United States
Environmental Protection
Agency

National Risk Management
Research Laboratory
Research Triangle Park, NC 27711

Research and Development | EPA/600/SR-95/091 | August 1995

EPA

Project Summary

User's Guide to the Personal Computer Version of the Biogenic Emissions Inventory System (PC-BEIS2)

Terri L. Birth

The document is a user's guide for an updated Personal Computer version of the Biogenic Emissions Inventory System (PC-BEIS2) allowing users to estimate hourly emissions of biogenic volatile organic compounds (BVOCs) and soil nitrogen oxide emissions for any county in the contiguous United States. Emission rates depend on land use, emission factors, temperature and solar radiation. A simple canopy model is used to adjust photosynthetically active solar radiation at five vertical levels in the forest canopy. Leaf temperature and photosynthetically active solar radiation derived from ambient conditions above the forest canopy are then used to drive empirical equations to estimate genus level emission rates of BVOCs vertically through canopies. Emission rates from vegetation other than forests are expressed as BVOC carbon mass per unit land area, with a constant peak growing season biomass assumed. Light and temperature corrections are applied, but no canopy model is used for non-forested areas.

This Project Summary was developed by the National Risk Management Research Laboratory's Air Pollution Prevention and Control Division, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

The Personal Computer version of the Biogenic Emissions Inventory System (PC-BEIS2) is an updated program that allows users to estimate hourly emissions of biogenic volatile organic compounds (BVOCs) and soil nitrogen oxide emissions for any county in the contiguous United States. PC-BEIS2 has been compiled using Microsoft FORTRAN and tested on IBM-compatible personal computers. The source code is written in ANSI FORTRAN 77 and should be transportable to most other computers. Emission rates depend on land use, emission factors, temperature, and solar radiation. A simple canopy model is used to adjust photosynthetically active solar radiation at five vertical levels in the forest canopy. Leaf temperature and photosynthetically active solar radiation derived from ambient conditions above the forest canopy are then used to drive empirical equations to estimate genus level emission rates of BVOCs vertically through canopies. Emission rates from vegetation other than forests are expressed as BVOC carbon mass per unit land area, with a constant peak growing season biomass assumed. Light and temperature corrections are applied, but no canopy model is used for non-forested areas.

Data Requirements

The data requirements for PC-BEIS2 are modest. The user needs to obtain information on the county of interest and hourly meteorological data. County land use data and normalized emission factors are already contained in the model. The land use file is compressed on the diskette and must be "unzipped" using the program PKUNZIP. To run PC-BEIS2, the user should obtain the following data:

Site information:

- County Federal Information Processing System (FIPS) code - an index of

FIPS codes can be retrieved from the same directory as the PC-BEIS2 system

- Latitude, longitude (decimal degrees, tenths) - centered in the county, used for solar radiation calculations
- Time zone (5=EST, 6=CST, etc.)
- Month, day, year, hour(s)

Meteorological data (hourly):

- Ambient air temperature (°C)
- Photosynthetically Active Radiation (PAR) - not required if using cloud cover data
- Opaque sky cover (fraction) - not required if providing PAR data

Computer Aspects

Computer aspects include installation procedures, machine requirements, software design, and data structures associated with PC-BEIS2.

Installation Procedures

The executable file, source code, and necessary data files are available on EPA's CHIEF (Clearinghouse for Inventories and Emission Factors) electronic bulletin board or via ftp at "ttnbbs.rtpnc.epa.gov." The access number for CHIEF is 919/541-5742. To install the program, simply follow the procedures given on the bulletin board.

Model Requirements

PC-BEIS2 is written to conform with the FORTRAN 77 standard and has been compiled on the PC with Microsoft FORTRAN version 5.0. The source code, however, should be easily adapted to most FORTRAN compilers. PC-BEIS2 has been compiled to allow its use on IBM-compatible personal computers. The current executable version does not require the use of a math co-processor.

The executable, source code, and necessary data files needed to run PC-BEIS2 will take up approximately 3.16 MB of memory. In order for the menu interface to function properly, ANSI.SYS must be installed on the PC. ANSI.SYS is available with MS-DOS. The DOS reference book contains instructions. It is recommended, but not required, that PC-BEIS2 users have a math co-processor.

Software Design

PC-BEIS2 has been written in a modular fashion and, to the extent possible, conforms to the ANSI FORTRAN 77 standard. It consists of a main program and six subroutines or functions.

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***Chris D. Geron** is the EPA Project Officer (see below).*
The complete report, entitled "User's Guide to the Personal Computer Version of the Biogenic Emissions Inventory System (PC-BEIS2)," (Order No. PB95-243184; Cost: $17.50, subject to change) will be available only from:
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703-487-4650
The EPA Project Officer can be contacted at:
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Research and Development

EPA/600/SR-95/089 July 1995

EPA

Project Summary

Methodologies for Quantifying Pollution Prevention Benefits from Landfill Gas Control and Utilization

S.M. Roe, P.G. Fields, and R. Coad

This report presents a methodology and examples for developing air pollutant emission factors and emission estimates for comparing air quality impacts associated with landfill gas (LFG) control and utilization equipment and other energy sources (e.g., coal, natural gas) on a common basis. The methodology also provides the necessary information to prepare uncontrolled and controlled landfill emission inventories of carbon monoxide (CO), nitrogen oxides (NO_x), sulfur dioxide, carbon dioxide, and methane. LFG flaring is the only control option addressed in this report, while the utilization options include reciprocating internal combustion (RIC) engines, steam and gas turbines, and boilers.

The report includes examples of how to use the data and methodology presented. The examples compare the air pollutant emissions expected from control or utilization of the LFG from an example landfill using a flare, a RIC engine, a gas turbine, and a boiler. The example assessment also compares the LFG utilization options to emissions expected from an equivalent amount of energy input to a coal-fired steam power plant, a natural gas turbine plant, a natural-gas-fired boiler, and a distillate-oil-fired boiler. Annual emissions are summarized from an uncontrolled landfill and from a landfill following control or utilization with a flare, RIC engine, gas turbine, or boiler.

This Project Summary was developed by EPA's National Risk Management Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

Municipal solid waste landfills are required under the New Source Performance Standards to install LFG collection and control or utilization systems to reduce emissions of non-methane organic compounds (NMOCs), hazardous air pollutants (HAPs), odorous substances, and compounds with an explosion potential (e.g., methane). LFG control systems refer to flares, where there is no recovery of the associated energy. On the other hand, LFG utilization refers to the recovery of LFG energy either as primary heat (e.g., industrial boiler or space heater) or as a fuel source to drive electricity generating equipment. Currently, these are the most common utilization options.

Primary emissions from municipal solid waste landfills, such as methane (CH_4) and NMOCs, can be combusted in either a control or utilization device. However, systems used to control or utilize LFG (e.g., flares, internal combustion (IC) engines, gas turbines, and boilers) produce emissions of NO_x and CO, often referred to as secondary emissions. Since CO and NO_x emissions are of concern in nonattainment areas, methods are needed to comparatively assess emissions resulting from LFG control/utilization with other forms of energy production. Also, greenhouse gas emissions from landfills are of global concern, and therefore, a compari-

son of the net benefits associated with LFG control or utilization and other forms of energy production is often of interest.

Methods to Develop Emission Factors and Emission Inventories

Methods to develop emission factors from each control/utilization option are included. The emission factors developed for comparison to other energy sources are designated EF_{col} to represent that only emissions associated with the combustion of the collected LFG are included. These emission factors will provide the best comparisons for alternative energy sources, since the emissions associated with collecting those fuels (e.g., coal mining, petroleum extraction, and refining) are not represented in published emission factors.

Methods to prepare uncontrolled and controlled emission inventories are presented along with the discussion of developing emission factors for the collected LFG. The controlled emission inventories, however, include emissions from both the control/utilization equipment and uncollected LFG.

Example LFG Control or Utilization Assessment

An example assessment is included that illustrates the use of the data and methods presented. The example provides emission factors in pounds per kilowatt-hour for IC engines and gas turbines fired on LFG compared to emissions from an equivalent amount of energy input to a coal-fired steam power plant and a natural gas turbine power plant. Also in the example, emission factors are developed for a LFG boiler and compared to emission factors from an industrial boiler fired on either natural gas or distillate oil. Annual emission inventories were prepared for each utilization option and comparison energy source and presented along with an annual inventory of emissions following flare control. The annual amount of electricity produced for each power-generating utilization/comparison energy source is also presented.

An annual emissions inventory of uncontrolled versus controlled landfill emissions (using a flare, IC engine, turbine, or boiler) is also presented.

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***Susan A. Thorneloe** is the EPA Project Officer (see below).*
The complete report, entitled "Methodologies for Quantifying Pollution Prevention Benefits from Landfill Gas Control and Utilization," (Order No. PB95-243176, Cost: $17.50, subject to change) will be available only from
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