INTRODUCTION

FIRST: Our next speaker is Dr. J Louis Kovach, President of NUCON International, Incorporated. Dr. Kovach is a chemical engineer who graduated from the Technical University in Hungary, his native country. This is Lou's seventeenth consecutive Air Cleaning Conference that he has attended. He tells me when he wants to remember how long he's been in the field of air and gas cleaning, he deducts seven from the current Air Cleaning Conference number, and multiplies by two, and that's how he knows how long he's been in the field. Those of you who have attended previous Conferences know that he has made a major contribution to the volumes of the Proceedings and we trust he will continue to do so. He has over a hundred papers in the field up to the present time. Currently he is on the High Level Waste Technical Advisory Panel for the Department of Energy. He is senior technical advisor of the Department of Energy's Hanford privatization initiative. And he is chairman of the Hanford Tank Waste Remediation Environmental Impact Statement preparation panel. He is a consultant for the US Department of Energy, US Environmental Protection Agency, and the US Nuclear Regulatory Commission. It seems like everybody wants a piece of Lou Kovach. We are delighted he is giving us one of the pieces this morning. The title of his paper is, "Challenges to Air and Gas Cleaning Systems".

NEW CHALLENGES TO AIR/GAS CLEANING SYSTEMS

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The construction of new nuclear power reactors in the U.S. has stopped now for over a decade. Thus, the currently generated conventional air cleaning system technical information is generally restricted to evaluation of operational problems with the existing systems. However, extensive nuclear waste management related needs have developed in the U.S. during this same period—mainly at DOE sites. The waste management and site remediation related air and gas cleaning needs are much broader in scope than the control of radioiodine and low concentration aerosols, and the systems in current design or in application also have different processing conditions.

The major difference is that many of the new air and gas cleaning needs are required to treat effluents continuously and under widely different processing conditions than those applied in the past for the nuclear power industry. Even the systems which are postulated for handling gases under potential upset conditions have different design envelopes than the conventional nuclear power plant (NPP) air cleaning or air handling units.

The new, greatly varied processing conditions of waste management activities make it difficult to use the standardized designs developed by ANSI and ASME for the NPPs, and most of the current design specifications and codes are not directly applicable for the new applications. The current conditions in the waste management and remediation activity are similar to the early days of the development of the NPP air cleaning systems in that their designs are highly individual and varied both by the specifiers, the designers and the manufacturers. The result is a greatly varied quality non-standard equipment specification and supply. At the same time, many of the application needs, but not all, are one of a kind systems, making the development and application of standard specifications and codes difficult and uneconomical.

There is a change needed in the design and manufacturing philosophy from the relatively large number of identical purpose units to the highly individualized special purpose design and manufacturing philosophy. For the new needs it is difficult to use the "cookbook" concept of such standards as ANSI/ASME N-509, ASME AG-1 or to follow the test requirements of ANSI/ASME N-510 or the currently developing Section TA of the ASME AG-1 code. This does not mean that the old NPP related standards are useless, but that their usefulness is only partial and inadequate to solve the waste management needs.

Examples of New Waste Management Related Problems

Radon control from uranium wastes

Uranium processing solids containing silos need to be degassed prior to further processing by vitrification or during the initial steps of vitrification. While extensive information was developed for noble gas control (krypton and xenon isotopes) of the BWR off gas system or PWR gaseous radwaste system design and operation, there is very limited data available for the commensurate radon control design and operating conditions. The recent literature and data relating to home radon control or uranium mining purge control has not been extended to satisfy the design and operating requirements of the waste management type radon processing field.

Effluent treatment from thermal processing of various radioactive wastes at greatly varying temperatures and gas compositions

Most waste management related activity is initially from dilute solutions which require concentration as a first step. As an example, evaporator effluents need to be treated under high humidity, corrosive or, in some cases, flammable gas presence conditions. Another process effluent is from drying radioisotope loaded spent liquid phase adsorbents which require both high efficiency solid particulate and vapor phase removal of hazardous constituents from humid and potentially corrosive streams.

Off gas treatment for vitrification facilities which need product recycle, and in some cases, product recovery at very high concentration of volatiles and semivolatiles and particulates

The radioactive waste vitrification technology always includes the capture and treatment of volatile and semivolatile radioactive and other hazardous constituents. In some cases, the operating temperatures are high enough to vaporize large amounts of alkali metals and other waste constituents which need to be quenched, converted to filterable components and result in an off gas stream which can be above the lower flammability limits without additional dilution. There are special selective constituent removal needs for elements such as mercury, selenium, cadmium, ruthenium, etc.

Filtration from potentially flammable gas streams

In several waste storage complexes, the original complexant organic material used to separate specific isotopes in the past is thermoradiolytically decomposing with a commensurate generation of hydrogen. This thermoradiolysis of organic compounds in the stored waste creates concerns of flammable or explosive environment generation even under normal storage temperature conditions. The various wastes have different gas retention capability and intrusive activity or transfer of the waste can release sufficient volumes of flammable gas mixtures which can result in structural damage in waste storage tanks if ignited.

Filtration from highly corrosive gases

The waste processing technology generally includes dissolution steps involving concentrated acids or alkalis. The currently used glass fiber based filtration elements do not have sufficient corrosion resistance and the typical adsorbents used (e.g. carbon based) are unsafe in highly oxidizing environments. At the present time there is inadequate corrosion resistant filter or adsorbent material development and application data available to select material of construction or estimate filter/adsorbent life and performance information.

Filtration from gas streams which may have significant pressure challenges

As an example, at the Hanford site of the U.S. DOE, many of the potential consequences of off design conditions can result in unacceptable radioactivity release estimates, if the sudden pressure rise causes failure of the conventional HEPA filters. Currently, a large percentage of the "unsafe" conditions could be eliminated from the safety analysis if the pressure resistance of the HEPA filters can be increased to prevent pressure spike related failure. There is also inadequate information available on the aging of conventional HEPA filter components, particularly under high humidity conditions, for which deterioration is not measurable by conventional in-place aerosol testing.

Back washable filter elements

The continuous processing of high particulate load streams does not permit the use of high efficiency filters which cannot be "regenerated" in place. The life of a conventional HEPA filter under many of the operating conditions is too short to permit economical and waste minimization satisfying requirements. While there is some development of metal filter media, currently there is very limited information on the efficiency, life, regenerability etc., of these media and often fibrous metal and sintered metal filters are considered as equals in performance.

Continuously operating demister elements

While in the NPP application area, demisters only have a very limited expected operating life. In the continuous waste processing applications there is a requirement for droplet elimination as a continuous unit operation. Even in the NPP field, one of the least understood components is the "moisture eliminator" element. However, for waste processing application, the mist elimination component design and continuous operating technical data is not available.

Adsorptive removal of varied constituents from air and gas streams

In the NPP applications, only radioiodine and noble gases are considered for gaseous phase treatment. The waste management area is much broader, and specific adsorbents need to be developed, optimized and applied for other elements or compounds under more adverse environmental conditions than that of the NPP field. Examples are mercury, ruthenium, iodine-129, etc.

In-place testing highly contaminated systems

One of the major shortcomings of even the NPP related air and gas cleaning activity is the proof testing of highly contaminated components or systems. (It is generally assumed that the event for the amelioration of which the "safety" train is installed will never occur, thus testing under those conditions would not be needed. This misconception, as an example, created some interesting problems even after the TMI accident when highly contaminated air cleaning systems needed to be tested or serviced.) However, in waste processing gaseous or particulate treatment systems, the air and gas cleaning components can be highly contaminated by either alpha, beta or gamma radiating components. Many of these systems do not permit man entry into the air/gas treatment units on the contaminated side and, at times, not even on the "clean" side due to the radiation fields or other hazards present. Most of the current in-place testing steps as described in the existing test procedures cannot be performed on highly contaminated or, as an example, flammable gas containing systems.

Maintainability under contaminated conditions

This is another area where even the NPP related currently available standards and codes fail to adequately address the design requirements. The consideration of replacement of most components of a contaminated air cleaning system are not included in the existing codes and standards. In the waste management field, the contamination of most air and gas processing systems, other than possibly the final building filtration units, is a forgone conclusion.

Waste minimization challenges for consumable components

In most cases, the disposal cost of contaminated air and gas cleaning components is higher than their initial new cost. At the same time, the least specified (if at all) of the properties of the filters or adsorbents used is their operating life or disposal cost. This is also true in the NPP field, where, as an example, radioiodine adsorbent is purchased solely on initial efficiency cost without any regard for adsorbent life.

It is intended that by describing examples of these new challenges that the standard preparers, designers and manufacturers will be better informed of the special needs of these new air cleaning/gas processing applications.

The major challenge is that all parties involved in the specification, design and operation of these systems will have to be better trained in the broader filtration, and other contaminant removal basic principles and less dependent on the set design and operation practice of the NPP related applications. There will be no time available to develop detailed consensus specifications or codes for components and systems for the waste management field, but there is time to assure that all those involved with the program have available additional training opportunities to satisfy the qualification needs, i.e. the chemical, physical and engineering principles required to comprehend the air and gas purification specification, design, construction and operation expertise.

Regulatory Concerns

The NPP related activity in the U.S. is regulated by the NRC, while the U.S. DOE sites are "self-regulated" with some oversight provided by the Defense Nuclear Facilities Safety Board (DNFSB). However, the impending privatization of some of the U.S. DOE activities postulates the integration of the NRC into the regulation of the waste management operations. The post-TMI new source term development in the U.S. has resulted in a lowered technical concern of air and gas cleaning activity by the NRC, while the administrative legalistic enforcement of Technical Specification or FSAR cited standards and codes has increased. Some of the "enforce the words," even if they are technically undefensible, has converted the regulation of the design, performance and testing of the NPP air cleaning systems into a "cargo cult" basis. This type of regulation will not suffice for the existing or the upcoming waste management area. There will be limited directly applicable standards and codes for the upcoming applications of air and gas cleaning systems and blind citing of standards and codes originally developed for other applications or of those which are outdated and, in many cases, withdrawn, that will not create a better or safer environment for the workers or the public. Both the DOE and the NRC has to establish a pool of competent technical personnel who clearly understand the technical basis for the specification, design control and operation of the existing, or to be developed, components and systems which are needed for the safe operation of waste management facilities.

The technical qualifications and the basic engineering expertise of all personnel involved in air and gas processing research, specification preparation, design, construction, operation and regulation for the waste management field needs to be far better than that which existed for the relatively narrow NPP type applications, which itself lately suffered from inadequate technical expertise. As John W. Crawford, one of the DNFSB members, explicitly pointed out in one of his recent reports "An Assessment Concerning Safety at Defense Nuclear Facilities, The DOE Technical Personnel Problem,"[1] the root cause of all currently identified safety and operational problems is lack of adequate technical expertise of design, operation and regulatory personnel. While the Crawford report concerned itself mainly with the DOE, its conclusions are valid for the entire U.S. nuclear industry whether public or private.

Conclusions

The great variety of type and purpose of air and gas cleaning needs for radioactive waste management industry will require individual, special designs rather than many identical air/gas treatment systems. It would be very difficult to apply the existing codes and standards developed for the nuclear power plant environmental protection, as they exist, for this new application. The design, construction and safe operation of the new systems will be strongly dependent on the good understanding of the commensurate filtration, adsorption and absorption science and the special needs of engineering knowhow relating to both the nuclear and the chemical processes involved. The very large and expensive, but mostly one or two of a kind systems, are not amenable to long duration consensus standardization. The challenge of still meeting the required protection factors or separation efficiencies of the air and gas cleaning systems, often with greatly different components than the conventional systems, will be dependent on the technical understanding of all of the relevant criteria by a limited pool of personnel involved from the design of the process to the regulation of the quality and performance of these systems.

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[1]Crawford, Jr., J.W., "An assessment concerning safety at defense nuclear facilities, the DOE technical personnel problem," DNFSB/TECH-X, Vol. iii, March 1996.

DISCUSSION

FIRST: I appreciate your comments, warnings, and peering into the crystal ball. As you were talking about many of the technologies that you say we need, I was reminded of the fact that back in the 1950's and some part of the 60's, we were very much involved with the kinds of equipment that you cited. The particular application at that time was incineration. All of the problems that you enumerated, corrosion, heavy dust loadings, and so on, were all encountered in these situations. And you know we never solved the problems in 1960, therefore, we still have them with us today.

BERGMAN: A lot of comments you made ring true to many of the technical people who are familiar with the problems. For example, for the last three years, maybe even five, I have been going up and down the halls of the bureaucrats in the Department of Energy with a shopping list at least as long as yours with issues and problems, some of which are very severe. Almost invariably the response is, "we have not had a major accident". By an accident, they mean an entire city having to be evacuated, things of that nature. The philosophy is that if you don't have a major accident, you don't have to put money in. And it is a local issue. For example, it is like a stop sign, usually local communities do not install a stop sign or a street light until somebody is killed. After someone is killed they start to think, "we'd better do something about it". For example, in the HEPA filter area after the '69 Rocky Flats fire, there was a lot of money. The attitude right now from all of the bureaucrats I've encountered is that we are not going to spend any money on HEPA filters. In fact we're going to downsize. ES&H activities are slated for at least a thirty percent decrease. So, not only are we not keeping up, DOE in particular is going dramatically down. If there is no money, there are no opportunities to do any of the activities you suggest. I would appreciate your comments.

KOVACH: In some of these areas we are not doing anything either. So it is no wonder we do not have accidents. As long as we are only studying the problems rather than processing the wastes we are reasonably safe. Once we start waste processing, I am not sure we can do it without accidents.

WEBER: Dr. Bergman's comment and your response remind me of these issues every time I step on an airplane. I mean, the airplane hasn't fallen down, so why should we spend money maintaining it? That is a comment, not a question. As a comment, you mentioned a problem which was encountered with backwashing a metallic filter. I am totally unfamiliar with that particular installation. Over my involvement with backwash filters I've learned that for all manner of industries, including electric power generation, chemicals, liquids, gases, there are many, many parameters to bear in mind when installing a backwash-cleanable filter, including, but not limited to, the backwash-technique. This is because there are a myriad of backwash techniques. They include the cleaning fluid itself as you pointed out. There may be chemical interactions with the contaminant, and there are important waste disposal issues, i.e. you don't want to create more backwash waste than you started out with. I recommend that when someone is thinking of procuring such a system, that they make the vendor responsible to educate them and in those areas where they do not feel knowledgeable, that they seek out vendors who have the expertise to work with them to solve all the problems. Education can be acquired that way. So, seek out a vendor who is qualified, because if the vendor doesn't know the answer, you must question whether their system will work.

KOVACH: I agree that we all have the duty, not only the vendors, to learn at each step about the entire life cycle of the components that we are designing. When we deal with a back-washable filter, it is not enough just to say, "okay", we will just put water on it or spray a solution on it and it will be back-washed. Instead, we have to understand clearly the consequences of operating such a system.