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EPA ORD ENGINEERING HIGHLIGHTS

A bi-monthly compilation of EPA's Office of Research and Development engineering research activities and results and related research activities in pollution prevention and mitigation. To discuss any of these activities, contact the ORD lead person listed below. For general information, contact Darlene Williams of the Office of Technology Transfer and Regulatory Support, Phone: FTS 260-7891.

NOTE:

Although many people may not have received previous issues due to a distribution error, this is the seventh issue of this newsletter. Hence, the last three issues are being sent out to everyone on our mailing list along with this issue. We apologize for any inconveniences.

What's Inside

Hazardous Waste

RREL Investigates Destruction of PCBs with Quicklime

At the request of EPA Region V, the Risk Reduction Engineering Laboratory (RREL) investigated the effects of quicklime on PCBs. Field observations had suggested significant PCB losses after wastes were solidified with materials containing quicklime.

RREL tests showed that when quicklime is added to PCBs in the soil, heat is generated by quicklime slaking, which raises the mixture temperature to about 180°C. Analysis and tests revealed that the PCB losses were largely due to steam stripping and volatilization rather than PCB destruction. While some limited decomposition of PCBs by quicklime occurred, the rates and extent of dechlorination were low, and the results of this study refuted the earlier claims.

RREL's next focus will be on studying possible deleterious effects of using quicklime-based materials to solidify PCB wastes for handling in removal actions. Although this common application of quicklime-based materials typically uses less reactive lime and is probably environmentally safe, the possibility of volatilization and/or chlorinated dibenzofuran formation needs to be examined. (Timothy Oppelt, Director, RREL, FTS 684-7418)

Chamber for Evaluating Radon Movement through Soil and Building Foundations

To design effective radon mitigation techniques, understanding of radon gas movement through soils must be improved. Mathematical models describing radon transport and entry have been developed; however, the models must be validated by simulating transport processes under controlled conditions. To simulate conditions for the movement of radon gas through soil, a research chamber that will contain 16 cubic meters of soil with high-levels of naturally occurring radium has been constructed by Air and Energy Research Laboratory (AEERL). Pressure-driven flow will be monitored along a two-dimensional plane intersecting the central length of the 2 by 2 by 4 meter structure. A driving force for the convective flow conditions will be provided by a vacuum along a perforated pipe placed at mid depth across the center and end of the chamber. Pressure differentials, radon levels, and airflow through the soil will be measured. The project will yield valuable information on radon movement through soil and radon entry into buildings. It also will serve to consolidate AEERL's understanding of other areas of research such as radon blocking and pressure and temperature driving forces. (Bruce Harris, AEERL, FTS 629-7807)

Research on Carbon Dioxide Cleaning Technology

An exploratory research effort has been initiated to develop

a lead paint abatement process that utilizes CO_2 pellet blasting systems. This technology has been successfully applied to paint removal, vapor degreasing, and other cleaning processes. The technology appears promising for removal of asbestos, lead-based paint, and other surface-bound contaminants. The major benefit of CO_2 cleaning technology is that no blasting material remains for disposal with the removed substrate. (Roger C. Wilmoth, RREL, FTS 684-7509)

New RCRA RD&D Permit for Hazardous Waste Incineration Lab

For the past two years, AEERL's Combustion Research Branch has performed hazardous waste incineration research under a limiting RCRA Research, Development and Demonstration (RD&D) permit. It only allowed incineration research to be performed with surrogate wastes on the three small combustors. The first permit has gone through closure and a new expanded five-combustors permit is now in effect. It allows for research on all size research combustors using surrogate or actual hazardous waste. The associated flue gas cleaning system is installed and operational. Initial tests will focus on trace metal aerosol formation. (Robert E. Hall, AEERL, FTS 629-2477)

Emission Potential of Landfill Methane

Data were collected from over 30 U.S. landfills with the goal of developing a more reliable estimate of global landfill methane emissions. In conjunction with collecting field test data, AEERL has been gathering country-specific data on the amount of waste being landfilled and its composition. The data collected from U.S. landfills are being used to develop an empirical model of methane emissions from landfills. The report containing field test data will be distributed this fall. (Susan Thorneloe, AEERL, FTS 629-2709)

Air

Innovative Technology Controls Organic Compounds

Tests have shown that an innovative, experimental reactor can destroy 95% of the organic compounds in an air stream at very low power consumption. Examples of such streams are painting operations, chemical blending processes, printing operations, and pharmaceutical plants. In addition, the reactor, which depends on low-power generation of electrical corona conditions, has proven effective for very low concentrations of organic compounds. This EPA-developed technology could become a vital component in achieving the environmental goals set by the Clean Air Act of 1990 for ozone non-attainment and for air toxics control. The corona destruction reactor develops very high intensity, localized electrical fields, and organic compounds are destroyed as they pass through the fields. A pilot reactor has been designed and operated with a flow rate of 20 to 50 cfm. The reactor system consists of modules, and the number of modules can be changed to accommodate various flow rates and concentrations. The corona technology will offer an alternative to conventional control technologies, such as carbon adsorption, catalytic oxidation, and thermal incineration, which have severe limitations at very low concentrations. (Geddes H. Ramsey, AEERL, FTS 629-7963; Carlos M. Nunez, AEERL, FTS 629-1156)

Landfill Gas Pretreatment System Design Approved

AEERL is funding an approximate four-year study to field demonstrate a 200 kw phosphoric acid fuel cell on landfill gas. A major goal of the study is to ascertain whether landfill gas is a technically and commercially feasible fuel option for fuel cells. Consequently, considerable effort will be devoted to construction and testing of a gas pretreater to process fuel gas (removal of sulfur, halides, and Non-Methane Organic Compounds [NMOC]) prior to introducing it into the fuel cell. Major technical progress was accomplished when a landfill gas pretreatment system was designed, rigorously reviewed, and approved by AEERL for construction and testing. The fuel pretreatment system incorporates two stages of refrigeration combined with three regenerable absorbent steps. The use of staged refrigeration provides tolerance to varying landfill gas constituents, and is, therefore, more flexible than utilizing dry bed absorbents alone. Condensates from the refrigeration processes and regeneration gas from the final bed are combusted via a low NO_x incinerator to provide 98% destruction of the NMOC from the raw landfill gas. The cleaned landfill gas is fed to the fuel cell for conversion to electricity and clean heat. Construction of the pretreatment module has commenced, with onsite testing scheduled for February 1992. (Ronald Spiegel, AEERL, FTS 629-7542)

Non-Ozone Depleting Refrigerants for Domestic Heat Pumps and Air Conditioner

Recent tests using an experimental heat pump apparatus show that two non-chlorine refrigerant mixtures are equal to or even exceed traditional HCFC-22 refrigerant in efficiency and capacity during heat pump operation, making them promising replacements for the ozone-depleting HCFC-22. The mixtures are HFC32/HFC152a and HFC32/HCFC134a. These chemicals are either commercially available or available from industry in test quantities. Prior modeling work showed this performance was possible, but this is the first experimental proof of the capabilities of the replacement refrigerants. Toxicity tests of the individual components have not indicated any problems. The Clean Air Act restricts production and use of HCFCs beginning in the year 2015; however, recent information showing greater stratospheric ozone depletion than originally thought will probably expedite this limitation on HCFCs. An innovative program is planned to evaluate operational and equipment changes associated with using these new refrigerant mixtures (e.g., potential flammability concerns); to evaluate other potentially environmentally superior mixtures; and to optimize overall operation. The work is managed by AEERL and is being conducted at the National Institute of Standards and Technology. (Frank Princiotta, Director, AEERL, FTS 629-2821)

Mercury Emissions Control from Municipal Waste Combustor

The control of mercury emissions from highly combustion efficient municipal waste combustors (MWCs) has been inconsistent and poses a problem in setting an emission limit for the MWC source category. AEERL is assisting EPA's Office of Air Quality Planning and Standards (OAQPS) in its effort to develop this standard as required by the Clean Air Act Amendments of 1990. AEERL will provide OAQPS with data and

results from a recently completed field test that addresses mercury control at the Ogden Martin of Stanislaus Systems, Inc., facility near Modesto, California. This plant uses selective noncatalytic reduction (ammonia injection into the furnace to limit nitrogen oxide emissions), and this process may affect mercury emission control. Activated powdered carbon was injected into flue gas upstream of the MWC unit's lime spray dryer absorber/fabric filter (flue gas cleaning) system and evaluated as a technology for supplementing mercury removal. Preliminary results suggest that this is an effective approach and show that mercury capture can be improved from 25% without carbon injection to over 90% with carbon injection. An engineering analysis of the validated test results is being prepared. This analysis also will address potential ammonia and flue gas cleaning operating parameters on mercury control. The draft final report is expected in November 1991. (T.G. Brna, AEERL, FTS 629-2683)

Air Emissions from the Treatment of Contaminated Soils

AEERL prepared a document to respond to requests through EPA's Control Technology Center (CTC) for guidance for State and local air pollution control agencies to evaluate the air emission potential of treatment processes and the cost effectiveness of applicable control technologies. The report evaluates seven general approaches for the disposal or treatment of soils contaminated with gasoline, oil, or diesel fuel. (Susan Thorneloe, AEERL, FTS 629-2709)

Low Emission Woodstoves on the Horizon

Low emission woodstove technology developed by AEERL is ready for field testing in 30 homes this winter. This process, which uses a gas pilot flame to ignite a second fire to burn the smoke from the wood fire, achieves nearly 100-fold reduction of particulates compared to EPA-certified 1992 noncatalytic woodstoves. It is estimated that this technology would add only 5 percent to the price of the stove and would cost only $2.25 per month for natural gas to fuel the pilot light. These costs would be partially offset by the reduction in wood used because of the increased efficiency of the stove and the additional heat given off from the gas pilot.

The laboratory is filing a patent application on behalf of the four ORD scientists who developed the technology. Thirty prototype stoves will be manufactured under a Federal Technology Transfer Act agreement and provided free to homeowners. ORD will conduct emissions testing of these stoves during the coming winter. (Frank Princiotta, Director, AEERL, FTS 629-2821)

Active Soil Depressurization Systems to Reduce Indoor Radon

Recent analysis has shown that cost-effective radon reduction technology is required for houses having initial radon concentrations below 4 pCi/L, because 78 to 86% of the national health risk is associated with those houses. Active soil depressurization (ASD) has proven to be a very effective radon reduction technology; however, ASD has not been widely utilized by homeowners, in part because of the installation cost ($800 to $1,500). A comprehensive cost analysis conducted by AEERL has shown that, through further research, ASD costs can potentially be reduced by several hundred dollars, especially for more complicated systems; however, their cost cannot be reduced below the lower end of the range cited above. In view of general homeowner apathy regarding radon, this cost reduction is not expected to significantly increase voluntary demand for ASD systems. Thus, although ASD is a highly effective and widely applicable technique, innovative, lower cost methods will be necessary. These innovative methods may achieve lesser radon reductions than ASD in a given house, but, if they are extensively utilized in houses with levels below 4 pCi/L because of their low cost, they may have a greater impact in reducing national health risk. Over the past year, AEERL's radon mitigation R&D program has focussed on the development of such innovative, low-cost approaches. (Bruce Henschel, AEERL, FTS 629-4112)

Emissions from Coke Pushing and Quenching Reduced by New Technology

A demonstration (co-funded by EPA and Bethlehem Steel) of the Kress Indirect Dry Cooling process is underway at Bethlehem's Sparrows Point, Maryland, facility. In this technology, a box is positioned flush against the coke oven and receives the coke. Next, the box is sealed and transferred to the quenching station where the coke is indirectly quenched by running cooling water on the outside of the box. In the conventional process, the hot coke free-falls into an open container and is cooled or quenched by direct contact with water, resulting in extensive particulate and VOC emissions. Additionally, this demonstration will use a door remover that cleans the coke-side door and door jam of the coke oven. This cleaning should help this facility meet the proposed Air Toxics Regulations on door leaks. (Chester Vogel, AEERL, FTS 629-2827)

Open Field Burning of Used Insecticide and Herbicide Bags

The "Executive Summary: Field Test of Open Burning of Pesticide Bags in Farm Fields," summarizes a study on realistic, field-generated emissions and residue data using open burning in farm fields to dispose of used insecticide and herbicide bags. The focus of the study was to characterize the gaseous emissions, particulates, and remaining residues as a result of open-burning. The study found that, despite the concerns over the hazards of disposing of such materials in this uncontrolled manner, the actual types, quantities, and concentrations of pollutants reported in this specific research study appear to be relatively small. (Donald A. Oberacker, RREL, FTS 684-7510)

Radon Mitigation Durability Study

The initial results from a durability study of houses in Denver, Colorado, mitigated for radon by sealing suspected entry routes, show failure rates approaching 50% after 18 months or longer. According to researchers, this study indicates sealing that is cheap and done for a "quick fix" doesn't maintain long term integrity. All of the houses in the durability study had levels above 4 pCi/L before sealing and below that level immediately after sealing. At this time, 25% of this batch of 60 houses has radon levels in excess of 10 pCi/L and one has returned to its premitigation level above 50 pCi/L . AEERL plans to continue its research on long-term control strategies including a large national study addressing the durability of radon mitigation systems, which is scheduled to begin later this year. (D. Bruce Harris, AEERL, FTS 629-7807)

Radon Reduction in Newly Constructed Buildings

A single-point active subslab depressurization (ASD) system was installed in a 60,000 square foot hospital building in Johnson City, Tennessee, for radon control. Subslab pressure measurements had previously indicated the system's effectiveness, and the results were recently confirmed with radon measurements. Measurements made when both the ASD (radon control) and air handling systems were turned off indicated that the building had elevated levels of radon, with the highest room measuring above 50 pCi/L. The second set of measurements was made with the ASD system turned off and the air handling system turned on; the highest radon level measured was 16 pCi/L. This indicates that because of the radon source strength (measured to be about 1,800 pCi/L under the slab), continuous operation of the air handling system and exhaust fans did not reduce radon levels below the EPA guideline of 4 pCi/L. The last set of measurements was made with both the ASD and air handling systems operating, and all 20 rooms measured were below 0.5 pCi/L. These findings are significant since the additional cost of installing the ASD system during construction was less than $0.10 per square foot, compared with costs of $0.30 to over $1.00 documented in other new large buildings. Since the data indicate that the same type of ASD system also would be effective in a much larger building, future research will demonstrate this design and others in additional schools and large buildings. The results will be incorporated into an AEERL guidance manual on radon-resistant new school construction. (A.B. Craig, AEERL, FTS 629-2824)

Computer Model for Estimating Exposure to Pollutants

AEERL recently published a computer model for analyzing the effects of indoor pollutant sources on individual exposure. The model, EXPOSURE Version 2, includes the effects of indoor sources, sinks, room-to-room air flow, and air flow between the indoors and outdoors. The effects of individual activity patterns are included in the model and it calculates both instantaneous and cumulative exposure. The model was developed in-house by AEERL engineers and incorporates the results of recent research on indoor sources, indoor sinks, and building dynamics. It replaces a previous model, INDOOR, that was widely used for study of indoor sources in the United States and abroad. Over 300 requests for the model have been received. (Leslie E. Sparks, AEERL, FTS 629-2458)

Bioremediation

Application of Oil-Degrading Bacteria to an Open-Water Spill

The Risk Reduction Engineering Laboratory (RREL) has negotiated a small contract with Southwest Research Institute (SWRI) to develop and test a new delivery system for applying oil-degrading bacteria and nutrients to a spill on open waters. Capsular material will be made from a natural product called sodium alginate. The alginate capsules can be made in any size distribution desired. They can be cross-linked in such a way that the density is slightly less than water but greater than oil. The capsules, made to entrap nutrients inside while oil-degrading bacteria are attached to the outside ring of the capsules, would position between the slick and the underlying water. The nutrients diffuse through the alginate material to the surrounding biomass, which actively degrades the hydrocarbons from the oil slick.

During the next few months, AEERL will conduct a joint research project in which SWRI will manufacture the capsules, while RREL will provide the oil-degrading consortium from Alaska for the encapsulation process. These oil degraders produce copious amounts of biosurfactants, so biodispersion of the oil is a possible added benefit. The treatability experiments should be completed in several months. Another larger contract to fully develop the technology may be negotiated in the future if this project is successful. (Albert D. Venosa, RREL, FTS 684-7668)

Ground-Water Bioremediation Pilot-Scale System

Installation of a ground-water bioremediation pilot-scale system in a chlorinated hydrocarbon plume is planned for early 1992 at a site in St. Joseph, Michigan. The research team consists of members from Robert S. Kerr Environmental Research Laboratory (RSKERL), Stanford University, and Allied Signal Corporation. The system will utilize injection/recirculation of ground water fortified with oxygen, methane, and nutrients to stimulate biodegradation of the contaminants. The width of the plume and severity of trichloroethene, dichloroethenes, and vinyl chloride contamination were determined recently by analyzing water samples collected from variable depth drilling transects. The analytical data obtained will be used to select the location and design of the bioremediation system. (D. Kampbell, RSKERL, FTS 743-2358)

Pollution Prevention

Purge and Recovery/Recycling for Air-Conditioning and Refrigeration Equipment

AEERL will help prepare a technology transfer document with the Office of Air and Radiation to promote the rapid installation of CFC-11 purge and recovery/recycling equipment on refrigeration and air-conditioning equipment in developing countries that are party to the Montreal Protocol and that qualify for financing from the Interim Multilateral Fund. Installation of such equipment can make a significant reduction in the amount of ozone-depleting CFC-11 being emitted to the atmosphere. AEERL will review literature provided by manufacturers of purge and recovery/recycle equipment and will prepare a summary of the equipment design features and performance. The technology transfer document will be used to support a demonstration project in a developing country. Advanced purge equipment and recovery/recycle equipment will be installed on one or more CFC-11 chillers used for air-conditioning of large buildings to minimize CFC-11 emissions. After a satisfactory demonstration, the document will then be distributed to other developing countries to promote rapid installation of similar equipment. (Dale L. Harmon, AEERL, FTS 629-2429)

EPA and Air Force to Conduct Pollution Prevention Projects

An Interagency Agreement between the Air Force and RREL has been approved to conduct joint pollution prevention research projects and to support the Air Force with the demonstration of a number of pollution prevention technologies at the

Tinker Air Force Base in Oklahoma City, Oklahoma. The first project will assess selected overhaul/repair processes to reduce chemical wastes, which are 80% of the Base's waste generation. Major chemical waste sources are electroplating, component cleaning, painting, and vapor degreasing. The output of this first project will be an evaluation of the process and strategy plan to eliminate or reduce multi-media waste generation. The second project will demonstrate and evaluate an advance brush plating implementation for chrome, nickel, cadmium, and silver replacement. This process is intended to replace a tank electroplating process whereby the chemical requirements of 1400 to 1700 gallon tanks will be reduced to 2 gallon tanks that would be replenished as the actual amount of metal plating needed decreases. The annual gallons of chemical needed to provide for plating could be reduced by 50% or more. (James Bridges, RREL, FTS 684-7683)

Waste Minimization in Navy Paint Booth

RREL and the U.S. Navy Norfolk Naval Aviation Depot measured particulate and organic emission rates from a selected paint spray booth to quantify VOC and particulate emissions prior to conversion of the paint booth. These results will be used to assess the impact of converting a water curtain type spray booth typically found in Navy painting facilities to dry filter type operation. If the waste minimization proof of concept tests are successful, a significant source of hazardous waste (i.e., paint sludge, metals, and organic constituents) may be eliminated. Post conversion tests will be run later in 1991 and a report will be generated comparing the results of the pre- and post-conversion test series. (Paul M. Randall, RREL, FTS 684-7673)

SITE Remediation

SITE Demonstration Technologies to be Marketed

A representative from Umweltschutz Nord (UN), a German company, visited the Environmental Research Laboratory (ERL) in Gulf Breeze, Florida, recently to sign agreements to market technologies being tested at the ORD Superfund Innovative Technology Evaluation Demonstration in Pensacola, Florida. The technologies were developed at ERL-Gulf Breeze under a technology transfer agreement with SBP Technologies of Stone Mountain, Georgia. Representatives of Bioremediation Services, Big Sandy, Texas, a UN American subsidiary, and Massey-Burch Investment Group, Nashville, Tennessee (venture capitalists for SBP), were also present to establish formal agreements whereby SBP will market UN bioremediation technologies in the U.S., and UN will market SBP technologies in Germany, and possibly Poland, Austria, Czechoslovakia, France, Italy, and Spain. The SITE Demonstration is being conducted at an abandoned creosote Superfund cleanup site in Pensacola, Florida. (Peter Chapman, ERL-Gulf Breeze, FTS 228-9261)

SITE Demonstration to Use Belgian Soil Washing Technology

Representatives from Dredging International, Belgium, visited ERL-Gulf Breeze recently to complete arrangements to field test their soil washing technology during a SITE Demonstration at an abandoned creosote Superfund site in Pensacola, Florida. The Belgian system will be integrated into a multiphase, mobile pilot-scale facility that can be transported for field remediation experiments. The SITE Demonstration will evaluate physical separation and bioremediation technologies developed at ERL-Gulf Breeze under a technology transfer agreement with SBP Technologies. Field tests began in August 1991 and will continue for approximately three months. (Peter Chapman, ERL-Gulf Breeze, FTS 228-9261)

Treatability Study Confirms Selection of Wetlands Treatment at Superfund Site

RREL conducted treatability tests on leachate from the Buckeye Reclamation Landfill, located in St. Clairsville, Ohio. The leachate has a high mineral acidity and is contaminated with heavy metals. The screening level treatability test showed that constructed wetlands look promising for treating leachate from this site. The laboratory level screening test developed for this effort can be used to evaluate the applicability of constructed wetlands at other sites. (Mark C. Meckes, RREL, FTS 684-7348)

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