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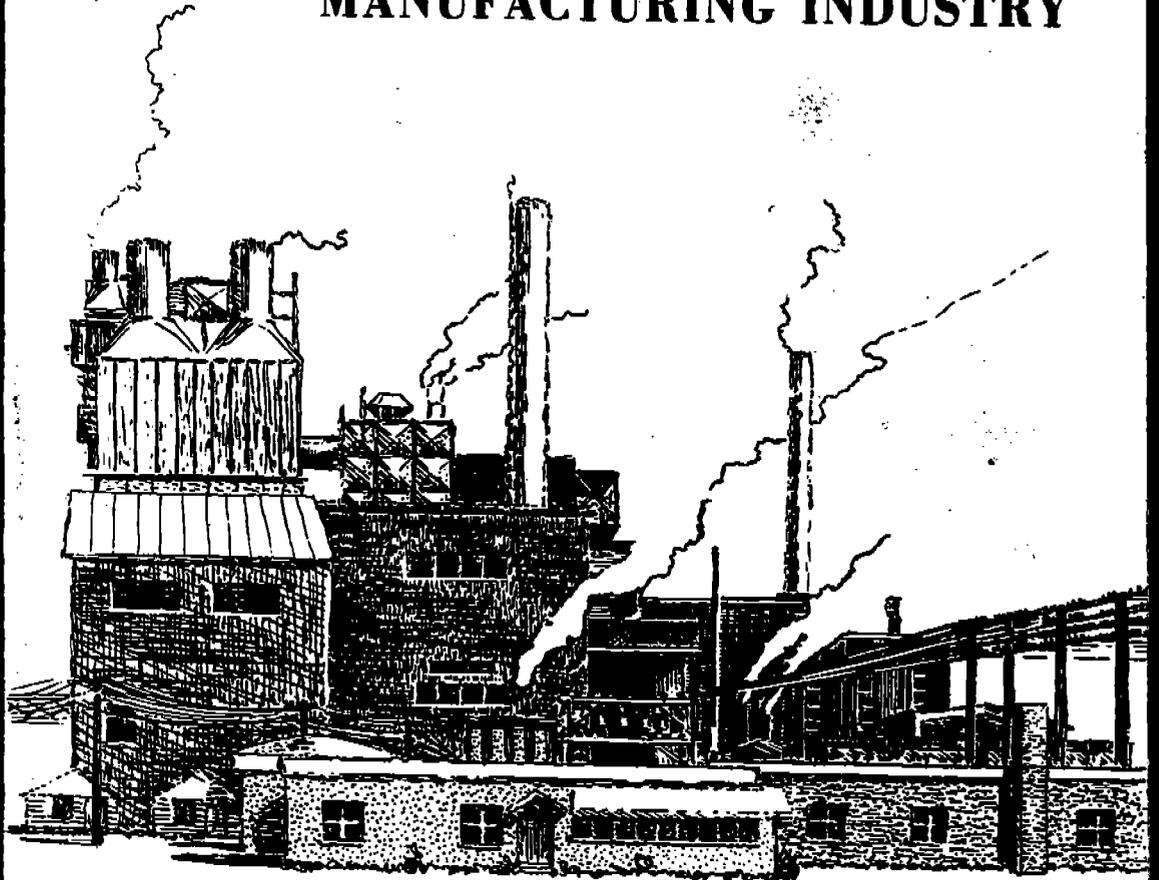
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ATMOSPHERIC EMISSIONS FROM THE PULP AND PAPER MANUFACTURING INDUSTRY



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EPA-450/1-73-002

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**ATMOSPHERIC EMISSIONS
FROM THE PULP AND PAPER
MANUFACTURING INDUSTRY**

Cooperative Study Project
National Council of the Paper Industry
for Air and Stream Improvement, Inc.
and
Environmental Protection Agency

ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Water Programs
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711
September 1973

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PREFACE

To provide reliable information on the air pollution aspects of the pulp and paper industry, the National Council of the Paper Industry for Air and Stream Improvement, Incorporated (NCASI), and the Office of Air Quality Planning and Standards of the U.S. Environmental Protection Agency (EPA) entered into an agreement in April 1967. A cooperative program was established to study atmospheric emissions from the various industry processes and publish information about them in a form helpful to air pollution control and planning agencies and to the pulp and paper industry management. Direction of this study was vested in a NCASI-EPA Steering Committee composed at the time of completion of the following representatives:

EPA

*Stanley T. Cuffe
John L. McGinnity
Joseph J. Sableski

NCASI

*Isaiah Gellman
Peter Wrist
Malcolm L. Taylor

Mr. Edwin J. Vincent of EPA and Mr. Russell O. Blosser of NCASI were the principal investigators during much of this project and authored much of this report. Before joining the steering committee, Mr. Joseph J. Sableski of EPA and Dr. Isaiah Gellman of NCASI also served as principal investigators.

Information in the report describes the nature and range of atmospheric emissions during normal operating conditions and the performance of established devices and methods employed to limit and control these emissions.

*Principal representative.

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Many companies and individuals in the pulp and paper industry have been helpful in providing plant-visit and questionnaire data for this study.

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TABLE OF CONTENTS

LIST OF TABLES	viii
LIST OF FIGURES	xi
ABSTRACT	xii
GLOSSARY	xiii
CONVERSION FACTORS, BRITISH TO METRIC UNITS	xvi
SUMMARY	xvii
Production of Chemical Pulp	xvii
Chemical Pulping Processes	
Kraft (Sulfate) Process	xviii
Sulfite Processes	xviii
Semichemical Processes	xviii
Soda Process	xviii
Kraft Process, Specific Emission Sources and Controls	xviii
Types of Emissions	xviii
Digester Relief and Blow	xix
Multiple Effect Evaporators	xix
Recovery Furnace Systems	xx
Black Liquor Oxidation Systems	xxi
Smelt Dissolving Tanks	xxi
Lime Kilns	xxii
Brown Stock Washers	xxii
Emission Ranges	xxii
Semichemical Sulfite Process	xxiii
Sulfite Process	xxiii
Steam and Power Generation	xxiv
INTRODUCTION	1
Background	1
Sources of Information	1
Questionnaire Surveys	2
Field Sampling Program	2
Literature	3
Pulp and Paper Manufacturing Industry	3
Current Production	4
Industry Growth Trends	5
KRAFT (SULFATE) PULPING PROCESS	7
Introduction	7
Process Description	7
Raw Materials and Process Characteristics	7
Emission Sources	9
Gaseous Emissions	9
Particulate Emissions	10

Emission Control Systems — General	10
Gaseous Emissions	10
Particulate Emissions	12
Specific Emission Sources and Controls	12
Digester Relief and Blow	12
Emissions	13
Control Techniques	13
Emission Data	14
Multiple Effect Evaporators	17
Emissions	17
Emission Data	17
Control Techniques	18
Kraft Recovery Furnace Systems	19
Introduction	19
Composition and Control of Emissions from Kraft Recovery Furnaces	24
Composition and Control of Emissions from Flue Gas Direct Contact Evaporators	30
Emission Data	34
Black Liquor Oxidation Systems	44
Designs, Application, and Performance	44
Emission Data	45
Control Techniques	48
Smelt Dissolving Tanks	48
Emissions	49
Control Techniques	49
Emission Data	49
Lime Kilns	53
Emissions	54
Control Techniques	54
Emission Data	55
Brown Stock Washing Systems and Other Miscellaneous Sources	58
Emission Data	58
Control Techniques	61
SEMICHEMICAL SULFITE PULPING PROCESSES	63
Introduction	63
Raw Materials	63
Process Description	63
Product Yield	64
Emissions	64
Sulfur Dioxide Absorption Tower	64
Blow Tank	65
Chemical and Heat Recovery Furnace	65
Emission Data	66
Control Techniques	67
SULFITE PULPING PROCESS	69
Introduction	69
Raw Materials	69

Process Description	69
Product Yield	70
Emissions	70
Absorption Towers	70
Blow Pits	70
Recovery Units	71
Multiple Effect Evaporators	72
Control Techniques	72
Sulfiting Tower	72
Blow Pit	72
Recovery Furnace Systems	73
Emission Data	74
STEAM AND POWER GENERATION	77
Introduction	77
Fuels Used	77
Steam Usage	80
Types of Boilers	80
Emissions	82
Control Techniques	82
New Technology	82
APPENDIX A: DETAILED EMISSION DATA FROM QUESTIONNAIRE SURVEY	87
APPENDIX B: SAMPLING AND ANALYTICAL PROCEDURES AND EQUIPMENT	95
Summary of Procedures	95
Gas Analysis	95
Questionnaire Data	95
Special Studies	95
EPA Field Investigation	96
Particulate Sampling and Analysis	96
EPA Mobile Field Sampling Laboratory	96
Gas Analysis	97
Instrumentation	97
Dilution System	98
Gas Chromatographic-Flame Photometric System	102
Particulate Sampling and Analysis	108
Sampling Site and Traverse Points	108
Sampling Train	108
Analysis	108
APPENDIX C: ODOR SURVEY	111
Introduction	111
Equipment and Procedures	111
Results	112
Evaluation	113
REFERENCES	117

LIST OF TABLES

<i>Table</i>	<i>Page</i>
1 Summary of U.S. Chemical Pulp Mill Production, 1969	5
2 Odor Thresholds of Some Malodorous Sulfur Compounds	9
3 Gaseous Emissions from Digester Relief and Blow, Questionnaire Data	15
4 Sulfur Compound Emissions from Continuous Digesters, Summary of Questionnaire Data	16
5 Composition of Gas Streams Vented to Lime Kiln, EPA Test Results	17
6 Emissions from Multiple Effect Evaporators, Summary of Questionnaire Data	19
7 Gaseous Emissions from Multiple Effect Evaporator, Questionnaire Data	20
8 Control Techniques for Multiple Effect Evaporator Emissions, Summary of Questionnaire Data	21
9 Effect of Furnace Firing Rate and Air Supply on TRS Emission for Kraft Recovery Furnace	28
10 Analysis of Direct Contact Evaporator Function in Altering Furnace Gas TRS Content	33
11 Particulate Emissions from Recovery Furnaces Controlled by Electrostatic Precipitators, Averaged by Decile Groups	34
12 Particulate Emissions from Recovery Furnaces with Venturi Scrubber Systems, Questionnaire Data	36
13 Particulate Emissions from Recovery Furnaces with Secondary Scrubbers after Electrostatic Precipitators, Questionnaire Data	37
14 Gaseous Emissions from Recovery Furnaces without Black Liquor Oxidation, Questionnaire Data	39
15 Gaseous Emissions from Recovery Furnaces with Black Liquor Oxidation, Questionnaire Data	41
16 Recovery Furnace System Particulate Emissions, Summary of EPA Test Results	42
17 Recovery Furnace System Gaseous Emissions, Mill A without Black Liquor Oxidation, EPA Test Results	43
18 Recovery Furnace System Gaseous Emissions, Mill B with Black Liquor Oxidation, EPA Test Results	43
19 Recovery Furnace System Gaseous Emissions, Mill C with Black Liquor Oxidation, EPA Test Results	43
20 Reduced Sulfur Emissions from Black Liquor Oxidation Systems, Special Studies Data	46

<i>Table</i>	<i>Page</i>
21 Gaseous Emissions from Black Liquor Oxidation, Questionnaire Data	47
22 Emissions from Black Liquor Oxidation Tanks, EPA Test Results	48
23 Effectiveness of Smelt Tank Particulate Control Devices, Questionnaire Data	50
24 Smelt Tank TRS Gaseous Emissions, Summary of Questionnaire Data	51
25 Smelt Tank TRS Emissions, Special Studies Data	52
26 Smelt Tank Gaseous Emissions, EPA Test Results	53
27 Lime Kiln Scrubber Efficiency, Summary of Questionnaire Data	56
28 Gaseous Lime Kiln Emissions, Summary of Questionnaire Data	57
29 Lime Kiln Particulate Emissions, EPA Test Results	57
30 Lime Kiln Gaseous Emissions, EPA Test Results	57
31 Brown Stock Washer System TRS Emissions, Special Studies Data	59
32 Brown Stock Washer System TRS Emissions, Roof Vents and Under Vents, Special Studies Data	60
33 Brown Stock Washer System TRS Emissions, Total System, Special Studies Data	60
34 Brown Stock Washer System TRS Emissions, Alternate Use of Fresh and Condensate Wash Water, Special Studies Data	60
35 Brown Stock Washer System Gaseous Emissions, EPA Test Results	61
36 Extent of Controls Used in Semicheical Pulping Operations, Questionnaire Data	66
37 Sulfur Dioxide Emissions from Semicheical Processes, Questionnaire Data	67
38 Extent of Controls Used in Sulfite Pulping Operations, Questionnaire Data	74
39 Sulfur Dioxide Emissions from Sulfite Process, Questionnaire Data	74
40 Types of Pulp and Paper Mills Reporting Information for Power Boiler Questionnaire Survey	78
41 Fuel Consumption in Pulp and Paper Mill Power Boilers	78
42 Fuel Usage Data for Pulp and Paper Mill Power Boilers	79
43 Characteristics of Fuels Burned in Power Boilers at Pulp and Paper Mills	79
44 Steam Use Distribution at Pulp and Paper Mills, Power Boilers Only	80
45 Types of Power Boilers Used in Pulp and Paper Industry	81
46 Power Boiler Flue Gas Characteristics	83
47 Power Boiler Particulate Control Equipment Data	83
48 Emission Data from Power Boilers Fired with Coal Only	83

<i>Table</i>	<i>Page</i>
49 Emission Data from Power Boilers Fired with Bark/Wood Plus Other Fuels	85
A-1 Particulate Emissions from Recovery Furnaces Controlled by Electrostatic Precipitators	88
A-2 Particulate Emissions from Smelt Tanks	90
A-3 Gaseous Emissions from Smelt Tanks	91
A-4 Particulate Emissions from Lime Kilns	92
A-5 Gaseous Emissions from Lime Kilns	94
C-1 Odor Panel Screening Tests	112
C-2 Example of Odor Panel Response	112
C-3 Odor Panel Results, Mill B	113
C-4 Odor Panel Results, Mill C	114

LIST OF FIGURES

<i>Figure</i>	<i>Page</i>
1 Kraft Pulpig Process	8
2 Multiple Effect Long-tube Vertical Evaporators	18
3 Typical Kraft Recovery Furnace System Options	22
4 Effect of Solids Firing Rate on Reduced Sulfur Emissions and Steam Generation Efficiency	27
5 Observed Frequency of Total Reduced Sulfur Concentrations in Exit Gases from Recovery Furnaces with Good Combustion Controls	29
6 Observed Frequency of Total Reduced Sulfur Concentrations in Exit Gases from a Recovery Furnace with Limited Combustion Controls	30
7 Total Sulfur Increase across the Direct Contact Evaporator, Sodium Sulfide Concentrations from 0 to 20 g/liter	32
8 Total Sulfur Increase across the Direct Contact Evaporator, Sodium Sulfide Concentrations from 0 to 1 g/liter	32
9 Particulate Emissions from Recovery Furnaces with Electrostatic Precipitators, Questionnaire Data	35
10 Smelt Tank Particulate Emissions, Questionnaire Data	50
11 Lime Kiln Particulate Emissions, Questionnaire Data	56
B-1 Arrangement of Gas-Sampling System of Mobile Sampling Van	99
B-2 Sample Dilution System and Related Equipment	100
B-3 Flame Photometric Detector	103
B-4 Gas Chromatographic-Flame Photometric Detector for Low-molecular-weight Sulfur Compounds	104
B-5 Chromatogram of Low-molecular-weight Sulfur Compounds	105
B-6 Gas Chromatographic-Flame Photometric Detector for High-molecular-weight Sulfur Compounds	106
B-7 Chromatogram of High-molecular-weight Sulfur Compounds	107
B-8 Minimum Number of Traverse Points	109
B-9 Particulate Sampling Train	110
C-1 Example of Method of Estimating Dilution Level for 50 percent Response	114

ABSTRACT

This report contains information on the nature and quantities of the atmospheric emissions from chemical pulping operations, principally the kraft process. The information was gathered in a cooperative study by the National Council of the Paper Industry for Air and Stream Improvement, Inc. (NCASI), and the Environmental Protection Agency (EPA). Principal sources of information were a comprehensive questionnaire sent to all the pulp mills, special NCASI studies reported in Technical Bulletins, other literature sources, and a field sampling program conducted by EPA. Control techniques are described and emission ranges reported for each of the operations involved in the chemical pulping processes.

GLOSSARY

ABBREVIATIONS

acfm	actual cubic feet per minute
ADP	air dried pulp (assumed to contain 10 percent moisture)
Btu	British thermal units
°C	degrees Celsius (centigrade)
cfm	cubic feet per minute
cm ³	cubic centimeters
dscfm	dry standard cubic feet per minute
EPA	U. S. Environmental Protection Agency
°F	degrees Fahrenheit
ft ³	cubic feet
g	grams
gal.	gallons
gpm	gallons per minute
gr	grains
hr	hours
i.d.	inside diameter
lb	pounds
max.	maximum
min.	minimum
min	minute
ml	milliliter
NCASI	National Council of Paper Industry for Air and Stream Improvement
NSSC	neutral sulfite semichemical
ppb	parts per billion by volume
ppm	parts per million by volume
psig	pounds per square inch gauge
scf	standard cubic feet
sec	seconds
T	tons
TRS	total reduced sulfur (expressed as an equivalent amount of hydrogen sulfide)

CHEMICAL SYMBOLS

CaCO_3	Calcium carbonate
CaO	calcium oxide
Ca(OH)_2	calcium hydroxide
CH_3SH	methyl mercaptan
$(\text{CH}_3)_2\text{S}$	dimethyl sulfide
$(\text{CH}_3)_2\text{S}_2$	dimethyl disulfide
CO_2	carbon dioxide
H_2	hydrogen
H_2O	water
H_2S	hydrogen sulfide
H_2SO_3	sulfurous acid
N_2	nitrogen
Na	sodium
Na_2CO_3	sodium carbonate
NaOH	sodium hydroxide
Na_2S	sodium sulfide
Na_2SO_3	sodium sulfate
$\text{Na}_2\text{S}_2\text{O}_3$	sodium thiosulfate
O_2	oxygen
SO_2	sulfur dioxide

DEFINITIONS

Black liquor	Liquor recovered from the digesters.
Green liquor	Liquor made by dissolving smelt in weak wash liquor.
Heavy (strong) liquor	Black liquor that has been concentrated in preparation for recovery.
Oxidation efficiency	Percentage of sodium sulfide in the black liquor that is oxidized by air introduced into the liquor.
Recovery furnace	Combustion unit used to recover the spent chemicals from the digestion liquor and to produce steam.
Smelt	Molten chemicals from the recovery furnace, consisting mostly of sodium carbonate and sodium sulfide.

Sulfidity

Percentage of sodium sulfide to total alkali in white liquor, obtained by the formula

$$\frac{\text{Na}_2\text{S}}{\text{Na}_2\text{S} + \text{NaOH}} \times 100$$

where the sodium compounds are expressed as sodium oxide.

Weak wash liquor

Liquid stream resulting from washing of the lime mud.

White (cooking) liquor

Liquor made by causticizing the green liquor with lime. White liquor is ready for use in the digesters.

Weak liquor

Black liquor as recovered from the digesters prior to concentration (see "heavy liquor").

CONVERSION FACTORS, BRITISH TO METRIC UNITS

Multiply	By	To obtain
British thermal units	1.06×10^3	newton-meters
cubic feet	2.83×10^{-2}	cubic meters
degrees Fahrenheit ^a	5/9	degrees Celsius (centigrade)
feet	3.05×10^{-1}	meters
gallons	3.79×10^{-3}	cubic meters
grains	6.48×10^{-5}	kilograms
inches	2.54×10^{-2}	meters
inches of water	2.49×10^2	newtons per square meter
pounds (mass)	4.54×10^{-1}	kilograms
pounds per square inch	6.89×10^3	newtons per square meter
tons	9.07×10^2	kilograms

^aTo obtain Celsius (centigrade) temperature (t_c) from Fahrenheit temperature (t_f), use the formula $t_c = (t_f - 32)/1.8$.

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