Applications of an IT Tool, OMS, on Real-Time Emission Inventory

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Abstract

An OMS (Operation, Maintenance, and Safety) Lab has been set up at Lamar University to study the feasibility of a real-time emission inventory in a chemical plant. Using a de-pentanizer unit as an example, an upset operation condition is emulated with a cooling tower water flow failure. This failure causes an abnormal vent open at the distillation tower reflux drum. The process data, the equipment identification tag number of the valve, and the process time can be transfer into a specific calculation program to calculate the real-time emission. The calculated real-time emission can be evaluated by the plant engineer, stored in data historian, or reported to TCEQ (Texas Commission of Environmental Quality) through EIMS (Environmental Information Management System) package. A calculation module is also developed to manage the fugitive emission such that the calculation and human errors can be minimized.

Introduction

The new legislation and guidelines being issued by TCEQ (Texas Commission of Environmental Quality, formerly TNRCC) under Title V regulation of EPA [1] mandate reporting of plant emission data under periodic monitoring and historical records for compliance assurance monitoring. The extensive data under these two sections require that the chemical process industry resort to electronic capture and distribution to be of value to the industry and for the environment. The real time emission data which will be available to the industry would help them to design better process, proper and timely reporting, and even commercially trade the emission credits.

With Clean Air Act coming into effect, Texas State Implementation Plan has given a high challenge to the chemical industries in Texas. The new revisions proposed to TAC (Texas Administrative Code) Title 30 Chapter 101 & Chapter 115 [2,3] issued by TCEQ will become effective upon adoption by January 2003. More and more stringent standards are required to meet for the chemical industry.

On the other hand, chemical manufacturing facilities constantly change to meet global competition and new environmental laws and regulations. The enterprise environmental data management system must reflect these changes to insure accurate, consistent reporting. For companies with dozens of facilities, the volume of information is huge and

the sources are many. A disciplined work process enabled by new technology is needed to effectively handle the volume and diversity of change information.

Information technology is an approach to help chemical process industry (CPI) get more accurate information of processes and emissions. So they can make more effective, reliable and proactive way for achieving air compliance. OMS lab, which has been setting up in Lamar University, is to integrate commercial software packages used in CPI by developing bridge packages. We can use the real-time process data from DCS to compute the emission data. The real-time emissions inventory can be very useful to help plant managers make a more accurate, reliable and proactive decision so as to reduce the number of events and minimize the emissions. Self-regulative environmental management can be achieved by this way.

The information technology package developed in this study can be used in the emissions inventory for the regional air monitoring and control. Emissions from fugitive area and point sources are the main contributors to the emissions inventory. A critical portion of air emission is VOC (Volatile Organic Compound) that contributes to the ozone formation [3]. The monitoring and control of highly reactive VOC (HR VOC) has been required by several states such as Texas [4]. Current inventory indicates that highly reactive VOC are released from the process plants in the Houston-Galveston Area as given in Table 1:

Table 1. Main sources of HR VOC in HGA [4]

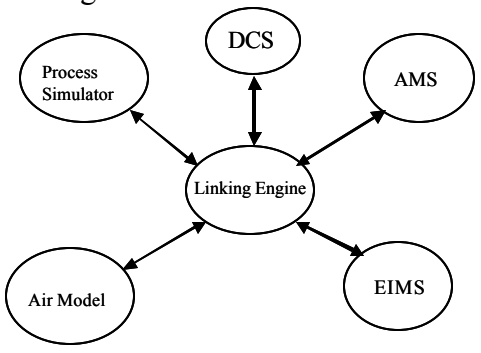
Fugitive Emission	48%
Flares	30%
Vent Gas Control	8%
Cooling Tower	7%

Both fugitive emission and flares are the major contributors to the emission inventory. OMS lab will deal with these two major sources in this paper.

OMS Lab

The OMS Lab consists of computer hardware and software to link all the components together: a DCS (Distributed Control System), a process dynamic simulator, an air model, an EIMS (environmental information management system), and an asset management solution (AMS). The OMS laboratory is not only a link but also allows communication and data exchange between the various components of the system. The data exchange between the different sources, applications, and users will be handled through a Linking engine. This allows seamless

Figure 1. OMS Lab at Lamar



transfer of data, and permit the analysis and report generation. The software being used are Aspen, Hysys for process plant simulation; PDC – COMPASS for emission inventory reports; and MocKingbird for the linking engine.

Fugitive Emission Management – OMS Application 1

Emissions that are not released through a stack, vent, duct pipes or other confines air streams are termed as fugitive sources. These emissions include equipment leaks and area emissions. It is very difficult and expensive to detect and estimate such emissions. It is advisable to calculate the fugitive emissions with the help of data available from the direct measurement. Industries are free to use any method to estimate the fugitive emissions. The emission factors given by the Synthetic Organic Chemical Manufacturing Industry (SOCMI) are widely used to perform the calculations.

Although fugitive emissions were known to the regulatory agencies, no estimation or standard method was developed until early 80's. Regulations during 80's required facilities to estimate and control fugitive emissions. The EPA began to develop a series of National Emission Standards for Hazardous Air Pollutants (NESHAPs), which established emission standard for industries. NESHAP includes the leak detection and repair (LDAR) program to detect, estimate and reduce fugitive emissions. In 1986, Congress passed the Superfund Amendments and Reauthorization Act (SARA), which require industries to quantify the levels of certain chemicals to waste as well as the loss of those chemicals to fugitive emissions. The plant are required to estimate fugitive emissions every six months to determine the facility's compliance with operating permits according to the Clean Air Act Amendment (CAA) of 1990.

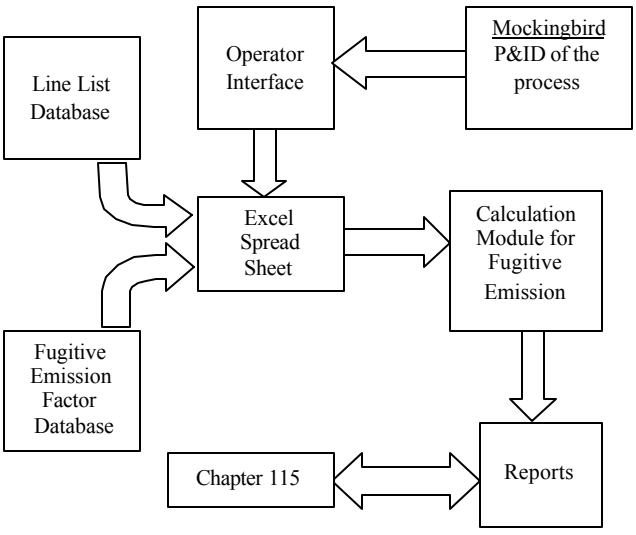


Figure 2. Flow-diagram for fugitive emissions calculation

In the OMS lab, the module for calculating fugitive emission is developed using Visual Basic. MocKingbird linking engine is used to provide the easy access for the operator to locate the leaking component from P&ID. Using the user interface, the operator enters the Tag ID of the leaking component, timestamp the start of a leak and the screening value measured for that component. Visual Basic module queries the "line list" database in order to check the phase and the composition of the process stream associated with the component. Based on the available data module queries the emission factor database to pull out the required emission factor for the mass

emission rate calculation. The obtained emission factor is transferred to the Excel Spread Sheet for calculation. Based on the emission factor, the emission rate is calculated in the Excel spreadsheet using built-in macro when repair/leak is rectified. The flow-diagram of this real-time emissions calculation process can be seen from Figure 2.

Process Upset Emission Management – OMS Application 2

Upset/Startup/Shutdown and maintenance activities can have significant emissions as compared to routine emission levels. These emissions may contribute to the ozone spike observed in a heavy industrial area. Conclusion from the Episodic Release Reduction Initiative (ERRI) Report of 2000 gives the root causes of these emissions is shown as Table 2.

From the results, equipment failure, process upsets, human factors and Startup/Shutdown are the main sources of the episodic release. TAC Title 30 Chapter 101 gives the new rules for process upset and scheduled maintenance, start up and shut down activities.

Table 2. Root Causes of Episodic Release [5]

Root Causes of Release (No. of releases)	**%**
Equipment failure	27
Process Upsets	14
Human Factors	10
Startup/Shutdown	9
Equipment Design	8
Procedures	8
Other (corrosion, instrument, seal etc)	24

In reality upset emissions are the least understood because there are many unexpected things happening at the same time and process is in a special unsteady state mode, hence many guesses have to be made for emission estimates. Sometimes, even the actual beginning time of an upset and associated emission are difficult to pinpoint. And the annual emission inventory number is not an accurate measurement. Real-time emissions inventory for upset event is necessary in order to have an accurate report. The real-time data can also be used for further analysis and study to reduce the emission events.

This application is focusing on the process-upset situation. An example of cooling water failure in a de-pentanizer unit is used, as can be seen from the flow-diagram given in Figure 3. When the cooling water failure is occurred, the temperature at the reflux condenser goes up, eventually the vent valve opens and the alarm goes on. Usually, the operator has to deal with this emergency situation. That is to cut down the steam to the re-boiler and cut down the feed stream to the distillation column. Currently, the emission

caused by this process upset is calculated manually. The decision for emission event notification to the regulatory agency will be made by the EHS (Environment, Health, and Safety) supervisor, and the report will be filed within two weeks after the event. This procedure is very time consuming and could make mistakes. Therefore, the information technology can be adapted to improve this emission calculations and reporting.

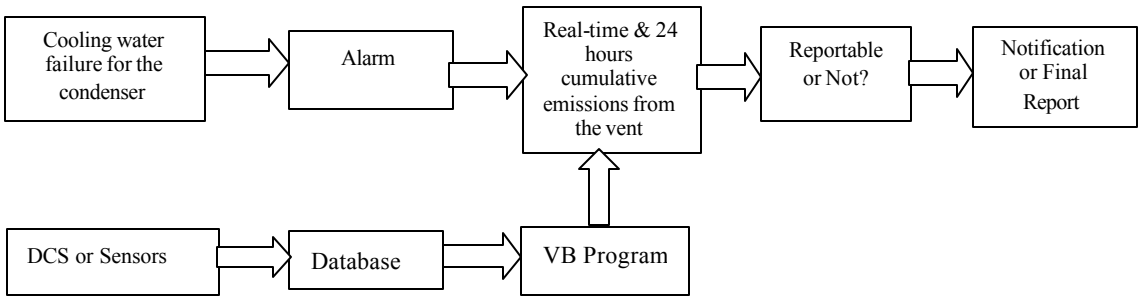


Figure 3. Flow Diagram For Upset Emissions Calculation

A computer module is developed here to transfer the process data from DCS (Distributed Control System) into the database for calculation. The real-time emissions can be calculated by a VB program and compared with the permit limitation. The operator can have the real-time emission information on line and can decide whether this is a reportable emission event or not. If this is a reportable event, notification and final report can be generated automatically by this module. Human mistakes can be avoided.

Conclusion

The OMS tool is a powerful IT tool for the application of calculating the real-time emission inventory in CPI (Chemical Process Industry). Human errors during the calculation and reporting can be reduced by using OMS tool. OMS lab will help industry to implement self-regulated environmental management system. OMS tool will considerably reduce manpower associated with environmental compliance and at the same time maintaining adequate records for analysis and trouble shooting.

Acknowledgment

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