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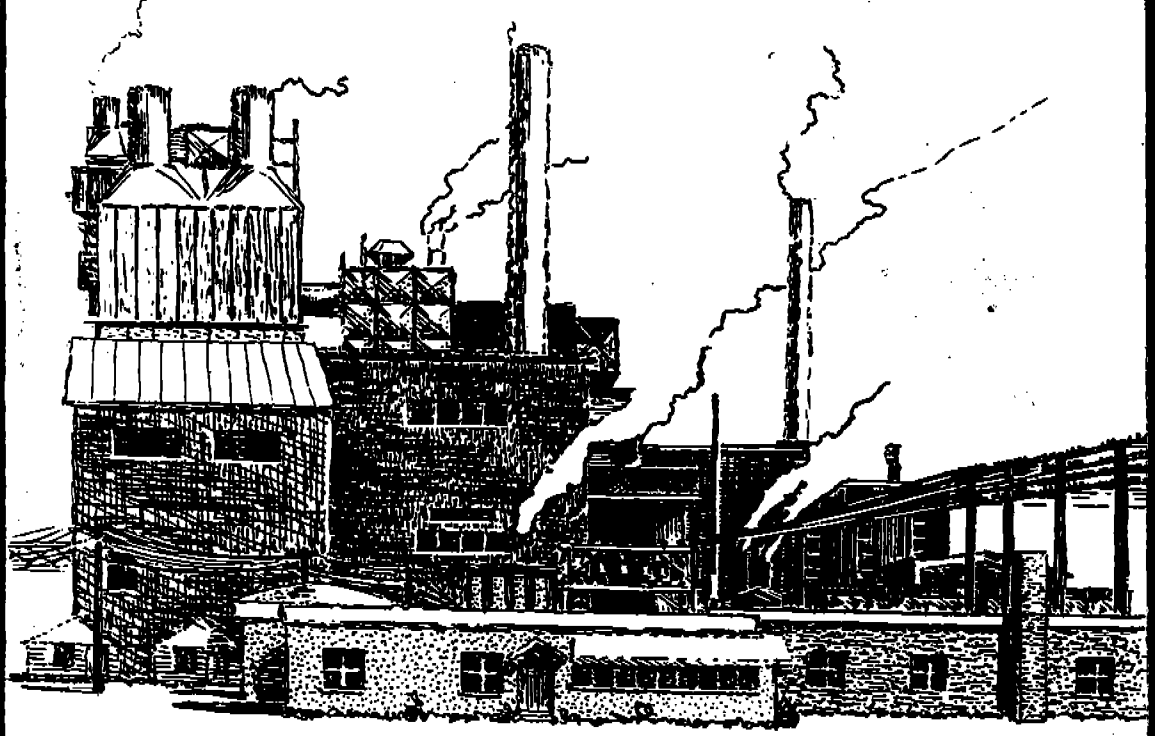

U.S. ENVIRONMENTAL PROTECTION AGENCY

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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	NCASI
*Stanley T. Cuffe	*Isaiah Gellman
John L. McGinnity	Peter Wrist
Joseph J. Sableski	Malcolm L. Taylor

Mr. Edwin J. Vincent of EPA and Mr. Rusell 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.

ACKNOWLEDGMENTS

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

The sponsors also wish to acknowledge the contributions of the source testing personnel of the Emission Measurement Branch, Office of Air Quality Planning and Standards, Environmental Protection Agency, and of the Division of Chemistry and Physics, Office of Research and Monitoring, Environmental Protection Agency.

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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
$(CH_3)_2S$	dimethyl sulfide
$(CH_3)_2S_2$	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
$Na_2S_2O_3$	sodium thiosulfate
O_2	oxygen
SO_2	sulfur dioxide

DEFINITIONS

Black liquor	Liquor recovered from the digesters.
Green liquor	Liquor made by disolving 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 recovery 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.

Sulfiditity	Percentage of sodium sulfide to total alkali in white liquor, obtained by the formula $$\frac{Na_2S}{Na_2S + NaOH} \times 100$$ 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

[a]To 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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