ANSI/N45-8 NUCLEAR GAS SYSTEMS TREATMENT STANDARDS

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Abstract

An ANSI ad-hoc subcommittee has been formed to develop standards which users, suppliers, and AEC can utilize to assure the maintaining of high efficiency nuclear gas treatment systems. This in turn should expedite the plant licensing. The scope of the subcommittee is:

> To develop standards, standard specifications, and method-of-test standards for the design, fabrication, installation, testing, and maintenance of very high efficiency gas treatment systems for the prevention of airborne release of radioactivity from nuclear power plants. The standards will cover the testability, maintainability, and leak and structural integrity of components and assemblies necessary to ensure performance and reliability, in addition to test methods, acceptance criteria, and quality assurance provisions needed to prove that these objectives have been met.

I. Introduction

On February 18, 1971 the AEC-DRL staff met with several suppliers and architect engineers to review the factors which affect the design of BWR standby gas treatment systems. The purpose of this meeting was to determine AEC's concern in order to develop a course of action to increase the filter efficiency to greater values than the 90% now endorsed by the AEC. As a result of this meeting came the recommendation to prepare an industry standard including scope of design, installation, maintenance and testing which enhances the reliability of the standby gas treatment system, including its performance at high efficiency. Such standards would facilitate the licensing of these systems.

The American National Standard Institute (ANSI) authorized the ANSI/N45 committee to develop standards for standby gas treatment systems. On July 20 and 21, 1971, at the ASME headquarters in New York, ANSI/N45 called a meeting to set up subcommittee ANSI/N45-8 to prepare such standards.

Although the initial purpose of the committee was directed to standby gas treatment systems for BWR's the results of the initial meeting in New York resulted in the scope of the subcommittee being expanded to cover Nuclear Power Plant Gas Treatment Systems of all types.

II. Organization

The subcommittee has been organized into four working groups to prepare the following standards:

N45-8.1 Requirements for Purge and Post Accident Gas Treatment Systems External to Primary Containments

N45-8.2 Requirements for Recirculating Purge and Post Accident Gas Treatment Systems (Inside Containment)
N45-8.3 Testing Programs for Nuclear Gas Treatment Systems
N45-8.4 Requirements for Condenser Off Gas Treatment Systems

The initial efforts of the subcommittee are to develop the N45-8.1 and N45-8.3 standards. Each of these working groups has had several meetings for purposes of preparing and reviewing drafts of these standards. The drafts of each of these standards are to be reviewed by the full N45-8 subcommittee with subsequent issue for trial use and comment. Preparation of drafts for the N45-8.2 and N45-8.4 standards will be inititated during or following the full subcommittee review period for the N45-8.1 and N45-8.3 standards.

A summary of all committee titles and the organization chart of the N45-8 subcommittee follow:

COMMITTEE TITLES

ANSI N45 Reactor Plants and Their Maintenance

ANSI N45-8 Nuclear Gas Treatment Systems

ANSI N45-8.1 Requirements for Purge and Post-Accident Gas Treatment Systems External to Primary Containments

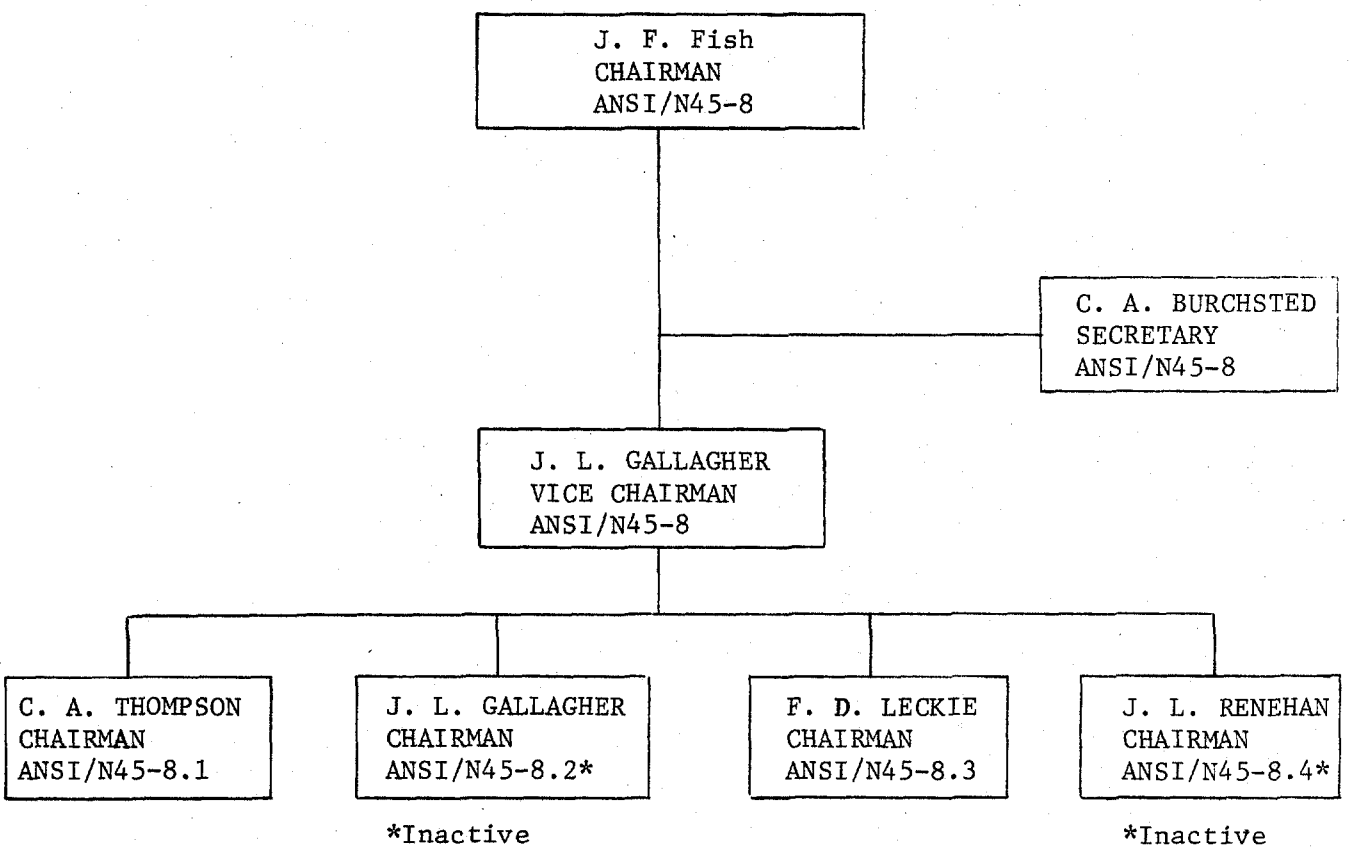
- N45-8.1.1 System Components Task Group
- N45-8.1.2 Design Requirements for Testability and Maintainability Task Group
- N45-8.1.3 Shipping, Storage and Installation Task Group
- N45-8.1.4 Requirements for Acceptance and Periodic Testing Task Group

ANSI N45-8.2 Requirements for Recirculating Purge and Post-Accident Gas Treatment System (Inside Containment)

ANSI N45-8.3 Testing Programs for Gas Treatment Systems For Nuclear Power Plants

ANSI N45-8.4 Requirements for Condenser Off Gas Treatment Systems

ANSI/N45-8 ORGANIZATION CHART



III. Progress to Date

The progress to date is indicated by the following summary of subcommittee meetings held.

INITIAL MEETING, JULY 20 - 21, 1971
ASME HEADQUARTERS, NEW YORK, NEW YORK

The organization of the N45-8 was achieved. Subcommittees were formed and scope of standard defined.

N45-8.1 COMMITTEE MEETING SEPTEMBER 8-9, 1971
COLUMBUS, OHIO

The purpose was to establish outline of N45-8.1 standard and make assignments to committee members.

N45-8.1 COMMITTEE MEETING FEBRUARY 8-9, 1972
PITTSBURGH, PA.

The purpose was to review first drafts of standard. It was concluded that a second draft will be required and it was scheduled for completion late March 1972.

N45-8.3 COMMITTEE MEETING OCTOBER 13-14, 1971
ORNL, OAK RIDGE, TENNESSEE

ANSI Subcommittee N45-8.3 met to organize the committee. It was then determined that the initial effort would be to develop a scope and outline of the test programs assignments and time schedule for standards.

ANSI N45-8.3 SUBCOMMITTEE MEETING MARCH 22-23, 1972
SAN FRANCISCO, CALIFORNIA

The purpose was to review first drafts and to assess the progress of the subject committee work to date.

The title of N45-8.3 standard was revised to "Testing Programs for Gas-Treatment Systems for Nuclear Power Stations."

ANSI N45-8.1 SUBCOMMITTEE MEETING APRIL 4-6, 1972
LOS ANGELES, CALIFORNIA

The meeting objective was for each of the four task groups plus the Fire Protection and Temperature Control Group to prepare revised drafts of their respective sections. The completed drafts would then be ready to be sent to all N45-8.1 members for comment.

ANSI N45-8 EXECUTIVE COMMITTEE MEETING JUNE 20, 1972
PITTSBURGH, PENNSYLVANIA

Activities of the 8.1 subcommittee (one-through purge and post-accident clean-up system) were reviewed. Monthly meetings of the 8.1 steering committee were planned so that drafts might be prepared for review by the full N45-8 committee.

Activities of the 8.3 (testing) subcommittee were reviewed and a meeting of 8.3 steering committee was planned for August to discuss drafts and prepare final drafts for full N45-8 review.

It was decided that 8.2 (recirculating post-accident systems) and 8.4 (off-gas systems) subcommittees should not start work until the 8.1 standard is reported out of the 8.1 sub committee. It has not been decided definitely that there will be four distinct standards, but the committee feels that the nature of 8.1, 8.3 and 8.4 are sufficiently distinct as to require separate standards. The N45-8 executive committee will tentatively meet in mid January, at which time final decision on 8.2 and 8.4 will be made. Meantime, the scope and outline of 8.4 will be started to present for discussion at the mid January meeting.

ANSI N45-8.1 STEERING COMMITTEE JULY 6, 1972
GAITHERSBURG, MARYLAND

The purpose of this meeting was to review and implement the actions taken at the ANSI N45-8 meeting held June 20, 1972 in Pittsburgh.

IV. N45-8.1 Standard

The purpose of the N45-8.1 standard is to specify requirements for component and system design, fabrication, shipping, storage, installation, acceptance tests, retests, maintainability provisions and special criteria. Applications to be covered by this standard include standby gas treatment, annulus or enclosure ventilation, penetration room filtration, post-accident purge and control room ventilation. Related applications include normal containment purge, auxiliary and radwaste buildings ventilation.

The N45-8.1 standard is part of a family of related standards included in N45-8.3 and other applicable industrial standards. Nonmandatory recommended practices will be provided for designing and evaluating gas treatment systems, but no standard systems will be specified.

The outline of the ANSI/N45-8.1 Standard follows:

ANSI/N45-8.1 STANDARD OUTLINE

REQUIREMENTS FOR PURGE AND POST ACCIDENT
GAS-TREATMENT SYSTEMS EXTERNAL TO PRIMARY CONTAINMENT

8.1.1. Scope

- 1.1 Purpose of the Standard
- 1.2 Application and Limitations of the Standard
- 1.3 Use of the Standard

8.1.2. Classification of Gas-Treatment Systems

8.1.3. Applicable Documents

8.1.4. Terms and Definitions

8.1.5. System Performance Criteria

- 5.1 Performance
- 5.2 Standard Applicability
- 5.3 Airflow Requirements
- 5.4 Pressure Requirements
- 5.5 Gas Stream Composition
- 5.6 System Efficiency Criteria
- 5.7 Performance Monitoring
- 5.8 Fission Product Decay Heat Cooling for Charcoal

8.1.6. System Mechanical Design Requirements

- 6.1 System Design Parameters
- 6.2 Seismic Requirements
- 6.3 Missile Protection
- 6.4 Housing Pressure Test
- 6.5 Air Distribution
- 6.6 Testability Criteria
- 6.7 Maintainability Criteria
- 6.8 Materials of Construction Criteria
- 6.9 Sound
- 6.10 Design Practices

8.1.7. Components

- 7.1 Dampers and Isolation Valves
- 7.2 Moisture Separators
- 7.3 Heaters and Coolers
- 7.4 Prefilters
- 7.5 HEPA Filters
- 7.6 Adsorber Filters
- 7.7 Fans, Motors and Drives
- 7.8 Housings and Ducts
- 7.9 Fire Protection Facilities
- 7.10 Controls and Instrumentation

8.1.8. Shipping, Storage & Installation

- 8.1 Shipping Schedule and Sequence
- 8.2 Preparation for Shipping
- 8.3 Inspection
- 8.4 Storage
- 8.5 Installation
- 8.6 Access and Chemical Control

8.1.9. Quality Assurance

- 9.1 QA Program
- 9.2 Qualification of Personnel
- 9.3 Documentation

8.1.10 Inspection and Tests

8.1.11 Maintenance and Operation

- 11.1 Surveillance of system
- 11.2 Radiation surveys - monitoring
- 11.3 Frequency of inspection and test
- 11.4 Integration of maintenance, inspection, and test with plant operations
- 11.5 Preparation for maintenance, inspection, and test
- 11.6 Criteria for maintainability - access, spatial layout, lighting
- 11.7 Maintenance procedures, methods, techniques, and component life

Appendicies

A.1. Non-Mandatory Criteria

A.2. Structural and Leak Tests

- 2.1 Filter Housing
- 2.2 Mounting Frame

A.3. Seismic Considerations

V. N45-8.3 Standard

The N45-8.3 standard covers acceptance and surveillance testing of very high efficiency air and gas treatment systems used for decontamination in nuclear power plants. The standard will describe test procedures, provide a standard format for reporting test results, and give requirements for a testing program and qualification of test personnel.

The N45-8.3 standard will require the owner to specify which tests are to be included in his Acceptance Testing Program and in his Surveillance Testing Program. Where acceptance criteria are not specified in the individual test procedure, the owner shall specify the required acceptance criteria in his Test Program. Tests required for a particular Test Program will vary with the type of system and its operating requirements. The non-mandatory appendices of this standard give recommendations for designing a test program for a specific application; discuss the significance and application of the various tests covered in the mandatory sections of the standard; and suggest minimum acceptance criteria.

The N45-8.3 standard will cover post delivery testing only. Predelivery qualification and acceptance testing of components will be covered in ANSI Standard N45-8.1.3.2 and are not repeated here.

The outline of the ANSI N45-8.3 standard follows.

ANSI N45-8.3 STANDARD OUTLINE

TESTING PROGRAMS FOR GAS-TREATMENT SYSTEMS FOR NUCLEAR POWER PLANTS

8.3.1 Scope

- 1.1 Purpose
- 1.2 Application and Applicability
- 1.3 Use of Standard
- 1.4 Types and Classification of Systems

8.3.2 Reference Documents

8.3.3 Terms and Definitions

8.3.4 Acceptance Test Program Requirements

- 4.1 Visual Requirements
- 4.2 Housing Field Weld Leak Tests
- 4.3 Damper Tests
- 4.4 Air Flow Tests and Residence Time Determination
- 4.5 In Place Leak Test - HEPA Filters
- 4.6 In Place Leak Test - Iodine Adsorbers
- 4.7 Carbon Tests
  - a. Laboratory Tests
  - b. Samplers

4.8 Noise Level
4.9 Duct Heating

8.3.5 Quality Assurance

5.1 Test for Equipment Calibration
5.2 Test Personnel Qualifications

Appendices - Non-Mandatory

A. Recommend Testing Program
B. Significance of In Place Tests
C. Acceptance Criteria
D. Visual Inspection, Table 2

RELATIONSHIPS BETWEEN ANSI N45-8, AACC, AND ASTM STANDARDS

ANSI/N45-8.3 is one of several standards dealing with various aspects of air and gas treatment systems for nuclear applications which are presently in progress. ANSI/N45-8.1, -2, and -4 deal with requirements for air and gas treatment systems for nuclear power stations. N45-8.3 provides the tests and procedures which will be used to evaluate those systems and will include in-place testing of HEPA filter systems, in-place testing of activated-carbon adsorber systems, leak tests of filter housings, filter mounting frames, and ducts, tests of dampers and heating and cooling facilities, visual inspection of installed components and accessories, and similar tests of interest to the responsible operator of a nuclear air or gas cleaning system.

In addition to these, the ASTM (American Society for Testing and Materials) is working on characterization tests and radioiodine-performance tests for activated carbon which will supplement the in-place adsorber-system leak-tests of N45-8.3. It must be recognized that in-place tests, whether of HEPA filter banks or adsorber banks, are only leak tests, and do not actually provide a measure of air-clean-up efficiency. On the other hand, if the condition of the media contained in the filters or adsorbers is known and it is within tolerance, and there are no leaks in the system, it can be inferred that the system efficiency is equivalent to the known efficiency of the media. The ASTM tests will establish the efficiency of the activated carbon media used in the adsorber system.

Two other standards of interest are being issued by the American Association for Contamination Control. The first of these, which is already out, is AACC CS-1, STANDARD FOR HEPA FILTERS, which establishes minimal requirements for the high efficiency particulate filters used in nuclear air and gas cleaning systems, including the minimum efficiency of the media and the completed filter cell. AACC CS-8, which is just coming out at this time, establishes minimal requirements for the adsorber cells in which the activated carbon characterized by the ASTM standards is packed.

Basically, then, ANSI N45-8.3 establishes the procedures which will verify that a system designed and built in accordance with ANSI N45-8.1 or 8.2 has, in fact, been properly designed and built, and that the components furnished in accordance with the AACC and ASTM standards, as installed, meet the requirements of an effective system.

DISCUSSION

FIRST: This very brief review of a most important program, establishment of nuclear standards, is undoubtedly deserving of much more time than we have devoted to it. I hope the next air cleaning conference will reserve a large block of time for this particular purpose.

BURCHSTED: To you in industry, we ask that you make comments and get them in to us as soon as possible and to "throw stones" where you have to. Second, remember that this is a standard; not a specification. And finally, we need this input as a continuing activity. I think that we can, after some refinement, make a very useful set of documents for the guidance of your future work.

FIRST: The paper on your program entitled, "Development of Spiral Crease HEPA Filters and their Application in Radioactive Air Cleaning Systems," will not be presented as Mr. E. Radu, Institute of Atomic Energy, Romania, has been unable to attend. Mr. W. H. Ray, Fuels Licensing, USAEC, wishes to speak about "Krypton-85 Hazards in Perspective".

RAY: Perhaps I should change the title to "Krypton-85 Control in Perspective," since I want to avoid the psychological implication of the term "hazards". I might at the outset also indicate that my remarks at this time are my own, and do not necessarily represent the Commission's stand, which is under evolution at the present time.

At the Conference at Oak Ridge in 1963, I was impelled to venture some remarks about the magnitude of noble gas curies that would be discharged to the atmosphere from nuclear fuel reprocessing operations, in contrast to the iodine and reactor accident dispersal matters that were getting primary attention at that Air Cleaning Conference. Since that time, considerable effort has been directed toward developing methods of removing noble gases from vent systems and at this meeting we not only heard about holdup of noble gases from routine reactor effluents for the decay of short-lived radionuclides, but about effots being made to extract 10-year krypton-85 from fuel reprocessing off-gases for long-term retention.

During the intervening years, I've had occasion to evaluate the impact of releasing krypton-85 from irradiated nuclear fuel reprocessing plants and to observe that the resulting exposures to the public will be insignificant radiologically. Indeed, it appears that except for injection into suitable deep-wells, the safest management of krypton-85 is prompt dispersal in the atmosphere. The small fraction of krypton-85 disintegrations that yield a quantum of gamma radiation results in a dose of only 0.7 mr for full submersion exposure of 1 curie-second per cubic meter. So, the genetic impact on the world population from full dispersal of krypton-85 generated

concomitantly by fission power reactors in the next half-century will be imperceptible.

Individual exposures in the vicinity of krypton-85 release chimneys will be above the world average, of course. But with meterological conditions that commonly prevail, a 100-meter chimney will permit fuel reprocessing rates of 30 or maybe 50 tons of uranium per day at a site under the present limits which we expect will be in effect for some time.

A temporary holdup system to retain krypton-85 during poor dispersion regimes and to meter releases under favorable conditions could be utilized to exploit favorable meterological conditions. Long-term storage methods of assured safety have yet to be developed for krypton-85. Balancing the radiological costs of alternatives, it is likely that human exposures during krypton-85 separation, packaging, and storage operations will exceed those to the non-occupationally exposed population in the immediate vicinity of a reprocessing plant as a result of prompt release of the same quantity of krypton-85 during fuel reprocessing.

In addition, the threat of an accidental release of bulk-stored krypton-85 can be obviated by controlled dispersal as krypton-85 is released from fuel in process. It is my professional opinion that a rational case can be made that quantitative release to the atmosphere under control conditions will result in the minimum practicable exposure to mankind from krypton-85.

FIRST: The next speaker is Dr. Leonard Jonas from Edgewood Arsenal who will talk on the topic of "Gas Adsorption Kinetics."

JONAS: I'd like to talk to you about some recent work of mine on gas adsorption kinetics. This research work was part of my doctoral thesis and has already been published in the Journal of Catalysis in March of this year. The study represents a method of gas adsorption evaluation different from the dynamic adsorption coefficient approach that has been mentioned in the early part of this Air Cleaning Conference.

The basic derivation is from a continuity equation of mass balance where the input to the adsorbent is equal to that adsorbed plus the output. From this continuity equation, one derives four simultaneous differential equations which represent everything that's happening in the fluid flow and adsorption processes in the carbon. After about 41 steps, one ends up with this relationship:

$$t_b(\text{min}) = \frac{W_e}{C_o Q} \left[W - \frac{\rho_B Q}{k_v} \ln\left(\frac{C_o}{C_x}\right) \right] \qquad (1)$$

which is valid for the range $0 \leq C_x/C_o \leq 0.04$.

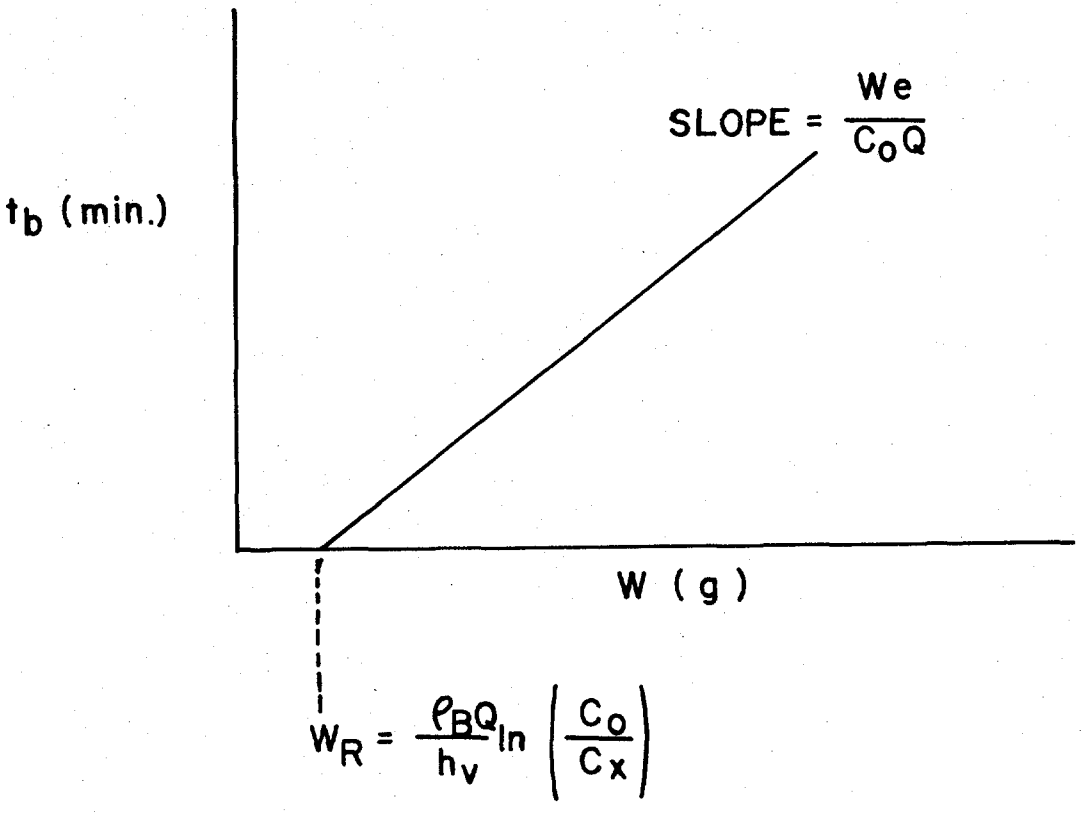
This equation indicates that the breakthrough time, t_b, in minutes for a particular exit concentration, C_x, is equal to the kinetic saturation capacity of the carbon, W_e, ^{x}(grams of gas picked up per gram of carbon) divided by the product of the inlet concentration and the volumetric flow rate, all multiplied by the expression in the large bracket. W, is the total weight in grams of the carbon and, $\frac{\rho_B Q}{k_v} \ln (\frac{C_o}{C_x})$, is equivalent to what we call the critical weight of the bed. The constant, k_v, is a pseudo first-order rate constant for the adsorption process. This equation has been found valid for a range of exit concentrations from 0 to 4%. In practice, one selects carbon weights and volumetric flow rate and plots breakthrough time in minutes against various carbon weights. This gives a straight line which intersects the abscissa of the weight axis as shown in Figure 1. The point at which, t_b, the breakthrough time is 0, i.e., the point at which the straight line crosses the abscissa, is considered the critical weight of the bed. From the slope of this line one can calculate, W_e, which is the kinetic saturation capacity of the carbon. This line is a specific line for a particular flow rate. Other flow rates give different lines which deviate from this one in both slope and intercept. The kinetic adsorption capacity which I have designated, W_e, (grams of vapor picked up per gram of carbon) is equal to 95 to 98% of the equilibrium value for a well-packed bed. The equilibrium value is obtained from the isotherm at the same relative pressure. The kinetic adsorption capacity is a measure of the internal pore area of the carbon due to the activation process.

The adsorption rate constant, k_v, which showed up as part of the X axis intercept is a pseudo first-order constant with respect to the decrease in gas molecules. It is also a measure of the velocity of the adsorption and the strength of the adsorptive force fields. The basic concept of the adsorption rate constant being a pseudo first-order rate constant was derived based upon the Langmuir model of adsorption which states that a reaction occurs between a gas molecule and a vacant active site to form an occupied active site, and the rate at which this occurs, k_v, is the rate of adsorption.

On the other hand, there is a force which tends to desorb the gas from the bed, k_d; the rate of desorption. One can calculate the equilibrium constant for this reaction by equating it to the adsorption constant divided by the desorption constant.

Equation (1) is in terms of weight of a bed. By a very simple arithmetic manipulation, this equation can be expressed in terms of bed depth, λ, instead of weight. In this case the coefficient which multiplies the bracket changes slightly, and so does the coefficient of the log term

$$t_b = \frac{W_e \rho_B}{C_o V_L} \left[\lambda - \frac{V_L}{k_v} \ln (\frac{C_o}{C_x}) \right] \qquad (2)$$



KIN. ADS. CAP. We (g/g)

1. EQUAL TO ≈ 0.95 - 0.98 EQUIL. VALUE FROM ISOTHERM AT SAME RELATIVE PRESSURE.
2. MEASURE OF THE INTERNAL PORE AREA DUE TO ACTIVATION.

FIGURE 1.

One can also relate Equation (1) to residence time of the gas in the carbon bed. This is the residence time due to flow, not a residence time due to flow plus retention of the gas in the bed.

$$t_b = \frac{W_e \rho_B}{C_o} \left[\tau - \frac{1}{k_v} \ln \left(\frac{C_o}{C_x}\right)\right] \qquad (3)$$

In this form, it may be seen that bed life, or breakthrough time, is equal to the capacity times the apparent density, divided by the inlet concentration, multiplied by the expression in the bracket. The mean residence time is now, τ. It represents $\frac{1}{k_v}$ times the natural log of the concentration reduction ratio and can be considered a critical residence time. Thus, in order to get a finite protective or adsorptive time, one must have a carbon bed which in weight exceeds the critical weight, or, in thickness, exceeds the critical thickness, or, in residence time, exceeds the critical residence time of gas in the bed.

This kinetic method of gas adsorption analysis permits separation of the capacity term and the rate parameter of the dynamic adsorption process.

Advantages of this method are: (1) it is rigorously derived from a continuity equation, (2) it is consistent with the concept of kinetic order of gas adsorption, and (3) since it separates the capacity and the rate terms, its form permits the application of recent techniques of predicting gas adsorption by carbons of untested gases.

Work that has appeared in the Russian literature of late has indicated that the capacity of carbons can be calculated. In the form of the equation that I have shown, I have been able to apply Dubinin's method of calculating the capacity of carbons against gases and have been able to confirm the calculations experimentally. The calculations are based upon an old theory that Dubinin up-dated, i.e., the Polanyi theory of the adsorption potential of an activated carbon for gases.

List of Symbols

t_b = breakthrough time (min.) when exit stream concentration C_x occurs

C_o = inlet concentration of gas (g/cm^3)

C_x = exit concentration of gas (g/cm^3)

W_e = kinetic adsorptive capacity of carbon (g/g carbon)

W = weight of carbon (g)

W_c = critical weight of carbon (g)

ρ_B = apparent density of packed carbon bed (g/cm^3)

Q = volume flow rate of gas-air mixture (cm^3/min)

k_v = pseudo first-order adsorption rate constant

λ = bed depth of carbon (cm)

τ = residence time of gas flow through carbon bed (min)

V_L = superficial linear velocity of gas-air flow (cm/min)

FIRST: The next speaker is Jack Murrow, Bechtel Corp., whose subject is "Informational and Educational Requirements for Satisfactory Application of Air Cleaning System Components."

MURROW: This is a plea for help. It has two parts; 1) more information and 2) more education.

Perhaps some of you remember two years ago, at the Eleventh AEC Air Cleaning Conference, I reported on the difficulty of extinguishing a fire in a charcoal bed, called the Savannah River type, as long as the air was flowing. Since then, as some of you know, I have moved from the cloistered confines of a research organization to the real life of a large design and construction organization, Bechtel Corporation. I have become aware of the fact that civilian nuclear reactors use carbon adsorption beds that are not of the same configuration as the units I tested. Present designs include water sprays and heat sensors in or on the carbon adsorbers. I am certain that no one has ever tried these systems either in place or in a mock-up to determine if they would do the job they were designed for if exposed to a maximum credible accident.

The first part of my plea, then, is for government and industry to try systems before they are installed and forgotten. This research or experimentation must continue.

Part two of my plea is the result of my membership on a subcommittee of ANSI N-45, writing Standards and Procedures for testing high efficiency air cleaning systems. On the last afternoon of a recent working session, Farr Co. invited us to a demonstration in their display room. I was shocked and dismayed when 15 of the 18 people present gathered around a HEPA filter; they had never seen one. Now remember, these were the people writing standards for the nuclear industry. I make a plea to the manufacturers and anyone else to remedy this situation. I believe the industry would be benefitted if the people who design air cleaning systems at least knew what they look like; if not how they perform.

BARNEBEY: Your point is extremely well taken. All one has to do is to read some of the specifications for equipment to be sure that the fellow who wrote them just hasn't "been there" and doesn't have the necessary experience. Many of the specifications are just copied from others and nobody remembers where they came from.

EDWARDS: Anytime a person is writing specifications and needs to get some first-hand information on HEPA filters, he can contact the Flanders plant or any other manufacturer of HEPA filters and get an invitation to visit the facility. Seeing a filter being made and tested would be a valuable experience to anyone who writes filter specifications. I extend an invitation to you, or anyone else present, to give me a ring and I will arrange for you to visit us.

MURROW: I think this invitation is a real fine thing. I hope that anybody who has anything to do with high efficiency air cleaning will take advantage of this invitation. They will give you all the help you want. It's there for the asking, please take advantage of it. Over the years I believe I have visited all of the manufacturers, and have found it most interesting and helpful. I know all the manufacturers will welcome you.

PHILLIPS: We're installing quite a number of these charcoal filters in our plants. Based on what you are saying, will the spray of water that's put on charcoal put the fire out? What is your recommendation for putting these fires out?

MURROW: I can speak with authority regarding only one adsorber configuration and under the test conditions I used, water did not extinguish the fire while the air was flowing. If you have parallel systems and can transfer to another, or shut off the air and then apply water, the fire can be extinguished eventually. To repeat myself, we are installing adsorber systems together with extinguishing systems throughout the country and these systems have never been tried.

When I began the series of tests three years ago, I would have been perfectly willing to sit down and write what we used to call a "graphite" solution, viz, the "results" of an assigned experiment without conducting the experiment. I was very surprised that the conclusions I had reached in my mind did not actually work. Therefore I hesitate to say that the "graphite" solution on a drawing, e.g., "The spray is going out across the adsorber and will extinguish any fire.", is a valid conclusion when not based on reality. I say, "Let's try it."

FIRST: I hope nobody will confuse the "graphite" with the "carbon" in this particular discussion. May I direct your attention to the Eleventh Air Cleaning Conference Proceedings in which you will find not only the paper which Mr. Murrow has mentioned, but a good deal of discussion about his findings. My own conclusion, after seeing some experiments and reading about the rest, is that there is only one solution to a carbon fire; don't let it get started! Because it's impossible to put it out by any practical method.

PHILLIPS: I understand that some experiments are taking place or have taken place, using liquid nitrogen to put out these fires. Is there any validity to that?

MURROW: While verbally reported at the meeting, it did not appear in the Proceedings. I used water at the rate of 115 gpm at 150 psig without extinguishment. I then used liquid nitrogen as a

a desperation move because I didn't want to conclude with a lot of negative answers, I wanted at least one positive answer, no matter how "far out."

MARBLE: I'd like to defend the industry slightly. Insurance organizations require that manufacturers of this equipment install water spray systems, even though we know it should not be done. To get a license, the Nuclear Energy Liability Insurance Association (NELIA) requires that we install a water spray system, a fire detection system, et cetera. It hopes that it will never have to go into operation, of course.

FISHER: I'm going to direct this question to Mr. Murrow since I didn't get to ask Mr. Nelson. It seems to me that in your experiments comparing sodium chloride aerosol and DOP aerosol that you open yourself to possible introduction of large experimental errors by not testing the filters with both agents in the same experimental apparatus. There's no way that you can be sure that the filters that were tested at Hanford and then moved down and tested in your facility are still in the same condition. Why did you do that?

MURROW: I think that perhaps that is answered in the full paper that will be in the Proceedings.

At Livermore, we did not have a thermal monodisperse DOP generator. At Hanford, they did not have a sodium chloride test rig. Therefore, we took ten filters from Hanford that were damaged, tested them at Hanford with DOP, and brought them to Livermore for sodium chloride testing. At Livermore we took ten damaged filters, checked them with sodium chloride and sent them to Hanford to be checked with DOP. It was a double-exchange test method. Granted, it would have been much better to have done as you suggested, but it was impossible because the two systems did not exist at the same place. By double-exchange we hoped to eliminate the problem you suggested. Everything doesn't coincide exactly, but the data are close enough that I think the rough comparison of 2 to 1 on the ranges that were tested is essentially valid.

FIRST: Humphrey Gilbert would like to speak on several subjects: Testing, Test Facilities, and New Filter Installations.

GILBERT: I will forego review of that portion of the session that I chaired yesterday and in the interest of brevity merely pass along a few assorted topics for your information. I would reiterate the fact that development of the large aerosol generator by Hanford Environmental Health Foundation has given us a testing capacity which we never had before. Now we can test with DOP those filters which clean the exhaust air from a chemical separations plant, such as the large air volumes of Hanford's Purex facility and the sand filters of Savannah River Plant's separations facility. We now have the first actual full-scale test of one such installation. Heretofore, filter efficiencies for these large plants have been little more than postulations.

As Mr. Anderson mentioned yesterday, there will be a change in the filter paper specification for the high-efficiency filter. Some time will be needed to realize the revised specification.

At this particular time, at the Idaho Chemical Processing Plant there is under design one of the glass fiber bed filters, similar to the fore-filter of Purex and somewhat larger. The fiber to be used in this filter is Owens-Corning's 115K, which is 28 microns in diameter and the only glass fiber made in a curly form. Therefore, the fiber resists packing that might otherwise occur and it does a very good dirt-collection job.

The departure of this installation from the Purex design is in the second stage of filtration. Rather than the two-media bag-filter type deep bed, high-efficiency filters will be used.

Concerning plutonium filtration, any uneasiness over the fire-resistant high-efficiency filter collecting a critical mass of material may be relieved. You may take comfort from the fact that the glass fiber, making up the medium for the HEPA filter, is derived from borosilicate and therefore contains sufficient boron to alleviate this problem.

Finally, I would draw your attention to the ANSI standard which has been released only recently. The number of the standard is N101.1-1972, and the title is "Efficiency Testing of Air Cleaning Systems Containing Devices for Removal of Particulates." This is the procedure for the in-place test of the HEPA filter system when installed in place. Some seven years were required for approval of the standard but this, of course, resulted merely from the two reorganizations that the approval organization underwent to become the American National Standards Institute. You should expect to see N101.1-1972 prescribed in the AEC Design Criteria and you should not be surprised to see it in Regulatory requirements. The standard is priced at $4.00 per copy.

FIRST: Our next speaker is Mr. W. B. Kerr, Allied Chemical. His topic is "Sampling Problems and Need for New Filter Media."

KERR: As just stated, at Idaho we are putting in deep bed filters followed by HEPA filters. In the near future everything that goes up our stack will have been filtered by HEPA filters.

People have told us how to make the air cleaner and cleaner but not how to find out how clean it is. What do you sample with after it has gone through the best filter we know?

This morning I was pleased to hear that you can sample with the same type of filter and you still retain 99.9+% of what penetrated the plant filter system. At Idaho, the particulate stack samples are analyzed by direct counting and then certain radioisotopes are separated for further analysis. Some of these cannot be leached from the glass fiber material without expensive, time-consuming work in the laboratory.

I am, therefore, issuing a plea to filter media manufacturers and hope those of you who have similar problems will also make your needs known. That plea is, "can't we have a filter medium that is similar to the HEPA filter in air flow rates and particle retention but made of a material that will dissolve in a cold mineral acid; preferably nitric acid?" Membrane filters are made in equivalent, or smaller, pore openings; but the flow rates are low at equivalent pressures. This requires large sampling equipment for a 10 cfm sample taken from a 100,000 cubic foot per minute stack.

So, again I ask, "Can't the filter media manufacturers spin plastic media that will give us a filter that is equivalent to the HEPA filter in flow and particle retention, but soluble?

FIRST: Are there any media manufacturers who would like to answer?

METZGER: We make deep fiber-bed filters and we do pack them in polypropylene fiber, which is soluble in nitric acid. Efficiencies are in excess of 99%. We've not yet tried to achieve higher efficiences, but we are sure higher efficiencies are possible.

FIRST: Is it practical to test a system which is 99.97+% efficient with a filter material which is only 99% efficient?

METZGER: Yes. It would be 99% efficient on whatever gets to it; as a HEPA would be 99.97% efficient on whatever gets to it. Therefore, using such a filter is as practical as using a HEPA to test a HEPA.

FIRST: I'm not sure I would consider either one as practical; that's the point of my question.

KERR: How does the flow rate vs. pressure differential compare with that of a HEPA filter?

METZGER: These filters can be built with virtually any flow rate and any pressure drop. There is no need to maintain velocities to get high performance. Velocities can be reduced by increasing the filter size to obtain the pressure drop required without sacrificing efficiency.

KERR: This was my complaint about membrane filters; I have to go to big filters.

METZGER: It's got to be a big filter if very low pressure drops are mandatory.

KERR: What I'm asking for is a filter medium that has favorable flow rate vs. pressure differential characteristics with particle retention similar to HEPA.

HUTTEN: As I understand your request, you want HEPA media that are soluble in nitric acid. This is inconsistent with HEPA media specifications which require a great deal of chemical resistance, including resistance to acids. This is one of the

reasons why glass fibers are used rather than some form of organic fiber.

KERR: I think you misunderstood my problem. I am just asking for a sampling filter. I am not talking about big HEPA filters for large system filtration. I just want to collect a sample and I don't think HEPA standards apply.

RIVERS: Some years ago Dow spun polypropylene, or perhaps polystyrene, fibers which were even finer than those used in the HEPA filter. Unfortunately, they were so electrified that they were almost impossible to handle. I can't offer you much hope on getting a paper maker to produce filter paper from this sort of fiber. There is a porous Teflon membrane which might allow your particles to be washed off pretty successfully and yet have efficiency comparable to other membrane materials.

KERR: Is this the G.E. nuclepore?

RIVERS: No. The name of the manufacturer is W. L. Gore and Associates, Newark, Delaware. It's quite different from Nuclepore.

EDWARDS: There is research constantly under way for improving HEPA media. You heard a report from the Herty Foundation on some HF-resistant paper they were trying to develop. All of the medium manufacturers are willing to try, under reasonable circumstances, any program that a user feels he needs. If you make your wishes known to Flanders, or to any other medium manufacturer, an effort will be made to respond to that need.

FIRST: I'm not sure that the HEPA filter manufacturers are the ones to make sampling papers. It may be that this need should be referred to the companies that make special filter papers for analytical use. They would be more likely to have solutions, I think.

KERR: I have personally contacted Gelman and Millipore and they offer me no help at all. Perhaps they don't understand the need. I'm appealing to users. If anyone else has this same problem, let the manufacturers know.

BURCHSTED: Dr. Wilhelm reported on some plastic fibers at the IAEA Conference held in conjunction with the 10th Air Cleaning Conference in New York. There is also what is known as a CWS paper. It is highly flammable, but can be consumed in acid. Perhaps it might be used as a sampling filter. There are very few CWS filters being made today. When we do use them, we destroy them by fire and they burn like a torch. You have to be careful with them.

FIRST: All except the asbestos content, of course.

BURCHSTED: Right, and you also have to consider the factor of flammability with plastic fibers. When you use them it has to be done with some degree of care.

Another point; I did not hear the paper that you referred to in which they talked about each of the sequential filters having a

99+% efficiency. At the 9th Air Cleaning Conference, Bob Kessie reported on tests with plutonium aerosols using two filters in series. The efficiency of the second filter for the aerosol approaching that filter was more nearly 36 to 48%. It was not 99.97% on the second filter.

STEPHENSON: In the United Kingdom, the Atomic Energy Establishments are using a Whatman GF/A glass fiber filter paper, 5.9 cm diameter, which has a pressure drop of the order of 4-in w.g. at a flow rate of about 30.1 per min. This filter paper is used for a variety of stack sampling purposes, including measurement of the amount of plutonium released to the environment. In general, the method of assay is direct alpha counting of the deposit on the filter paper. Stevens at Harwell, using radon daughters on condensation nuclei, has shown that absorption of alpha particles by glass fibers is very small since a very large fraction of the deposited dust particles is captured in the upper surface layers of the filter media.

FIRST: I am afraid we are not being response to Mr. Kerr's question. My suggestion is that everyone who needs this kind of paper, such as Allied Chemical, should get together now and invest some money cooperatively in basic research on the subject and not just wait until Uncle Sam decides to solve the problem for them.

FISHER: I would like to respond to Mr. Kerr. I suggest that you look at the Pall-Trinity-Micro Ultipore series. They will sell you a membrane filter that will do anything that Gelman's or Millipore's will do. It will also fit standard 10" cylindrical industrial housings. It is an extended surface filter. As such, it has very low pressure drop compared to the single, flat disk types that Millipore sells. They are available with various internals, including carbon steel. As to the other part of your problem, I am a dishpan chemist, and I would like to run nitric acid through these things. Unfortunately, for my purposes, they show a distressing tendency to dissolve quite rapidly in concentrated nitric acid. In fact, I can't use them.

FIRST: The next speaker is Mr. Thomas from the Health and Safety Laboratory, New York Operations, on the topic of "Air Cleaning System Testing Using Ionized Air".

THOMAS: What I'm going to talk about is mainly a concept and there has been very little experimental work done. I don't usually speak without data to back me up, but I want to describe a new concept of testing air cleaning systems, particularly carbon beds. It is a completely non-destructive test and doesn't use Freon, or oily DOP, or any chemicals of that nature. You use ionized air.

It's easy to prepare ionized air by the use of radioactive sources or gas flames. The important thing about ionized air is that when an ion hits a surface, it loses its charge and a neutral air molecule bounces back off. Therefore, it's completely non-destructive. What you must do is pass ionized air through a particulate filter or carbon bed and measure upstream and downstream ion concentrations. This tells you whether or not surfaces have been contacted by ions

during their passage through the filter. Ions diffuse at about the same rate as gas molecules, having diffusion coefficients of 0.03 - 0.04 cm^2/sec. If ions go through the carbon bed without being discharged, i.e., if ionization is detected downstream, that means that unionized gas molecules will also miss the carbon granules and there will be adsorbable gas penetration through the bed.

It's possible to use ionized air for leak testing air filters or carbon beds. This summer, a graduate student from Cooper Union, New York City, did some tests with ionized air for me. It so happened that it was convenient to test filter papers rather than carbon beds. We really should have worked on carbon beds, but time limitations prevented this. He put leaks of known size in filter papers and measured ionization downstream and upstream of the leak to see if there was agreement between the leak size calculated from ionization measurements and from measurement. Agreement was good.

Perhaps ionized air could replace the Freon test for in-place carbon bed testing. What I like about it, is it's completely non-destructive characteristics--and you don't have to remove adsorbed Freon after the test is over. I don't think it would affect the carbon bed if you ran ionized air through it for a hundred years. I like the instrumentation better because I think it's easier to use a flow ion chamber and measure ionization upstream and downstream than to use gas chromotography. I haven't tested any carbon beds but I think one of the main points will be whether or not the test is sensitive enough. From what I know about measuring ionization currents, we ought to be able to get a factor of 10^4 or even more, easily. In conclusion, I'll just say I think that ionized air might have a future for a new, completely non-destructive method for testing carbon beds. It could also be used for testing particulate filters, but I don't recommend it, because results will not be as accurate as with the DOP test. However, there may be special cases where DOP cannot be used on filters. The reason ion testing won't be as accurate as DOP is because more ions than particles will be taken out going through a hole because ions diffuse more rapidly. But, for carbon beds, I think it might be a good thing.

THAXTER: I don't know what level of ionization density you are talking about, but I can't help recalling an experience of about 1951 or 1952 when one of our biology researchers wanted to do some work on inhalation experiments with carbon-14 in animals and got some very screwy data because his ionization currents were flopping all over the place. It turns out he was using ordinary room air for his carrier gas supply and the radon content varies manyfold from day to day, so his data were no good until he started to use stored air in bottles. Normal radon decay took care of this variable background. He got good data thereafter.

THOMAS: That's a valid point. What you would have to do, of course, is run an experiment first without adding any ions and use this as a blank. Incidentally, I did not mention that we used a propane torch as an ion generator. It's very easy to generate a lot of ions this way. The quantity is not too dependent on the intensity of the flame or how much gas is burned. Typical ion

currents are 10^{-8} amperes upstream and 10^{-11} downstream. I think you can subtract backgrounds if they don't change too rapidly.

RIVERS: I might say that this isn't theoretical at all. I would say, from some work we've done, that it's quite feasible. We used ozone as a contaminant (generated by ozone lamps and wire and strut-type ionizers) and a chemiluminscent ozone detector. It works like a charm and there is no residual contaminant in the filter or in the duct system.

THOMAS: You were using this for testing particulate filters?

RIVERS: No; for carbon. Carbon has a tremendous affinity for ozone. It hadn't occurred to me that you could use it for particulate filter testing.

THOMAS: I don't recommend either technique for particulate filters. But your test is completely non-destructive, too. You don't have to blow anything off.

RIVERS: In fact, it may even help. There is one thing, of course. Both ions and ozone have a decay constant. There will be an apparent efficiency even if there is no filter there. However, it's very simple to place the detectors close to the filter upstream and downstream and, then, decay is negligible.

THOMAS: Yes, you have to watch out for a few things like that, but I think they can be taken care of.

JONAS: On behalf of Vic Deitz, who has left, I would like to comment on what Dick Rivers mentioned. You can't use ozone on carbons because it reacts. Vic Deitz has published information on this reaction. Ozone is absolutely out. When you get carbon monoxide and carbon dioxide as a result of this reaction, you change the nature of the surface of the carbon. However, I would like to say that I think Jess Thomas' idea of ionized air is a very interesting one. We have an interest in non-destructive testing and I think it's a very good idea.

THOMAS: Let me just say this in return. I intended to mention right after you spoke that I like the looks of your gas adsorption theory. It would be very interesting if you would take the experimental results obtained by some of the people here (which they use to calculte dynamic adsorption coefficient) and use their raw data in your equations to see how they come out. When that's done, I would like to hear about it.

RIVERS: Indeed, ozone may be unusable for certain applications. I haven't been involved directly in the thing that you are talking about. This was our own work with regard to nuclear application. There is ozone present in the air all the time and every carbon filter is, of course, filtering out some of it constantly, and yet they do continue working. We have followed ozone exposure with radioisotope tests and have had no problem whatsoever with degradation.

FIRST: Thank you very much, Mr. Thomas, for your very provocative suggestion. The next person to speak is Thomas Metzger, Monsanto Environmental, on the topic of "Packed Fiber Filters."

METZGER: I would like to discuss a type of deep fiber bed that is different from the Hanford-type that was discussed in the Savannah River report* given yesterday and to present our experience very briefly.

I'm sure that the report that the Savannah River people put out did not intend to characterize all deep fiber beds, but rather the Purex-type fiber bed, and I would like to mention first that my comments don't apply to a specific fiber bed, but to a group of relatively thin fiber beds that we've worked with over the past fifteen years.

Our work with fiber beds has given us a considerable amount of information on the performance we can expect from one of these thin fiber beds before it is built. Efficiency and pressure drop have become very predictable. The Savannah River report discussed the performance of a Hanford type filter, and its summary includes many important traits of the deep fiber-bed filter. I would like to offer analogous information on the thinner, more rigid fiber beds with which we are working. Perhaps the most meaningful way to do this is to go through Savannah's summary and compare each deep-bed characteristic with what might be expected of our thinner fiber-bed elements.

The first two conclusions for the deep-bed filter were ability to operate at very low pressure and design flexibility as regards collection efficiency. These also characterize thinner beds.

The third conclusion was that deep-bed filters have a more easily predicted life status. I would like to postpone for a few minutes my comments on the life of thin fiber beds, because these comments are somewhat involved.

The remaining conclusions for the deep-bed filters include a tendency to bypass or leak, variable efficiency, and difficulties in design and quality control. These same problems arose in our early work on the thinner fiber beds, but have long since been solved.

Our work with fiber beds was originally directed toward mist collection, so our performance criteria included wet operation and provision for draining out collected mist. We have since learned that when solid particles are collected concomitantly with mist, the solids can often be flushed out of the fiber bed with the liquid drainage.

This brings me back to the question of the effective life of these thinner fiber beds. The usual life definitions (such as the weight of solids collected) are meaningless if collected solids can be flushed from the fiber bed, and its original pressure drop restored.

* p. 596

In conclusion, there is much information available on different types of fiber beds, and this information is available to those who are seeking specific solutions to problems, or generalized information on which they can base their future research.

FIRST: I have a final name on my list, Douglas Craig, Battelle Northwest, who will speak on "Filtration of Plutonium Aerosols."

CRAIG: I'd like to talk about filtration in general, particularly as it relates to particle size and to plutonium. I was going to make this comment earlier but, because of the shortage of time in the general discussion, I didn't get a chance to do so.

My qualifications for talking on this subject are that I have been working extensively with both 238- and 239-plutonium dioxide for the last three years. We have taken thousands of samples and attempted to obtain particle size distributions on thousands of samples of both isotopes. The first comment that I would like to make is that we have consistently found a significant difference in particle size distribution of plutonium-238 and plutonium-239 dioxide aerosols even though we've used absolutely, as far as possible, identical methods of preparation. This is a comment that might be of some importance in considering filtration.

The second point refers to the relationship between particle size and filtration. Now, if we neglect electrostatic effects, the major mechanisms determining filtration of particles are impaction, sedimentation, and diffusion. If we plot particle diameter on a log scale, stretching from 0.01 to 10 μm, and displacement in cm/sec, also on a log scale, the curves for sedimentation of spheres of different density are shown in Figure 1. The curves for particles of higher effective density are displaced to the left. For diffusional displacement, which is independent of density, the curve slopes the other way (Figure 1) and it is these characteristics that lead to maximum penetration at a certain size. This size is different for DOP or other essentially unit density spheres than for aerosols containing plutonium dioxide which has a density of approximately 10 g/cc. The size at which maximum penetration of fibrous filters occurs is displaced toward smaller sizes as density increases. This could be a significant factor in determining what size aerosol to use for testing filters.

Another very important point to me is that if one gets good agreement in testing filters with a polydisperse aerosol and with a monodisperse aerosol, that is an accident, and I really mean that seriously. It's an accident. It is fairly easy to show that if one uses different size of monodisperse test aerosols, one is going to get different filter efficiencies, so filter efficiencies obtained with a polydisperse test aerosol apply only to other aerosols with the same size distribution. I think that is an important point to be stressed.

It seems to me that many other effects that influence filtration efficiency have been neglected at this meeting. Electrostatic effects have scarcely been mentioned. Mr. Dorman mentioned them

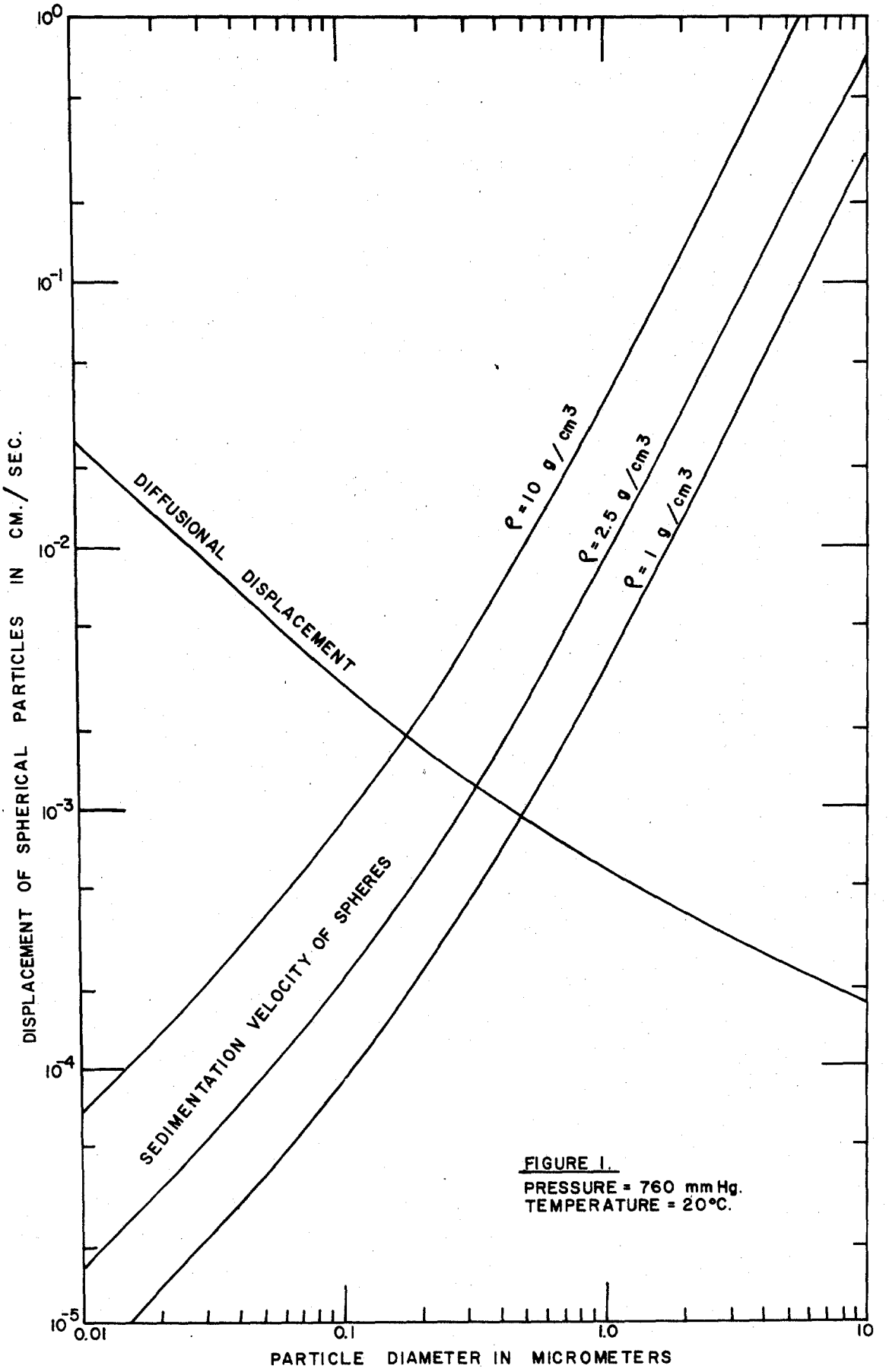


FIGURE 1.
PRESSURE = 760 mm Hg.
TEMPERATURE = 20°C.

very briefly, and said that with a discharged aerosol he observed greater penetration of filters than with a highly charged aerosol. A variety of factors have to be taken into consideration, of course. Relative humidity is going to affect the charge. Mr. Dorman spoke only of charge on the aerosol but there is also the charge that builds up on the surface of a fibrous mat that is collecting particles. In high radiation fields, with air ionization, the charge tends to dissipate to some extent and, therefore, one would expect, at least theoretically, to get higher penetration of aerosols when the radiation field is high than when testing filters with dry aerosols that, potentially, could have a fairly high charge.

One last point, and this is something that I think has been alluded to but hasn't really been sufficiently emphasized, the effective decontamination factor of a filter is perhaps not the most important thing to be considered in testing filters. What is important, ultimately, is how much material is escaping into the atmosphere. If filters have 99.99% efficiency and the upstream concentration is 10 mg/cu m, the decontamination factor is 10,000 and 1 µg/cu m gets through. If the upstream concentration is 1 µg/cu m and the filters have only 99% efficiency, the decontamination factor is 100 and 0.01 µg/cu m escapes. Which would you rather have? This is something that needs to be considered in all discussion about the effect of concentration on efficiency of filters. What ultimately matters, particularly for plutonium, which for all practical purposes is in the environment forever once it gets out, is what gets through; what goes up that stack; not the filter efficiency.

DORMAN: I agree with you, sir, that it could be accidental that the polydisperse aerosol has the same penetration as the monodisperse, but results do depend on the degree of polydispersity and the mean size.

For example, consider the sodium chloride and the DOP aerosols; basically, with a HEPA filter, very little above half a micron penetrates and nothing perhaps below 0.1 µm gets through because of the diffusion effect. So the useful part of the sodium chloride cloud is effectively 0.1 to 0.5 µm (about half the total mass is in this range), whereas the DOP is effectively perhaps 0.2 to 0.4 µm. So, both are centered about 0.3 µm as far as penetration is concerned and this is why, in those two particular test aerosols, one often gets very similar penetrations (i.e., within a factor of 2).

FIRST: Anyone who considers Mr. Craig's comments on filtration to be original hasn't been reading the literature on filtration for the last 20 years. Perhaps we need to be reminded from time to time.

GOVERNMENT-INDUSTRY CONFERENCE ON ADSORBERS AND ADSORBENTS*

C. A. Burchsted
Oak Ridge National Laboratory

Like the Government-Industry Conference on Filters and Filter Media, reported earlier by W. L. Anderson, the Government-Industry Conference on Adsorbers and Adsorbents started when a group of interested perople met informally in a hotel room, during an earlier air cleaning conference, to discuss operational problems. Eleven persons attended the first meeting, 27 the latest, which was held during this conference. These included 11 from industry, eight from Government, five from prime contractors to the Government, and three international observers.

Domestic Carbon Survey

A primary question at that time, as now, was the strategic aspect of the activated carbon supply. The most widely used activated carbons for nuclear gas treatment are made from coconut shell. However, practically all of the coconut shell-carbons are imported from tenuous sources which potentially could become unavailable to this country in the event of a national emergency. Little, if any, coconut is grown commercially in this country. As a result, it was decided to investigate domestic bases for the manufacture of activated carbon. These include coal, coke, petroleum, wood, and domestic nuts. A preliminary survey of potential suppliers was made after the first meeting and a list of candidate materials, with characterizing properties, was distributed to this meeting of the Conference (see attached). Samples of most of the candidate materials are on hand or are forthcoming.

It was recommended that the suppliers be recontacted to furnish (1) the pressure drop for a standard apparent density; (2) performance data for elemental radio-iodine; (3) the iodine number; (4) aging properties; and (5) reaction of the material with ozone. It was pointed out that standardized tests for these, except the iodine number and possibly the ozone reaction, do not exist and would have to be developed before we go to the manufacturers. A manufacturer's representative also pointed out that suppliers may not be willing to make additional tests unless there is promise of substantial business in the nuclear market. A question was asked also concerning verification of data furnished to date; it was suggested that any verification needed might be obtained by an independent or Government laboratory from the samples on hand.

Adsorber Cells

The Chairman (Humphrey Gilbert) reported that AACC (American Association for Contamination Control) standard CS-8, High-Efficiency Gas-Phase Adsorber Cells, has been approved by AACC and is now being readied for printing.

Carbon Mesh Size

Pence (Allied Chemical, Idaho Falls) opened the discussion with a statement that, within any mesh-size distribution, there is an optimum distribution, by proportion, of each specific granule size within the range. In the past, it has been common to state merely the limiting sizes of the range, for example, 8 x 16 mesh, with rather gross limits on the proportions passing or retained on each intermediate size of sieve. Kovach (Nuclear Consulting Services) agreed, and noted also

* Submitted after conclusion of the meeting.

that there is an optimal internesting of granules of different sizes; too large a proportion of either small or large granules upsets this balance. Optimal packing of any mixture, as furnished, can be attained by the test for apparent density of ASTM D2854; this method is recommended for referee purposes. For an optimally packed mixture, there is a characteristic apparent density (AD) and a characteristic pressure drop (ΔP) at some specified linear air flow velocity. Wilhelm (Germany) suggested that efficiency is also a function of this characteristic ΔP and recommended standardization of tests at a velocity of 25 cm per second, temperature of 25°C, and bed thickness of 10 cm. In Germany, he stated, this is a standard test for performance and has great value to the engineer in designing the system.

Evans (Savannah River Laboratory) suggested the alternate approach of specifying very close "cuts" on each granule size within the range. However, it was pointed out that, if the optimum distribution and its equivalent AD and ΔP are known, the standardized pressure drop, with appropriate tolerances, is preferable since it is a performance test. Conversely, it was indicated that it is essential to closely tailor the requirements of the HEPA filter media to achieve necessary performance and quality, and the same approach may be needed for adsorbers and adsorbents. This means that there could be a problem of what to do with material rejected during the additional screening required, with some additional cost. None of the manufacturers present would postulate what this increase would be, although some experience is available with carbons supplied to Savannah River Plant. Wilhelm noted that if we have a correlation between ΔP and decontamination efficiency (i.e., for radioactive CH_3I), we can predict the bed thickness necessary for a given system efficiency.

Nondestructive Leak Test

Thomas (AEC Health and Safety Laboratory) reported on a study using ionized air for in-place testing of both adsorbers and HEPA filters, in lieu of Freon or DOP, respectively. This method, which uses a propane-torch ion-generator, would be nondestructive. The work is highly preliminary but, according to Thomas, looks promising. Anderson (Naval Weapons Laboratory) cautioned that flow-ionization chambers, although easy to use, are notoriously unreliable. Kovach suggested that ^{133}Xe may also be useful for testing.

Water Sprays

Marble (Farr Co.) reported that a preliminary study by graduate students at UCLA showed that water sprayed on activated carbon, even at temperature as low as 185°F, releases the iodine with which the carbon has been impregnated, and would therefore also release any radio-iodine trapped on the carbon. This would, of course, result in loss of containment for iodine. It should be pointed out at the same time that the designer, in certain cases, is required to provide for water sprays to impinge directly upon the gas-treatment-system-carbon beds.

U. S. Atomic Energy Commission

DOMESTIC CARBON SURVEY

Properties of 6 × 16 and 8 × 16 Mesh Base Carbons

Item	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Manufacturer	W Vaco	Carbide	Carbide	Carbide	Witco	Witco	Calgon	NAC	B-C	B-C	B-C	B-C	B-C	Carbide
Grade	WV-H	JXC	MBV	SXWC	337	888	BPL	GX-163	224	164	191	213	257	ACC 6/14x
Base Material	Coal	Pet	Coal	Pet	Pet	Pet	Coal	Wood	Coal	Nut	Nut	Coal	Pet	Pet
U.S. Std. Mesh - Range	6 × 16	6 × 14	6 × 14	6 × 14	6 × 16	8 × 16	6 × 16	6 × 16	8 × 16	8 × 16	8 × 16	8 × 16	8 × 16	6 × 16
A.D. - ASTM D2845 g/cc	.46-.56	.53	.46	.47	.39-.44	.39-.44	.48	.27-.32	.5	.35	.35	.6	.5	.47
CCl_4 Act., MIL-C-17605 - %	60	63	63	64	65	85-95	60-65	65-70	70	90	80	55	60	65
Area, BET - m^2 / g	1050-1150	1200	1000	1100	1300-1500	1700	1050-1150	1000-1150	1200	1500	1400	1100	1000	1100
Hardness, MIL-C-17605	90	98	98	98	90	90	90	90	95	98	98	99	98	90
pH - proposed ASTM	8-9	10.5	10.5	10.5	8	8	7-8	2-3	7	10	10	7	6	10.5
Ignition - proposed ASTM, °C	460	370	360	400	480	470	460	340-360	450	340	340	450	450	360
Ash - ASTM D2866 %	5-7	1	8	1	1	1	8	7	10	5	7	10	2	2
Moisture - ASTM D2867 %	2	1	1	1	1	1	2	7	5	5	5	5	5	2
Sulfur - ASTM D2492 %	--	1.2	1.3	0.3	2	2	0.8	0.1	1.5	nil	nil	0.5	2	1.2
Micropore - N_2 Adorb. cc/g	.48-.55	.66	.54	.71	.50	.65	.46 *	.72	.60	.85	.75	.55	.55	.66
Macropore - Hg Int'n cc/g	.24-.32	.35	.44	.40	.20	.37	.24	.5	.45	.30	.50	.25	.45	.35
Micropore/Macropore Ratio	1.7-2.1	1.90	1.23	1.78	2.50	1.75	1.92	1.44	1.33	2.83	1.50	2.20	1.22	1.90
Cost, $/lb, 2000 lb lots	.46-.48	.58	.52	.97	----	----	.505	.55	.70	.85	.80	.50	.60	.62

W Vaco -- WestVaco
Carbide -- Union Carbide Corp.
Witco -- Witco Chemicals Co.
Calgon -- Pittsburgh Activated Carbon Division, Calgon Corp.
NAC -- North American Carbon Co.
B-C -- Barneby-Cheney, Inc.

*Calgon procedure; comparable ASTM value not given.