with emphasis on acidic sizing and the use of alum products.	Why calcium carbonate is incompatible with acidic conditions • Acidic sizing systems • Mechanisms of rosin sizing • Alum chemistry and usage • Aging of paper

29	Alkaline Papermaking	Review some of the advances in retention, drainage, and formation uniformity that can be achieved with an optimized alkaline papermaking system.	Alkaline papermaking strategies for good retention, drainage, and formation • Charge balancing as a drainage strategy • Microparticle retention & drainage systems • Colloidal silica • Bentonite
30	Dealing with Foam	Understand the various causes of foam problems in papermaking systems and to understand different ways of dealing with them.	Ways that foam hurts sheet properties • Case study involving foam: • Defoamers • What stabilizes foam bubbles • Foam control • Deaeration equipment
31	Steps in the Justification, Selection, Optimization, and Marketing of Wet-end Additives	Understand some key steps that can help in making good decisions about whether to implement a new wet-end chemistry program on a paper machine, including the marketing of wet-end chemical products.	Reasons why a papermaker buys chemical additives • Reasons why justifications are needed before making changes • How wet-end chemistry can impact the costs of operations • Ways to minimize risk • Safety labeling • Encouragement of students to continue their reading

Paper Coating Technology

Course Description:

This course is designed for coating mill production and engineering personnel, technical service personnel, product developers, and research & development personnel employed by chemical manufacturers.

The overall objectives of this course are to provide participants with the following:

1) an understanding of coatings for paper and paperboard,

2) the ability to interact more knowledgeably with process engineers, operators, and technicians, and

3) the skill and ability to optimize mill performance.

Upon successful completion of this course, participants will have gained an understanding of:

- The printing methods used to print coated grades of paper and board, the coating requirements for these grades, and the methods used to test the print properties of coated papers.
- The impact of pigment selection on the optical and surface properties of the coating, the basic criteria used to classify pigments and select pigments for coated grades of paper and board, and the equipment and procedure used to properly prepare a pigment for application.
- The chemistry and properties of starch and protein binders and the processes used to prepare both binder types.
- The chemistry and properties of latex and polyvinyl alcohol binders, the advantages and disadvantages of their use, and the processes used to prepare both binder types.
- The basic materials within the class of coating additives, including the functional role and general chemical characteristics of each additive.
- The calculations used to prepare a batch of coating in the lab from a coating recipe. The basic principles learned can be used to scale-up a batch to commercial quantities.
- The equipment and design configurations used to manufacture coated paper and board. Emphasis is placed on the differences in each process and how these differences affect the properties of the coated base sheet.

Textbook:

Lehtinen, E., **Pigment Coating and Surface Sizing of Paper**, Papermaking Science and Technology, Volume 11, TAPPI Press

Module	Title	Objectives	Subject
1	Introduction	Gain an understanding of why papers are coated and the properties of the base sheet that affect the quality of the coating layer.	Course Introduction • Why paper is coated • Comparison of Coated and Uncoated Surfaces • Porosity • Ink Receptivity • Surface Improvement • Controlling Base Sheet Properties
2	Market Overview—Terminology	Identify the different grades of coated paper and paperboard. • Examine the criteria used in the classification of coated paper grades.	Grade Terminology • Classification of Coated Grades • Paper Furnishes • Coated Wood Free Papers • Recycled Pulps • Coating Terms • Overview of Coated Papers • Coated Paperboard • Solid Bleached Sulfite • Examples of CSBS • Examples of CUBK • Examples of CRB • Summary of Coated Board Properties
3	Principles of Printing	Describe the four major printing processes and examine the most important paper and coating properties for each printing method.	Principles of Printing • Printing Inks • Coating Properties Coating Requirements • Types of Processes • 4 Color Sheetfed Press • Printing Methods • Offset Printing • Flexographic Printing • Rotogravure Processes • Electromechanical & Director Laser Engraving
4	Print Properties	Increase understanding of the mechanisms of ink setting and drying for each coating process and examine how both properties are influences by the structure of the dried coating layer.	Ink Setting • Absorption Ink Drying • Evaporation Ink Drying • Oxidative Polymerization Ink Drying • Radiation Curing and UV Ink Drying • Coating Structure Influences • Porosity Influence on Absorption • Formulation Criteria for Oxidative Drying • Formulation Criteria for Offset Printing • Formulation Criteria for Rotogravure • Formulation Criteria for Flexo
5	Print Testing	Increase knowledge of techniques used to measure the optical and rub resistant properties of printed subtrate.	Print Testing • Important Properties • Measurement of Ink Gloss • Ink Density • Measurement of Tobias Mottle • Image Quality • Ink Rub-Off Resistance • Factors Influencing Ink Rub-Off • Ink Viscosity • Ink Tack
6	Print Identification	Identify the method of printing for commercial grade paper & board. • Gain and increased understanding of common defects associated with each printing process.	Identifying Web & Sheetfed Offset Substrates • Identifying Offset Printed Products • Identifying Gravure Printed Products • Identifying Inkjet Printed Products • Identifying Flexographic Printed Products • Identifying Electrostatic Printed Products • Coating Related Problems • Back Trap Mottle & Color Bleed • Wet Repellency • Picking • Donuts & Poor Image Quality • Fill-in • Heatset Web Offset Print Defects
7	Pigments: Part I	Gain an increased understanding of terminology used to describe properties of pigments. • Study optical theory.	Gloss • Brightness • Opacity • Index of Refraction • Optical Theory • Mechanism of Light Scatter • Refraction • Measuring Opacity • Pigmented Coating • Key Pigment Attributes • Role of Pigments in Paper • Classification of Pigments • Types of Clays • Structure and Properties of Clays
8	Pigments: Part II	Gain an increased understanding of terminology used to describe properties of pigments. • Study optical theory.	Sources, Production, Structure, and Properties of Calcium Carbonate • Influence of Particle Size on Glass & Opacity • Precipitated Calcium Carbonate (PCC) • Ultra Fine Ground Calcium Carbonate (UFGCC) • Application of PCC • Application of UFGCC) • Specialty Pigments • Titanium Dioxide and Plastic Pigments • Classification and Properties of Plastic Pigments • Calendering Response • Properties and Application of Hollow Sphere Pigments
9	Dispersing	Gain an increased understanding of the dispersion process and problems associated with the improper dispersion of the coating pigment.	Dispersing Agents • Mechanisms of Cluster Formation • Preventing Floc Formation • Magnetic or Electrostatic Cluster Formation • Resistance to Shear • Mechanical and Chemical Dispersion • Machinery for Dispersing Pigments • Requirement for Success
10	Binders	Examine the differences in chemistry & properties of modified and unmodified starches and protein binders.	Overview of Binders • Binder Selection • Binder Demand • Binder Flexibility • Sources of Starch • Composition of Starch • Starch Comparison • Retrogradation • Starch Cooking • Keys to Cooking Starch • Converted Starches • Substituted Starches • Introduction to Natural Binders • Derivatized Starches

11	Protein	Gain an increased understanding of the differences in protein types and the advantages & disadvantages of using protein binders.	Protein Binders • Composition of Proteins • Protein Interactions • Protein Preparation • Protein Shock • Cause of Pigment Shock • Commercial Soy Proteins • Unhydrolyzed Soy Polymers • Hydrolyzed Polymers • Carboxylated Soy Polymer • Binder Comparison
12	Latex Binders: Part I	Examine the different types of synthetic latex binders and the physical & chemical properties that determine their performance in a coating formulation.	Latex Used in Paper & Paperboards • Basic Definitions • Properties Impacted by Latex (wet state) • Properties Impacted by Latex (dry state) • Polymerization • Emulsion and Latexes • Emulsion and Latexes • Emulsion Polymerization Reaction • Emulsifying Agents • Emulsification of Monomer • Key Dimensions for Polymer Dispersions • Common Synthetic Binders • Rigidity • Structure of Monomers • Structure of Polymers • Acrylates • Binding Strength • Carboxylated Latex • Latex Product Parameters • Role of Modifiers • Blistering in Web Offset Printing.
13	Latex Binders: Part II	Examine the different types of synthetic latex binders and the physical & chemical properties that determine their performance in a coating formulation.	Pick Strength • IGT Pick Test • Wet Rub • Varnish Holdout • Binders: Effect on Coated Paper • Binders: Comparison • Advantages/Disadvantages of Synthetic Binders • Storage and Handling • Stiffness • Smoothness • Dot Gain • Binder Migration • Mottle • Croda Stain Test • Drying Conditions • Effect of Butadiniene Level • Polyvinyl Alcohol (POVH) • Classification of POVH • Application of POVH • Binders: Summary
14	Additives: Part I	Gain an increased knowledge of the purpose and chemistry of coating additives used by the paper industry. • Analyze the selection process used in determining the best product chemistry for a given application.	Types of Additives • Functional Coating Additives • Batch Coating Make-Down System • Continuous Coating Make-Down System • Foam Controlling Additives • Skips • Craters • Defoaming Efficiency • Defoaming Mechanism • Foam Control Products • Types of Microbes • Environments for Growth • Problems Associated with Microbial Activities • Water Retention Aids • Coating Defects Associated with Dewatering • Problems Associated with Binder Migration • Factors Influencing Dewatering • Function of Water Retention Aids • Mechanism of Thickening • Modification of Coating Rheology • Hydration • Entanglements • Coating Immobilization.
15	Additives: Part II	Gain an increased knowledge of the purpose and chemistry of coating additives used by the paper industry. • Analyze the selection process used in determining the best product chemistry for a given application.	Introduction to Crosslinkers • Types of Crosslinkers • Crosslinker Selection • Glyoxal Reaction Mechanism • Glyoxal Dosage Levels • Advantages/Disadvantages of Glyoxal Use • Zirconium Based Crosslinkers • Advantages/Disadvantages of Zirconium Use • Zirconium Dosage Levels • Introduction to Optical Brighteners (OBAs) • Application of OBAs • OBA Carriers • Factors That Affect OBA Performance • Introduction to Lubricants • Relative Effects of Lubricants on Wet Coating • Relative Effects of Lubricants on Dry Coating • Relative Effects of Lubricants on Converting Operations • Lubricant Dosage Levels • Lubricant Concerns • Introduction to Dispersants • Bridging • Classification of Dispersants • Dyes and Colorants • Dyes vs. Pigments • Coating Makedown • Order of Addition
16	Coating Calculations	Apply knowledge of coating components and formulations.	This module introduces a laboratory exercise in which students will perform calculations needed to prepare a coating. The calculations performed can be used to scale-up any coating formulation to any desired batch size.
17	Size Press & Roll Transfer	Gain an increased understanding of the various types of size presses and roll transfer coaters, how the differ, the advantages and disadvantages of each, and the types of coatings being applied by each process.	Size Press • Puddle Size Press Operation • Types of Puddle Size Presses • Operating Parameters • Conventional Size Press • Surface Sizing Chemicals • Size Press—Pigment Coater • Nip Rejections • Factors Contribution to Nip Rejection • Transfer Roll Coaters • Gate Roll Size Press • Advantages and Disadvantages of Gate Roll Size Press • Film Transfer • Metered Size Press and Applications • Metered Size Press Applicators • Metering Elements • Key Factors

18	Rod & Blade	Examine the equipment and design configurations used to manufacture coated paper & board. Emphasis is placed on the differences in each process and how these differences affect properties of the coated base sheet.	Role of Metering Device • Rheological Properties & Desired Coat Weight • Surface Smoothness & Coating Uniformity • Types of Metering Devices • Types of Coating Blades • Blade Coaters • Advantages and Disadvantages of Blade Coaters • Coating Applicators • Blade Coater Configurations • Blade Coating Systems • Blade Characteristics • Blade Wear • Changing the Blade • Rod Coaters • Traditional Configurations • High Speed Road Coaters • Backing Roll • Flooded Nip Applicator • Wash/Roll Moisture Addition
19	Contour Coaters	Examine the differences between contour (non-contact) & director contact coating metering processes, and to understand the special considerations given to the formulation of coatings for these processes.	Coating Profiles • Air Knife Coaters • Coating Systems • Single Roll • Two Roll • Three Roll • Jet Fountain • Smoothing Roll • Air Knife Metering • Typical Operating Parameters • Four Air Knife Designs • Air Knife Assembly • Setting the Geometry • Coating Sequence • Curtain Coating • Curtain Coating Terminology • Curtain Coating Applications • Spray Coaters
20	Calendering: Part I	Understand the properties gained and lost by calendering and how temperature, pressure, and moisture influence the properties of coated paper during the calendering process. • Examine the different types of calenders and understand how they vary in the surface finish they impact.	Calender Overview • Reasons for Calendering • Calendering Parameters • Calendering Influences on LWC Paper Roughness • Roughness Development in a Supercalender • Effects of Calendering • Types of Calenders and Applications • Effect of Roll Hardness • Types of Calendering Rolls • Moisture Content • Calender Options • Advantages & Disadvantages of Off Machine Calenders
21	Calendering: Part II	Understand the properties gained and lost by calendering and how temperature, pressure, and moisture influence the properties of coated paper during the calendering process. • Examine the different types of calenders and understand how they vary in the surface finish they impact.	Hard Nip & Supercalenders • Off Machine Calendering • Supercalendered Finish • Applications Coated and Uncoated • Types of Hard Nip Calenders • Soft Nip Calendering • Advantages of Hot/Soft Nip Calendering • Soft Nip Calendering Technology • Calendering Board • Shoe Calender • Influence of Moisture • Influence of Coating Pigments • Influence of Temperature • Types of Roll Covers • Brush Calendering
22	Barrier Coating	Learn about Functional Coated Papers, including: • Coating materials used to coat these papers • The applications of Functional Coated Paper • Test methods used to measure their performance	Defining Barrier Coating • Types of Barrier Coating • Barrier Coating Materials • Tests for Oil & Grease Resistance (OGR) • Kit Test • Ralston Purina Test • Fluroploymers • Wax Coatings • PE Coatings • Water-Based Barrier Coatings • Water-Based Chemistries • Application Concerns • Basesheet Influence on Barrier Properties • Testing of Barrier Performance • Barrier Coating Market Trends • Barrier Coating Market Drivers • OGR Drivers • Wax Replacement Markets & Drivers • Cost Considerations
23	Barrier Strategies	Examine important properties of coated paper, and review strategies that can be employed to produce a good barrier layer.	This module uses the problem-solving method to analyze three different strategies for creating a high barrier coating layer.
24	Drying	Examine coating drying technologies, to evaluate methods of minimizing energy cost associated with the drying process, and to explore approaches for maximizing sheet properties and quality of coated papers.	Energy Consumption • Dewatering • Three Phases of Coating Consolidation • Factors that Influence Coating Penetration • Dryer Operation • Energy Transfer • Mass Transfer • Mechanisms of Heat Transfer • Drying Systems • Steam Cylinders • Air Impingement Cylinders • Air Flotation Dryers • Infrared Dryers • Jet Foil Systems
25	Testing	Examine various testing equipment and perform essential tests involved in the coating process.	Solids Analyzer • Brookfield • Hercules Rheometer • Coating Density • Static Water Retention • Dynamic Water Retention • CLC • Dynamic Contact Angle • Image Expert • Deltack • IGT Pick • Parker Print Smoothness and Compressibility • Dyne Pen Test • Ink Density • Ink Gloss & Delta Gloss • Dot Gain • Kit Test
26	IMS Point Testing	Examine an alternate approach for the measurement of the immobilization solids.	Dewatering Unit • Measurement and Recording System • Sample Metering & Application • Data & Results

Technology and Science of Paper Recycling

Dr. Richard Venditti, Professor, Paper Science & Engineering, NC State University

Course Description:

The overall objective is to increase the ability to make decisions to improve the paper recycling process. Specific learning objectives include the ability to understand and address recycling processes and issues, including quality of the raw materials; requirements to be environmentally friendly; and strategies to produce pulp at the lowest cost.

Topics include:

1. Paper recycling and technology course introduction and objectives
2. The US paper recycling industry
3. Introduction to papermaking fibers
4. Grades of recovered paper
5. Common contaminants in recovered paper
6. Collection, sorting, storage of recovered Paper
7. Papermaking fiber types and the effect of recycling on strength properties
8. Basic paper recycling process terms
9. Pulping of recovered paper
10. Screening
11. Centrifugal cleaning
12. Wash deinking
13. Flotation deinking
14. Dispersion and Kneading
15. Bleaching
17. Paper recycling system design strategies
18. Paper Recycling Systems
19. Cost to produce deinked pulp
20. Automated image analysis of paper to detect contaminants
21. Refining of recovered fibers
22. Fiber fractionation
23. Stickies: tacky contaminants
24. Stickies: control and removal
25. Stickies: measurement
26. Manufacture of packaging grades from recovered paper
27. Manufacture of newsprint from recovered paper
28. Manufacture of tissue from recovered paper
29. Manufacture of printing and writing papers from recovered paper
30. Mill Tour: Recycling mill producing packaging grade paper
31. Mill Tour: Material recovery facility
32. Guest Lecture: Danny Hayes: Introduction to bleaching recycled pulps
33. Guest Lecture: Danny Hayes: Bleaching systems used for recycled pulps
34. Guest Lecture: Danny Hayes: Case studies for bleaching recycled pulps

Paper Machine Optimization

Michael Kocurek, Editor | Chuck Klass, Principal Instructor | Stephen Keown, Director

This capstone course represents a major advancement in e-learning papermaking courses. It is intermediate in scope, designed for more experienced operators and perhaps technical. The focus of this 55+ lecture course is to cover variables important for optimization. Instructors will be among the best suppliers and consultants in the Industry. Additional topics will be added as updates.

WET END OPERATIONS

Lecture Topics	Presenters
1. Course Overview	Chuck Klass, Klass Associates
2. Evolution of Paper Machine Performance Standards	Dick Reese, Reese & Associates
3. Improving Paper Machine Performance	Dick Reese, Reese & Associates
4. Paper & Board Structure & Properties Overview	Mike Kocurek, NC State; Alabama Southern
5. Wet End Effects on Product Properties	Mike Kocurek, NC State; Alabama Southern
6. Stock Prep Refining Operations, Mechanisms, Variables	Arvind Singhal, J&L Fiber Services
7. Refining Intensity, Freeness Drops, Plates, Systems	Arvind Singhal, J&L Fiber Services
8. Approach System Key Factors, Design, Performance	Dick Reese, Reese & Associates
9. Cleaning Operations	Dick Reese, Reese & Associates
10. Screening Operations	Dick Reese, Reese & Associates
11. Review of Headbox Operations I,II	Mike Kocurek, NC State; Alabama Southern
12. Headbox Optimization	Chuck Klass, Klass Associates
13. Headbox Optimization Using Ultrasonics	Marty Wakefield, L&W
14. Wet End Chemistry Problems and Optimization	Chuck Klass, Klass Associates
15. Wet End Starch Addition, Retention & Retention Aids	Chuck Klass, Klass Associates
16. Wet End Sizing, pH control, Biological Control	Chuck Klass, Klass Associates
17. Wet End Charge, Retention & Drainage Measurements	Ronnie Skinner, BTG
18. Consistency Control	Ronnie Skinner, BTG
19. Process Control of Air, Freeness, Charge & Refining	Ronnie Skinner, BTG
20. Review of Fourdrinier Wet End Basics	Ken Stager, Paperchine QS
21. Fourdrinier Machine Wet End Optimization	Ken Stager, Paperchine QS
22. Gap Former Designs and Variables	Claes Holmqvist, Paperchine QS
23. Dynamics of Gap Forming and Drainage	Claes Holmqvist, Paperchine QS
24. Gap Former Troubleshooting, Shear Levels & Vacuums	Claes Holmqvist, Paperchine QS
25. Forming Fabric Types and Applications	Daryl Wells, Asten-Johnson
26. Grade Specific Forming Fabric Requirements	Daryl Wells, Asten-Johnson
27. Forming Fabric Deposit Control	John Schwamberger, DuBois Chemicals
28. Save All Operations	Chuck Klass, Klass Associates
29. Pumps and Pump Efficiency	Mike Pemberton, ITT Industrial Processes
30. Vacuum Systems	John Neun, Albany International
31. Paper Machine Energy Evaluation Considerations	Dick Reese, Reese & Associates
32. Summary of Wet End Optimization	Chuck Klass, Klass Associates

PRESSING & DRY END OPERATIONS

Lecture Topics	Presenters
1. Effect of Dry End Operations on Sheet Properties	Mike Kocurek, NC State University
2. Key Variables in Press Dewatering	Dick Reese, Reese & Associates
3. Press Rolls & Roll Cover Design & applications	Dick Reese, Reese & Associates
4. Wet Press Fabrics Design and Applications	Rick Phillips, Asten-Johnson
5. Felt Conditioning & Deposit Control	John Schwamberger, DuBois
6. High Pressure Showers & Cleaning Chemicals	John Schwamberger, DuBois
7. Drying Optimization Process, Variables, Models	Ken Hill, Kadant
8. Dryer Surface Temperatures and Heat Transfer	Ken Hill, Kadant
9. Dryer Steam and Condensate Systems	Ken Hill, Kadant
10. Hoods and Dryer Air Systems	Ken Hill, Kadant
11. Dryer Fabrics Design and Applications	Blake Farmer, Asten-Johnson
12. Dryer Fabrics Deposit Control	John Schwamberger, Dubois
13. Conventional Size Presses	Chuck Klass, Klass Associates
14. Starch Preparation & Handling	Chuck Klass, Klass Associates
15. Metering Size Presses	Chuck Klass, Klass Associates
16. Calendering Basics, Equipment, Variables	Mark Sorenson, Andritz
17. Calendering High Finished Papers	Mark Sorenson, Andritz
18. Calendering High Bulk Grades	Mark Sorenson, Andritz
19. Calendering Tissue	Mark Sorenson, Andritz
20. Doctor Blades	William Frawley, Coldwater Seals
21. Reels	Karl Westlund, PaperChine/TBD
22. Winder Operations and Optimization	Jeff Brown, Paperchine
23. Paper Machine Measurements and Control	TBD
24. Summary & Wrap Up	Chuck Klass, Klass Associates

Pulping Laboratories

Dale Smith, Alabama Southern Community College
Michael Kocurek, PhD, North Carolina State University

Scope and Learning Objectives:

These labs and videos demonstrate various procedures used to analyze raw materials such as wood, chips, pulping liquor, bleaching chemicals; and the resulting pulp. They will also illustrate with video demonstrations the pulping process, screening, bleaching, preparation of laboratory handsheets, flotation deinking, microscopes, and others. The overall learning objective is to increase your understanding of why and how these tests and procedures are performed.

Topics

Introduction and Overview

Laboratory Safety

Chip Evaluations

1. Chip Moisture & Density
2. Chip Classification

Pulping Liquor Analysis

3. White Liquor ABC test

Pulping

4. Pulping Digester Operation
5. Screening of Pulp

Bleaching of Pulp

6. Pulp Bleaching
7. Pulp Brightness
8. Bleach Liquor Analysis

Analysis & Testing of Pulp

9. Permanganate Number of Pulp
10. Viscosity of Pulp
11. CSF Freeness of Pulp
12. Consistency of Pulp
13. Refining of Pulp – Valley Beater
14 Refining of Pulp – PFI Mill
15. Preparation of Handsheets
16. Use of Microscopes

Recycling

17. Flotation Deinking

Introduction & Overview

If you are studying these laboratories as part of a training or educational program, it is recommended that you complete all of the labs, including the thought questions at the end of each lab. Some of the labs will require analysis of data, and other labs are demonstration only, with no data. The outline you should follow for each lab is as follows:

1. Read the Objectives.

2. Read the section on Background to familiarize yourself with the topic and test.

3. Perform the Tasks

   3.1 View the Testing Video

   3.2 Review Instructor directions; and/ or the appropriate Lab Manual instructions; and/or the TAPPI Standard, or Useful Method for in depth details and instructions.

   3.3 Perform the tests and collect the data; or use the video data. Do the Calculations, if required.

4. Answer the Thought Questions.

For additional information on this and other new courses, contact:
Martha Wynn at mwynn@ascc.edu or Mike Kocurek at mjkocurek@ascc.edu

Paper & Board Testing Laboratories

Roman Popil, PhD, Institute of Paper Science & Technology
Michael Kocurek, PhD, North Carolina State University

Scope and Learning Objectives:

These labs and videos demonstrate various procedures used to test paper and board. They will also provide some Background about the property being tested. The overall learning objective is to increase your understanding of why and how these tests and procedures are performed.

Topics

1. Introduction and Overview
2. Basic Statistics
3. Laboratory Safety
4. Preparation & Conditioning
5. Basis Weight, Caliper, Moisture
6. Ash Measurement

Mechanical Properties

7. Tensile, Stretch, Modulus
8. Elmendorf Tear
9. Mullen /Burs
10. Bending Resistance
11. Ring Crush
12. Short Span Compression
13. MIT Fold
14. TSI & TSO Measurement

Printability Properties

15. Sheffield, Emveco, PPS Roughness
16. Air Permeability, Porosity

Optical Properties

17. Brightness
18. Opacity
19. Gloss
20. Cobb
21. Hercules Size Test
22. Contact Angle

Introduction & Overview

If you are studying these laboratories as part of a training or educational program, it is recommended that you complete all of the labs, including the thought questions at the end of each lab. Some of the labs will require calculations and analysis of data, and other labs will provide final data without calculations. The outline you should follow for each lab is :

1. Read the Objectives.

2. Read the section on Background to familiarize yourself with the topic and test.

3. Perform the Tasks

   3.1 View the Testing Video

   3.2 Review Instructor directions; and/ or the appropriate Lab Manual instructions; and/or the TAPPI Standard, or Useful Method in for in depth details and instructions .

   3.3 Perform the tests and collect the data; or use the video data. Do the Calculations, if required.

4. Answer the Thought Questions.