

Integrated Environmental Control Model (IECM)
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Readme + Version History
November 5, 2012

This document describes the history of changes made to the IECM between the first official release of version 3.1 and the current release.

CONTENTS

The IECM is composed of two types of files: (1) common Windows files installed into the \windows, \windows\system, or \winnt\system32 directory, (2) particular files installed into a user-specified directory.

SUPPORTED OPERATING SYSTEMS

The IECM currently runs on Windows XP (32-bit only), Vista (32 and 64 bit), and 7 (32 and 64 bit). We believe it also runs under Windows 8, but it has not been extensively tested.

This version of the IECM is also believed to run under Wine on MacOS X (Intel) and Linux systems. This is not officially supported, however one of our developers uses a Mac and regularly runs the IECM on it using Wineskin, which is a wrapper for Wine on the Mac.

INSTALLATION

If you have saved sessions in the default session database (IECM_CS\sessdb\sessdb.idb or sessdb.sdb), you should make a copy of this database before you install to avoid loss of data. Note that sessions from versions prior to 6.2 are not be compatible with this version.

The IECM uses a new database format starting with version 8.0.1 Beta. Among other things, this makes the installer more compact and allows the IECM to run under Wine on computers running MacOS X or Linux. If you have saved sessions and/or custom fuels in an older version of the IECM, you will need to download the conversion program from our web site to convert these databases into the new format. (Note that, although this version of the IECM runs under Wine, the conversion program does not; you have to run it under Windows.)

If you are installing the IECM under Windows, just run the installer to install it. If you are using MacOS X (Intel) or Linux, you will need to install it under Wine. For Linux, Wine is probably available in whatever software manager your distro uses, or you can download it here: <<http://www.winehq.org/>>. For MacOS X, see the next section.

MAC INSTALLATION

For MacOS X, we suggest you use Wineskin, available here: <<http://wineskin.urgesoftware.com/>>. The manual, available on the

Wineskin web site <<http://wineskin.urgesoftware.com/tiki-index.php?page=Manual>>, has some information on how to use it. Basically, you need to create a wrapper (section 2.3 Creating Wrappers) and then run the wrapper and tell it to install the IECM (section 4.1 The Installer, "way 1" works best for the IECM). The main executable file is "iecmint.exe".

If you need to change the configuration after you've installed it, e.g. to upgrade the wrapper and/or engine, section 3.1 "A Look Inside a Wrapper" tells you how to get to the configuration.

KNOWN ISSUES

There are some issues with Carbon Injection for Mercury removal. We expect to have this fixed in the next release.

On the Mac, certain OS and Wineskin versions may interact in a way that prevents the graphing package from displaying properly. The symptom is that the graph briefly appears in the graph window, and is immediately replaced by whatever is behind it. If this happens, you can use the "Save Graph As" command in the "File" menu to save the graph for viewing outside the IECM. This is strictly a graphics issue; it does not affect the numerical operation of the IECM.

PROBLEMS

If you are having trouble reading an old session or fuel database, note that this version of the IECM uses a different database format. You will need to download the conversion program from our web site to convert your old database(s) to this format.

If you are running the IECM under Wine, you may notice that some of the fonts and/or controls don't look quite as nice as they do under Windows. We believe that everything is functional, however our primary focus is functionality under Windows. We are interested in hearing if you have difficulty getting it to work under Wine, however we cannot devote any significant time to getting it to work in a non-Windows environment. (Having said that, one of our developers uses a Mac, so we do have an interest in keeping the IECM working under Wine as long as it is feasible to do so.)

All versions of the IECM share the same Windows library files (such as the Visual C++ runtime) installed in your \windows, \windows\system, or \winnt\system32 directory. Other specific support files are placed in the IECM_CS folder so as to not interfere with other software on the user computer. If you have problems running the IECM, first try reinstalling the IECM entirely.

If you have further problems installing or running the IECM, contact technical support by sending email to ped.modeling@net1.doe.gov.

VERSION HISTORY

11-05-12 | _____ | IECM-CS Version 8.0.2

The following bug fixes and adjustments have been made since 8.0.1 Beta:

- * Capital Cost Parameter screens for CCS in PC, NGCC were being hidden by overlapping O&M Cost screens; the O&M screens have been moved to tab 7.

- * Heat-to-Electricity is now hidden in the Ammonia system when there is an aux boiler, for consistency with the Amine system.

- * There was a stray "Overall O&M" process type in IGCC; this has been removed.

- * The "value" in the summary in the unc editor no longer has unit conversions applied when it is a "menu".

- * Input Tools and Result Tools have been combined into a single Unit Tools dialog; the cost year and inflation control have been removed, as they are normally set on the Overall Plant Financing Parameter screen.

- * Regen Heat Requirement in the Ammonia system now affects the rest of the plant.

- * The "Delete This Fuel" button is now enabled when a new fuel is added to a previously empty database.

- * Unit conversions are now done on the Fuel Properties screen.

- * Default Cost is now displayed for the currently selected coal in the database browser.

- * A couple of titles have been shortened to allow the full title and units to be displayed.

- * A couple of calculations in the Chemical Looping module were not properly accounting for the Purification Unit when used with a GE gasifier. This affected Purge Out of the Purification Unit, and the CO2 flow in the Pipeline Transport results.

- * CO2 Product Purity in Chemical Looping has been made read-only.

- * Operating Labor Rate is now properly displayed on the Overall Plant O&M Cost Parameters screen for IGCC plants. It has been made read-only on the GE Gasifier O&M Cost screen.

The following is a summary of updates have been made since 7.0.0 Beta which affect costs:

- * There is now a separate Real Escalation Rate for fuels.

- * Cost year 2011 has been added and made the default.

- * A couple of the CCS technologies had been using the wrong cost year for their disposal costs.

- * Pre-production costs have been updated to not include utility costs and CO2 transportation and storage.

- * Transport & storage costs removed from the cost of CO2 captured on the total cost result screens.

- * Operating Labor Cost updated based on NETL 2010 Baseline Rev 2.

- * Natural gas cost updated to 6.55 \$/MBtu (6.719 \$/mscf) in 2007 dollars in accordance with NETL Baseline REV2 (2010).

- * Cost of Illinois #6 changed to 38.18 \$/ton in accordance with NETL Baseline REV2 (2010).

- * Direct capital costs updated for NGCC plants based on DOE/NETL Baseline Study, 2010, Rev2.

There is a paper, "Understanding the pitfalls of CCS cost estimates", in the "IECM Publications" section on our web site which gives a more detailed explanation of the changes we've made regarding the inclusion/exclusion of T&S costs in CCS costs.

(This version is being released as a "beta" since there have been some significant changes since the previous beta. We anticipate releasing a new public release 8.0.2 in November.)

The following changes have been made since 7.0.0 Beta:

* New Features:

- o A new database format makes the installer simpler and smaller, and allows the IECM to run under Wine on MacOS X (Intel) and Linux. A conversion program is available for older fuel and session databases. (Running on non-Windows operating systems is not officially supported, but we expect it to continue to work.)

- o A fuel database "userfuels" is be created in the "sessdb" folder if it doesn't already exist, to give users a place to save their own coals without having to create and keep track of their own database. (Additional databases can still be created if desired.)

- o New Chemical Looping module.

* Adjustments:

- o Pre-production costs updated to exclude utility costs and CO2 transportation and storage.

- o Non-utility O&M costs are levelized in all results, not just on the "Total Cost" screens.

- o Transport & storage costs removed from the cost of CO2 captured on the total cost result screens.

- o Some predefined configurations have been updated.

- o Some O&M costs have been moved to the Overall Plant.

- o Overall Plant O&M Costs have been split across 2 screens.

- o Numerous interface adjustments to make things clearer and/or more consistent.

- o The default session database is now created by the interface if it doesn't already exist rather than having the installer overwrite it.

- o Various updates based on NETL Baseline REV2 (2010):

- Default natural gas cost and composition

- Operating labor cost

- Cost of Illinois #6

- PFC factor for Power Block and Wet Cooling Tower in NGCC

- Amine, Ammonia Heat-to-Electricity Efficiency

- o More information provided on CO2 Summary screens.

- o Separate Real Escalation Rate for fuels.

- o Cost year 2011 has been added and made the default.

- o Wastewater treatment costs and energy use are now being reported on summary screens.

- o Some optimizations to speed up graphs and saving samples when unit conversions are involved.

- o Some optimizations in "Export Samples".

- o Some improvements in the Uncertainty Editor.

- o Cleaned up graphing dialog.

* Bug Fixes:

- o The "Export Samples" command was not exporting some variables in result tables.

- o The energy penalty in Selexol is now dependent on the compressor efficiency.

- o CO2 Unit Compression Energy is now calculated in Selexol.

- o "Turbine Shaft Losses" in NGCC/IGCC was including "Total Steam Turbine Output" in the calculation.
- o Sessions are now properly unlocked when "save as" is used to save the session in a different database.
- o "Menu" inputs that represent numeric values are properly converted when the user changes unit systems.
- o Title-only input lines are now displayed correctly.
- o SiO2 in coal ash properties adjusted to make totals 100%.
- o The "No Mixing" Flyash Disposal option wasn't being properly recognized.
- o The Membrane and Ammonia systems were using the wrong cost year for the CO2 disposal cost.
- o The Amine system no longer tries to regenerate more sorbent than is actually used if the user sets the Nominal Sorbent Loss to be extremely low.
- o Turning off the CO2 Product Compressor in the Membrane system was not fully disabling the compressor.
- o In the IGCC, the user-specified syngas composition was not being consistently used.

11-03-11 | _____ | IECM-CS Version 7.0.0 (beta)

The following changes were made between the previous public version (6.2.4) and the beta version (7.0.0):

* Two new CO2 capture technologies (post-combustion) added for PC and NGCC plants:

- o Ammonia (chilled)
- o Membrane separation

* New software capabilities

- o User-specified samples option added to Uncertainty Editor
- o A new command- "Export Samples" added to the File/Export

menu

* New default values for some model parameters

- o Cost year changed from 2009 to 2010
- o Inflation rate changed from 3.5% to 3%
- o Natural gas cost adjusted to \$6.0/MBtu for NGCC plants
- o Maximum lean CO2 loading changed from 0.5 to 0.3 for

amine system

- o Gas turbine type changed from 7FA to 7FB for NGCC and

IGCC plants

- o Plant gross power output changed from 500MW to 650MW for

PC plants

- o Plant type changed from Subcritical to Supercritical for

PC plants

- o Min/Max values for some parameters

- o Some common variables (e.g. chemical costs) moved to the

Overall Plant section and made read-only in individual modules

* Bug fixes

- o Unit conversions in exported graphs and some table

columns

- o Floating point errors in exceptional cases

- o Base case cost year for wet cooling tower at IGCC and

NGCC plants

- o Export of difference graphs

- o Incorrect presentation of some results (e.g. flue gas temperature out of stack in some cases)

05-07-10 | _____ | IECM-CS Version 6.2.4

The following changes were made between the beta version (6.2.1) and the current public version (6.2.4):

- * New default values for several model parameters (including financial parameters and CO2 storage cost)

The following changes were made between the previous public version (5.2.2) and the beta version (6.2.1):

- * New Technology Options
 - o Advanced amine system for CO2 capture
 - o Integrated steam cycle model for PC plants
 - o Dry feed IGCC gasifier and sulfur capture system
 - o 7FB gas turbine option for IGCC plants
 - o Wet tower, dry tower and once-thru cooling water systems
 - o Wastewater treatment systems for PC plants
- * Updated Capital and O&M Cost Models
 - o Aligned to NETL 2007 baseline studies
- * New default values for some model parameters
- * New Software Capabilities
 - o Improved user-friendly screens for data entry
 - o Advanced graphing and uncertainty analysis capabilities

11-13-09 | _____ | IECM-CS Version 6.2

See the Technical Documentation.

08-10-09 | _____ | IECM-CS Version 6.1.0 (beta)

Enhancements

1. Ambient pressure sensitivity added to plant performance for IGCC and NGCC.
2. Steam cycle heat rate is now a function of boiler type (PC), cooling technologies and CO2 capture options (PC, NGCC).
3. Energy penalty for cooling system in NGCC, IGCC updated.
4. Some parameter defaults have been updated.

06-30-09 | _____ | IECM-CS Version 6.0.0 (beta)

New Features

1. Once-through cooling option added to all power plant systems
2. Wet cooling tower option added to all power plant systems
3. Cooling water treatment option added to all power plant systems
4. Dry cooling tower option added to all power plant systems

systems

5. Wastewater treatment system added to PC systems
6. Consumptive water use is now calculated
7. Shell gasifier added as an IGCC system option
8. Mercury capture added as an IGCC subsystem option
9. Sulfinol (sulfur capture) added as an IGCC subsystem

option

parameter screen

no release | _____ | IECM-CS Version 5.2.3 (final)

New Features

1. Graphs can now be scaled and re-labeled.
2. Sample size increased from 200 to 250 (larger shows no improvement in quality)
3. Graph smoothing turned off as default

Enhancements

1. GE 7FB gas turbine option calibrated (and activated). This also has 3-stage cooling
2. IECM now compatible with all non-default monitor DPI settings.
3. Beavon-Stretford molar gas table (inlet) corrected.

06-01-07 | _____ | IECM-CS Version 5.2.2 (final)

New Features

1. IECM can be run from a compact disk
2. NETL default coals added (5 total)
3. NETL natural gas added (1 total)
4. An advanced graphing system was added. Ability to graph results against inputs (scatter plot) added (but grayed out)
5. Graphing tools expanded to allow any variable graphed against another variable. A separate interface with online help for the graphing tools is also available.

Enhancements

1. GE 7FA gas turbine 3-stage cooling added (was one stage)
2. Session database template updated (tables added)
3. File attributes cleared when creating database copies
4. Chemical Engineering Cost Index updated (2006 added)
5. Critical fluid properties updated (temp, pres, vol) [used for compressor and transport models]
6. Pipeline model updated
 - a. Peng-Robinson interaction parameters
 - b. Pipeline max distance increased to 1000 km
 - c. Pipeline minimum elevation decreased to -100 m
 - d. Pipeline elevation error fixed
7. Fixed an error in the Selexol makeup rate (use variable capacity factor)
8. Fixed an error in the Claus plant catalyst makeup (use variable capacity factor)

9. lognormal "error factor" corrected
10. ASU capital cost equation updated
11. Selexol sulfur capital cost year basis corrected

02-02-07 | _____ | IECM-CS Version 5.2.1 (final)

New Features

1. GE 7FB gas turbine option placeholder added (but not shown)

2. H2S removal from the CO2 selexol unit added

Enhancements

1. Installer files added (support DLLs for graphs)

11-30-06 | _____ | IECM-CS Version 5.2.0 (final)

Enhancements

1. User docs updated.
2. Texaco gasifier name changed to GE (entrained)

11-01-06 | _____ | IECM-CS Version 5.1.3 (final)

Enhancements

1. Stack emission table corrected.

08-31-06 | _____ | IECM-CS Version 5.1.2 (beta)

Enhancements

1. GE gasifier energy use updated.
2. GE gasifier capital costs updated.

06-21-06 | _____ | IECM-CS Version 5.1.1 (beta)

Enhancements

1. NGCC iteration problem fixed (all simulations converge when amine system added)

06-19-06 | _____ | IECM-CS Version 5.1.0 (beta)

New Features

1. CO2 pipeline model added; automatically included with all CO2 capture technologies.
2. Navigation buttons added to "Configure Plant" section.
3. Comprehensive gas stream component table added.
4. Comprehensive solids stream component table added.
5. VR-Suite models and plugins created

(www.vrac.iastate.edu).

Enhancements

1. Cost indices updated.
2. Cost indices updated; basis year changed to 2003.
3. NGCC iteration problem fixed

08-19-05 | _____ | IECM-CS Version 5.0.3 (final)

Enhancements

1. CO2 Control Menu corrected.
2. Supported IGCC coals increased.
3. O2-CO2 COE (actual) corrected.
4. Oxidized mercury removal across FGD updated.

08-15-05 | _____ | IECM-CS Version 5.0.2 (beta)

Enhancements

1. Cost indices updated; basis year changed to 2002.
2. Steam input to GE gasifier is a function of coal and gasifier temperature (no longer user-specified).
3. GE syngas concentrations updated.
4. Energy use summary added to PC Plant summary screen.
5. Sulfur recovery power use corrected (sulfur byproduct credit).

04-14-05 | _____ | IECM-CS Version 5.0.1 (DOE only)

New Features

1. Oxyfuel option added to PC plant (ASU w/ recycled flue gas)
2. Flue gas recycle module added.

Enhancements

1. Booklife input corrected.
2. Ash properties for coals corrected.
3. Coal costs updated.
4. ASU construction time reduced from 4 to 2.5 years.
5. ASU cost year basis for capital cost corrected.
6. ASU power use equations are now a function of purity.

12-06-04 | _____ | IECM-CS version 4.1.0 (alpha)

New Features

1. Electricity cost basis options added to PC plant.
2. Reagent unit costs input screen added (consolidation).
3. Added ultra super-critical boiler to PC plant. Heat rate adjusted.

Enhancements

1. PC base plant water cost corrected.
2. PC base plant preproduction cost corrected.
3. By-product management inputs for energy use removed.
4. Wet and dry FGD steam cost basis corrected.
5. ASU gas components reported as flue gas, not a syngas.

6. Base plant COE maximum input increased to 200 \$/MWh.
7. WGSR and selexol capital costs corrected for larger plants.
8. Wet FGD bypass improved (identical to amine system).
9. CO2 emission constraint use corrected.

10-13-04 | _____ | IECM-CS version 4.0.5 (internal)

New Features

1. Amine scrubber flue gas bypass added.
2. Hydrolizer added to IGCC to convert COS to H2S
3. Emission constraint for CO2 capture added.

Enhancements

1. Amine scrubber steam and power cost basis corrected.
2. Compiler software upgraded; models recalibrated

08-20-04 | _____ | IECM-CS version 4.0.4 (rereleased)

Enhancements

1. Context-sensitive help updated.

06-30-04 | _____ | IECM-CS version 4.0.4 (beta)

New Features

1. Natural gas properties for amine scrubber available.
2. Hydrolizer for IGCC system added (COS converted to H2S).
3. Emission tax on CO2, SO2, and NOx for total emissions added.
4. Emission from aux. boiler added to stack result table.
5. Added subtotal to overall costs for IGCC and NGCC.
6. Added super-critical boiler to PC plant. Heat rate adjusted.

Enhancements

1. Wet FGD bypass corrected.
2. Natural Gas HHV calculation corrected.
3. HRSG capital cost equation updated.
4. Temperature and Pressure exiting ASU corrected.
5. Net MW value reported corrected.
6. Coal and Oil costs added to database and assigned unique values.
7. Aux. boiler stack emission corrected.

05-07-04 | _____ | IECM-CS version 4.0.3 (beta)

New Features

1. Natural gas was expanded to include C2H6, C3H8, COS, H2S, and HCl.
2. Syngas components for C2H6 and C3H8 were added.

Enhancements

1. Ammonia injection into SCR units were corrected.

04-26-04 | _____ | IECM-CS version 4.0.2 (alpha)
Special version for an internal project
with DOE, ISU, CMU, and REI

01-05-04 | _____ | IECM-CS version 4.0.1 (alpha)

Enhancements

1. Syngas water saturation prior to combustion improved.
2. Construction times updated across all plant types.
3. Steam saturation of fuel gas into combustor improved.

10-24-03 | _____ | IECM-CS version 4.0.0 (alpha)

New Features

1. V21P 3.6.x module components incorporated into IECM-CS.
2. IGCC GE gasifier performance inputs menu-driven.
3. Gasifier cold-gas efficiency added to results.
4. Shift reactor (WGSR) and CO2 scrubber added.
5. CO2 sequestration input and output options added.
6. Online help file for CS modules added.

Enhancements

1. Performance of selexol CO2 capture calibrated to CMU
model
developed independently.
2. Cost models of selexol CO2 capture calibrated to CMU
model
developed independently.
3. Selexol CO2 and WRSR output diagrams improved.
4. Online help file upgraded.

08-26-03 | _____ | IECM-CS version 3.5.5 (beta)

New Features

1. User database files can be named, saved, and opened.
2. Net plant efficiency added to results.
3. Power use breakdown added to results.

Enhancements

1. NGCC heat rate corrected.
2. Amine scrubber energy use corrected.
3. Amine scrubber regeneration heat corrected.
4. Fuel selection screen corrected.
5. Natural gas flow rate corrected.

05-02-03 | _____ | V21P version 3.6.0 (alpha)

New Features

1. IGCC KRW system with hot-gas cleanup added (IGCC) -
offline.
2. IGCC GE gasifier system with cool gas quench added

(IGCC).

3. IGCC E-Gas system added (IGCC) - offline.
4. Water gas shift reactor added (IGCC).
5. CO2 capture module by selexol process added (IGCC).
6. DBA flow rate added to result table
7. Combustion with natural gas combined cycle (NGCC) added as a new plant type. (CS)

Enhancements

1. Limestone with additives (DBA) molecular weight, reagent purity, flue gas exiting wet FGD, and wet solids removed were corrected (lime values used instead of limestone)
2. Interface window opens to 800 x 600 for monitor

resolutions

greater than 800 x 600. The interface continues to open full-screen for monitor resolutions below 800 x 600.

3. Unit conversion of sq ft/T-R set (ESP) corrected.
4. Ash removed from Wet FGD corrected.
5. Natural gas density used in natural gas final cost

corrected.

6. Wet FGD capital costs updated.
7. Wet FGD performance input parameter values updated
 - a. No spares
 - b. 100% of flue gas treated by one vessel
 - c. Higher maximum SO2 removal efficiency

11-14-02 | _____ | Alpha version 3.5.3 (IECM CS - special version)

New Features

1. Uncertainty can be turned on and off by technology type. It is accessed from an additional pane.

Enhancements

1. User data (session input and output) are saved to user-specified files; previously they went into one standard file.
2. "Save" and "Save As..." now work like other Windows applications.
3. Database files holding session data can be saved to any location and retrieved. This allows the IECM to be used on a network, by multiple users, and data traded.
4. Default values for stock and bond fractions are updated. The result is a new discount rate and fixed charge

factor.

5. Bond and stock rates are updated according to EPRI TAG 1999.
6. Federal and state tax rates were updated to reflect the EPRI TAG 1999.
7. Several errors in the energy penalty, TRR, and power cost functions of the CO2 module were corrected.

Remaining Issues

1. Tax changes present in the EPRI TAG 1999 must be made.
2. The debt, and stock inputs should be replaced with calc inputs that are a function of inflation.
3. Natural gas and fuel oil have been temporarily removed from the fuel selection options.

4. Total Plant Investment (TPI) has been changed to match the EPRI TAG 1999. The change implicitly alters the way the total cash expended and AFUDC are handled.

10-24-02 | _____ | Alpha version 3.5.2 (IECM CS - special version)

New Features

1. Auxiliary boiler added to CO2 module to produce steam and optional electricity. Options include:
 - a. None (no auxiliary boiler)
 - b. Steam production for use in CO2 regenerator
 - c. Steam and auxiliary power (from a steam turbine)

Enhancements

1. Process area capital costs were updated for the CO2 module. Cost scaling parameters were modified.
2. Steam taken from a base plant steam turbine is treated as equivalent electricity (electricity no longer produced).
3. SO2 removal efficiency is set to maximum when CO2 capture is configured.

10-29-01 | _____ | Alpha version 3.5.0 (IECM CS - special version)

New Features

1. CO2 removal added as a process type (Config screen menu).
2. MEA-solvent CO2 scrubber added as CO2 removal type.
3. FGD Reheater Temperature Change input added.
4. Plant diagram area expanded to allow for additional icon.
5. Total Capital Required (TCR) can be adjusted by a factor to allow for situations where the plant is partially or fully paid off.
6. Petroleum (oil), natural gas (ngas), and other (other) are added as possible fuel types. The tabs reflect the word "fuel" instead of "coal". Several fuel properties are added.
7. NH3 added as a flue gas constituent
8. CuO and NOXSO technologies removed

Enhancements

1. Conversion from acfm to acmm fixed.
2. Context-sensitive help via "F1" corrected.
3. Utility and Power cost refer to the same items for all modules: base plant electricity cost and module energy penalty.
4. ESP utility cost is a function of gross plant size, as the other modules already were.

5. Mercury removal constraint maximum set to 99.
6. Spray Dryer SO2 maximum removal default set to 90.
7. Wet FGD SO2 maximum removal default set to 99.

Remaining Issues

1. Base plant financial input assumptions modified to consider interest value, due to deregulation of the power industry (e.g., rates, booklife, taxes, cost of energy, net present internal rate of return, payback period, financial structures).
2. Inputs should be hidden if they are not being used.
3. HCl is removed in scrubber but not added to discharge.
4. SCR should include bypass
5. SCR has no power cost
6. Sorbent concentration in flue gas out (input) for CO2
7. CO2 capital cost basis on actual flow rate not normal
8. Add Total Hours of Operation to the perf summary table
- 9 .Change result table units from kg/kWh to g/kWh
- 10.Update fuel costs

04-30-01 | _____ | Final version 3.4.5

Enhancements

1. Mercury input tab is visible in all plant configurations.
2. ESP and FF total mercury removal without control default is now displayed for the user to override.

11-30-00 | _____ | Alpha version 3.4.4

New Features

1. Stack emission rates of equivalent SO2, equivalent NO2, ash, and Hg in units of lb/MBtu added.

Enhancements

1. Printed results show the proper name of the technology. SCR was being shown on Boiler NOx technology printouts.
2. Ash properties sum to the proper number.
3. Notations added where equivalent NO2 is used rather than NOx.
4. Boiler direct capital cost adjusted from net plant size basis to gross size basis.
5. ESP specific collection area corrected (which corrects capital costs also).
6. Uncertainty on variables used to changed output units is not implicitly used (e.g., capacity factor).
7. Base plant retrofit factors can be safely set to zero to

simulate \$0 capital costs (no floating point divide by zero).

10-05-00 | _____ | Alpha version 3.4.3

New Features
and
text
injections.
screens.

1. User documentation updated with Mercury module additions and modifications to other modules.
2. Air preheater flue gas exit arrow is yellow with "Inj." text above it on plant diagram to exhibit flue gas injections.
3. The yellow arrow opens the Mercury input and result screens.

Enhancements
diagram
device(s).
eliminate

1. Mercury flow rate in and out of the injection result diagram is removed and replaced with a text note to see TSP device(s).
2. Carbon injection user input calculation corrected.
3. NOXSO module NOx and SOx constraints corrected to eliminate divide by zero problems.

Known Problems
sum

1. Ash properties in the coal are not added correctly. The sum appears above the properties.

09-27-00 | _____ | Alpha version 3.4.2

New Features
in
when the

1. Mercury removed in solid streams is tracked and reported in disposal diagrams.
2. Results saved in the user session database are deleted when the software is upgraded to maintain backward compatibility.

Enhancements
with no
data.
bituminous coal
full ICR.
their
versions of

1. Mercury removed from CS-ESP is 31% for bituminous coal with no activated carbon injection. This is based on full ICR data.
2. Mercury removal from a fabric filter is 39% for bituminous coal with no activated carbon injection. This is based on full ICR.
3. Solids management input and result screens are linked to their respective icons on the plant diagram.
4. Uncertainty graphs are displayed for newly installed versions of the IECM software.

Remaining Issues
1. Activated carbon injection input calculation error for

SCR/FGD.

2. Flue gas injection indicator on the plant diagram with navigation.
3. NOXSO module produces a divide by zero in all configurations.

09-26-00 | _____ | Alpha version 3.4.1

New Features

1. Flue gas component summary tables display total NO_x, total SO_x, and total flue gas in mass and molar flow rates.
2. SO₃ removal efficiency added to the air preheater, cold-side ESP, fabric filter, wet FGD, and spray dryer. (SO₃ conditioning was already intrinsically present in the hot-side SCR). Default values correspond to the Southern Company method.
3. Mercury speciation and mass flow rate is tracked throughout all the IECM components. Default inputs are a function of coalrank, technology, and speciation type.
 - a. Concentration in coal
 - b. Speciation after cooling (elemental vs. oxidized)
 - c. Removal efficiency in the boiler, ESP, FF, and wet FGD
 - d. Speciation adjustments in the SNCR and SCR
 - e. Results displayed on all output diagrams (removal and flow) adjusted speciation added enhance constraint temperature removal, gas. format
4. Mercury removal constraint added; ESP and FF removals as a function of the removal in the wet FGD and change in the SCR.
5. Carbon injection with or without water injection module upstream of particulate and desulfurization units to mercury removal (lessen the requirement of the FF or ESP).
 - a. Overall mercury removal constraint
 - b. Calculated removal efficiency in wet FGD
 - c. ESP and FF removal efficiency adjusted to meet
 - d. Water is injected as a function of the required drop (enhancing mercury removal).
 - e. Carbon injected is a function of the necessary flue gas temperature, and SO₃ content of the flue
 - f. Capital and O&M cost model added using the EPRI TAG

and default values from DOE (based on EPA defaults).

Enhancements

1. Session database generation fixed. A table was not being created and causing graphs not to display.
2. Interface window size reduced to allow other windows to remain on top (e.g., Microsoft Office Shortcut Bar).
3. Flue gas component summary tables display weight and volume percent when the output units are changed to "% Total".
4. The fraction of total SOx as SO3 was updated to incorporate the default values from the Southern Company method. The default is a function of the fueltype and the coalrank.
5. Particulate removal requirement is reduced for the ESP when a wet FGD is present (to account for FGD ash removal).
6. Technology navigation combo box (at the bottom of input and result screens) are linked to the other navigation tabs.
7. Landfill and Pond result screens combined into a "Solids Mgmt." result tab.
8. Sulfuric acid dew point is calculated as a function of the gas pressure, SO3 partial pressure, and moisture partial pressure.
9. User saved results are discarded when upgrading IECM to a newer version to maintain configuration and input compatibility.

Remaining Issues

1. Sulfuric acid removed with ash not tracked
2. COHPAC or PJ-FF addition technologies to enhance mercury removal.
3. Uncertainty functions for mercury removal, speciation, and activated carbon cost.
4. Trace removal efficiencies cannot be accessed when there is no additional mercury controls.

08-29-00 | _____ | Beta version 3.3.1

Enhancements

1. Average natural gas properties used instead of methane in CuO and SNCR modules (mass flow and cost).
2. Natural gas O&M cost added to SNCR result sheet.

06-01-00 | _____ | Beta version 3.3

New Features

1. LNB menu options are not accessible for cyclone boilers.
2. Ammonia from SNCR and SCR are summed and reported

together

in performance result table.

3. Urea and natural gas are added to the performance result table. Total fuel was replaced with coal flow rate.
4. SNCR and SCR are allowed to be present together.
5. Some objects are masked when printing.
6. Disclaimer added to installer program.

Enhancements

1. Maximum NOx removal for SNCR is calculated based on an assumption of 20 ppm NH3 slip. The removal is enhanced

when

LNB is added (lowers NOx emission factor to a "low nox" classification). Min and max for the parameter were

relaxed

as well.

2. LNB wall NOx removal is constant for an emission factor

less

than 0.45 lb/MBtu and greater than 1.1 lb/MBtu (limit of regression curves).

3. LNB capital cost for large plants (>500 MWg) are based

on

EPA cost data. Smaller plants are based on DOE cost correlations.

4. In-Furnace Controls selection popup now is a function of the boiler type (e.g., no LNB with cyclone boiler).

Other

inputs are hidden/shown as a function of the popup

selection.

Results shown on the Boiler NOx result diagram are also hidden/shown as a function of the popup.

5. Gross plant size performance input limits tightened to 100->1,500 due to limits in boiler NOx regression

curves.

6. SNCR energy penalty only effects net plant size for urea (water pumps).

7. Removal of NOx by natural gas reburn is a function of

the

gas energy input and the boiler type (continuous

function).

8. SNCR stoichiometry removed from input screen. It is

shown on

the SNCR result diagram.

9. Boiler NOx Capital Cost units on input screen corrected.

10. Context-sensitive help added.

Remaining Issues

1. SNCR stoichiometry should be present as an input and

provide

an alternative method of determining NH3 slip and NOx efficiency.

removal

2. Slip from the SNCR should reduce the stoichiometry

calculated

for the SCR if it is present also.

3. Urea/NH3 which is unreacted and not present as slip need

to

be burned.

4. Flue gas bypass of SCR.
5. Inclusion of N2O and ammonia in flue gas array.
6. LOI correlation to boiler NOx retrofit parameters.
7. Inclusion of ammonia salts in solids array.
8. Multiple session operations (add results)
9. O&M cost savings for gas reburn
10. Horizontal scroll bars for large table result screens.
11. Upgrade uninstall control via roll-back with Windows

NT4.

02-14-00 | _____ | Alpha version 3.205

New Features

1. WISE installer used; benefits include version management (Backup folder) and flexibility in installing all software (including system files).
2. User coal and session database files are generated by interface if they do not exist; they are not installed.
3. New variables are added by the interface to existing sessions as they are opened (backward compatibility).
4. Unit conversion of annualized plant cost in mass/ton removed.
5. Flexibility of interface code added; allows creation of optional screens and screen components (dynamically show

or

hide input/output screens & components).

6. Result tables can be generated landscape or portrait.
7. Annualized cost summary table for each technology added.
8. Flue gas component summary table for all technologies.
9. Inputs for cost summary table added.
10. Sluice water input expressed as %water instead of

%solids

(fabric filter, cold-side ESP, wet FGD, boiler)

Enhancements

1. Flue gas moisture additions when urea injected
2. LNB and SNCR+LNB parameters set to zero for cyclone
3. Compatibility with version 3.1 sessions restored; alpha versions remain incompatible (input lines mismatched).

boilers.

12-16-99 | _____ | Alpha version 3.204

New Features

1. Total annual plant cost per ton of NOx/SOx/Ash demo.

12-08-99 | _____ | Alpha version 3.203

Enhancements

1. Natural gas cost minimum reduced from 3.5 to 2.0
2. Retrofit capital costs were scaled incorrectly

12-06-99 | _____ | Alpha version 3.202

New Features

1. Gas Reburn implemented
 - a. specify energy percent from natural gas
 - b. flue gas composition adjusted (mass balance)
 - c. NOx reduction based on uncontrolled plant
 - d. SCR removal adjusts to reburn removal
 - e. result diagram shows natural gas used
2. O&M Costs
 - a. labor basis and year updated
 - b. natural gas cost added (\$/MCF)
3. Cost Year (1998) added, using 1997 values

Enhancements

1. Chlorine combustion corrected

11-13-99 | _____ | Alpha version 3.201

New Features

1. Coal input screen has new field for summing components
2. Better graph and axis titles
3. Smoother graphs
4. Additional parameter to control graph smoothness
5. Half and negative half normal functions added
6. Process type navigation popup added (bottom of all screens)
7. Boiler NOx reduction model (perf & cost)
8. Input and output lines can be hidden when appropriate
9. Input unit changes added

Enhancements

1. Spray dryer SO2 removal input (override now works)
2. NOx emission factor input (override now works)
3. SCR catalyst cost units corrected (now \$/cu ft)
4. Base plant cost year corrected (now 1993)
5. Miscellaneous cosmetic interface errors fixed
6. Placement of graph legend corrected
7. Default coal components corrected (Low Sulfur & WPS

Utah)

8. LOI removed from coal prior to and added in after combustion
9. SNCR cost year initialization corrected (costs were being evaluated in 1977 dollars)

05-19-99 | _____ | Final version 3.1 released

07-12-98 | _____ | Version 2.0 released (DOE only)

07-01-97 | _____ | Version 1.0 released (DOE only)

- New Features
- 1. Windows 95 and NT support (ported from Analytica on Macintosh)
 - 2. Modular programming components
 - a. Stochastic Engine (FORTRAN)
 - b. Technical Model (FORTRAN)
 - c. Graphical interface library (C++)
 - d. Graphical interface (C++)
 - 2. Simple, robust and stand-alone graphical user interface (GUI)
 - a. Floating palettes
 - b. Menus
 - c. Tool bars
 - d. Multi-document support (sessions, graphs)
 - e. Tab-based navigation
 - 3. Robust tables and graphs (commercially licensed DLLs)
 - 4. Robust database support (Microsoft Access format)
 - 5. Limited access to underlying model structure and variables
 - 6. Enhanced performance (compared to Macintosh)
 - 7. No 3rd party licenses requiring payment
 - 8. Color highlighting