Air Cleaning Activities at Argonne National Laboratory

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The majority of the air cleaning studies made at Argonne vary little
from those that would be made in any large diversified research laboratory.
This morning I would like to discuss two of the investigations we've made
within the past year, one of which has already been completed, the other
is still in progress.

The first concerned the investigation of the absorption of some halogen
gases from an air stream. Before any work was started on this project a
search of the literature revealed that essentially two methods used in the
past should be investigated to determine their applicability to our setup.
These were first, a method by T. P. Hignett and M. R. Siegel in Industrial
Engineering Chemistry, 41,2493 (1949) wherein they used a four foot deep bed
of $\frac{1}{4}$" - $\frac{1}{2}$" oölitic limestone particles to extract HF from the exhaust gases
of a phosphate roasting process where the temperature of the gases ranged
from 200 to 900°F. Efficiencies of 71 to 96% were obtained with the aid of
a recycle process used to remove the calcium fluoride fines and thereby pro-
vide fresh reaction surface. The oölitic type, i.e., the large open grained
type limestone, was found to be superior to non-oölitic (fine grain structure)
such as crushed marble, because the calcium fluoride reaction product held to
the parent calcium carbonate less tenaciously.

The other method for removal of halogens was that of absorption by scrubbing.
This had been investigated by W. B. Burford and J. M. Hamilton in National

maintain the spray cone had little effect on the efficiency. With contact time as short as 1.7 seconds, it was found that 98½% efficiencies were obtained for fluorine absorption, while hydrogen halides showed comparable absorption efficiencies.

At concentrations ranging from 900 to 70,000 PPM and under various operating conditions, the lowest efficiency obtained for any halogen or inter-halogen in the scrubber was greater than 90%.

From these results, and many others which time will not permit us to discuss, it was concluded that the öolitic-limestone is adequate for the removal of HF from air streams at room temperature until about 50% of the bed is consumed, providing particles $\frac{1}{4} - \frac{1}{2}$" in diameter are used. An increase in the depth of bed will give an increase in efficiency while a decrease in particle size will increase capacity. The limestone, however, is not adequate for halogens other than HF particularly bromides if a high efficiency and capacity are desired.

The concurrent spray tower with 1 stage will effectively remove halides and interhalogens with efficiencies greater than 90% when a 5% KOH scrubber solution is used. In addition, there is the advantage of working under a negligible pressure drop through the system because of the aspiratory effect of the spray nozzle, making an increase in blower capacity or strengthening of ductwork in the existing system unnecessary. It is estimated that using the conservative distance of 1 foot between each of three stages and using 3000 to 6000 pounds per hour of scrubber liquid per sq. ft. of tower with a gas contact time of 1.7 seconds, a halogen concentration of 2000 ppm would be reduced to an effluent concentration of 10 ppm.

This work was done by Messrs. R. C. Liimatainen and M. Levenson of the ANL Chemical Engineering Division and is written up more thoroughly in ANL Report 5015.

Another study brought on by economic considerations revolves around the prefilters being used in the laboratory hoods. These filters used in the rear of all hoods as shown previously by Mr. VanValzah serve two useful purposes; first, they act as diffusers making for an even flow across the face of the hood, and secondly, they prefilter the air before it passes through the final filter and thereby it is hoped they increase the life of the final AEC filter. However, this second point has never definitely been established and the exact effect on the life of the final filter is not known. The pre-filters in use (PF 314) have an average life of from 3 to 6 months. While the final filters vary from 12 to 18 months, the relative cost of the final to the prefilter is approximately 10-1.

Theoretically, the prefilter could shorten the life of the final filter by only intercepting the large particles and thereby permit the smaller ones to pass through to the final filter where they could plug it more rapidly than if the large particles had been allowed to pass. This possibility is, of course, remote, but has not been resolved, so a test was undertaken to determine the true situation.

A typical hood was selected in a new building in which the supply air is prefiltered and air samples were taken simultaneously on the clean and dirty side of a new hood prefilter using AA millipore filters.

These samples were taken periodically over a two months period, counted, and sized. The counts ranged from 32,000 to 900,000 particles per cubic foot, and had an estimated geometric mean diameter of .17 μ and a standard deviation

of 3.28 on the dirty side and .12 μ with a standard deviation of 3.0 on the clean side. These values for the geometric mean diameter were obtained by extrapolating the curves obtained by plotting the cumulative percent less than a certain size vs. that size on logarithmic probability paper. For example, on the dirty side it was found that 80% of the dust was .52 μ or less in diameter and that 98.5% of the dust was 3.0 μ or less in diameter. There were other intermediate points that fell along this line, but the smallest sized group plotted was that in the range from .52 μ down to the limit of resolution of the microscope which was plotted at the .52 μ size. Since this group contained 80% of the dust it was then necessary to extrapolate back to the 50% size to determine the geometric mean size of the dust.

The standard deviations were obtained by dividing the 84.13% size by the 50% size as selected from the logarithmic probability plot.

Efficiencies of the prefilter, by count, ranged from 17.2% to 69% with an average of 42.2%. These efficiencies were for particles .33 μ in diameter or larger, .33 μ being the limit of resolution for the lens combination used for counting. However, only 30% of the dust sized was greater than .33 μ in diameter as determined by the logarithmic probability curve and so it is expected that the true efficiency will be somewhat less.

From these preliminary studies, we now know the approximate size distribution of the dust we're dealing with, and the efficiency by count of the PF314 prefilter. However, the really important work lies ahead, that is the effect of the prefilter on the life of the final filter. We plan to get information on this by installing three or four different types of prefilters in different modules with similar dust exposure. By pre-weighing these filters

and the final AEC filter, and determining the original pressure drop across

both, the life and weight gain of each type including the final filter can

be determined. A single sample with each type will not be significant

statistically and so it is expected that this work will continue over a

period of time.

It is hoped that more conclusive results will be available next year.

VENTILATION ACTIVITIES AND PROGRAMS AT ARGONNE NATIONAL LABORATORY

By R. W. Van Valzah, ANL

The ventilation program at Argonne may be considered as having progressed through three periods, the first being the design and construction period, the second being an operating period of several years, and the third being a transition period in which modifications to the present systems are necessary in order to meet the new requirements and demands of the scientific staff. Changes and additions have been made during the operating period but the capacity limit of the present supply systems has been reached. More supply and exhaust air is particularly needed throughout the Chemistry Building 200 while the Physics Building 203 and the Chemical Engineering Building 205 have only a limited number of laboratories which require additional ventilation. With this increased ventilation problem there also is the attendant provision for increased air conditioning facilities. A preliminary proposal has recently been submitted to the AEC for making the required changes to the present ventilation systems.

The ventilation systems in all three of the above mentioned buildings are not identical. However, the Chemistry Building 200 may be considered representative of all three and a brief resume of the ventilation facilities in this building will be given. The systems were originally designed on the basis that all toxic and radioactive experiments would be performed in hoods. Blickman hoods with or without glove panels, and vacuum hoods, were generally adapted for the research activities which cover a wide range of chemistry applications. Special ventilation problems which the standard design would not accomodate were to be dealt with individually. Some of these special problems will be described later.

The Chemistry Building is divided up into six wings tied together at both ends by transverse corridors connecting with the wing corridors. The wings are separated by courtyards so that the plan resembles a ladder. Each wing is divided up into laboratories and offices with a corridor between them. The unit of width for a module is 10 feet so that a laboratory or office may be any multiple of this number. The normal laboratory unit consists of two 10 foot modules and two 10 foot offices. Hauserman steel panel partitions are used for dividing each wing into the required number of laboratories and offices, the maximum being 24 of each.

All six wings of the building are of similar design and construction and contain practically identical heating and ventilating equipment. Perhaps the starting point for an understanding of the ventilating and air conditioning systems is a description of the supply system. Slide 501-219 is a schematic diagram of the supply ventilation system in each wing. All fresh air is taken from the outside and passed through the primary and secondary filters. These are AAF Company Type PL-24 filters with standard 5 ply fire resistant airmat in the primary filters and standard 10 ply fire resistant airmat in the secondary filters. The life of the primary and secondary media ranges from 1 to 2 months and 2 to 4 months respectively based on a maximum pressure drop of approximately .5" WG for each. These filters are removing a high percentage of the dust particles as indicated by the particle size efficiency tests conducted by Mr. O'Neil on the hood prefilters.

The supply air is next drawn through the preheat coil by two fans and discharged into a plenum from which there are three separate branches. The first main branch supplies a constant volume of air to the offices and corridor, the second main branch supplies a constant volume of air to the laboratories and the third main branch supplies a variable amount of air to the corridor. Cooling and reheat coils in the three mains temper the air to the required conditions for maintaining the specified temperature and humidity. Special rooms are provided with booster heating and cooling coils in the supply risers where lower than general conditions are required.

The air flow pattern is as follows: air from the offices is vitiated to the corridor; the corridor air and the vitiated office air is vitiated into the laboratories; and this air together with the laboratory supply air is removed by the laboratory exhaust systems.

Whenever the laboratory exhaust air demand is greater than the minimum air supply, the extra supply air is provided through the variable air branch which discharges into the corridor from which it is vitiated to the laboratories. A static pressure regulator controls the opening of the variable air damper. The other temperature and humidity controls are also indicated but time does not permit further explanation of them.

The removal of the minimum supply air for air conditioning purposes and the maximum exhaust requirements will be discussed next. In view of the varying exhaust demands per laboratory and the necessity for flexibility, the exhaust systems were set up on a modular basis. Each ten foot module may have a maximum of two fans and two runouts exhausting approximately 1000 cfm each. The number of hoods in the laboratory determines the number of fans. A maximum of three Blickman hoods per runout has been established. One hood fully open requires 1000 cfm at a 150 fpm face velocity but this available quantity of exhaust air may be divided up between the other hoods on the runout. An alarm bell on the system notifies the occupant when the exhaust limit has been reached.

The runouts from the laboratory go up to the fan loft where they discharge into the dirty plenum. Slide 420-315 shows the risers connecting into the dirty plenum. Between the dirty plenum and the clean plenum are located the high efficiency filters. Slide 420-313 shows the mounting of the filters with inspection doors above and below the filters. The damper operating sectors which allow for the isolation of the filter from the system when filter changes are made are also shown. Slide 420-312 shows the exhaust fans connected to the clean plenum and discharging the air above the fan loft roof to the atmosphere.

Wherever radioactive hoods are installed, a laboratory bypass duct from the dirty plenum in the fan loft to a register in the laboratory is used so that a minimum amount of air is exhausted at all times from the laboratory. The hoods are provided with air velocity regulators which maintain nearly a constant air flow velocity for any position of the hood door. Air may either be exhausted from the hoods or from the laboratory bypass. A plenum static pressure regulator controls the laboratory bypass damper and also a clean plenum damper. All the exhaust fans on the system run continuously so that the above dampers regulate the amount of air removed from the laboratory up to the capacity of the fans. Slide 501-218 shows a control diagram for the hood, lab bypass and plenum bypass dampers. Where the minimum air is removed by a constant exhaust from another piece of equipment such as a vacuum hood or canopy no lab bypass is required.

No doubt you all are familiar with Blickman hoods. Slide 420-314 shows one of these hoods installed in a laboratory. At the back of the hood are four prefilters. These maintain uniformity of air distribution across the face of the hood, remove a certain portion of the particulate matter thereby increasing the

life of the special filters and condense some of the vapors that would otherwise
be carried into the system. Two types of media have been used in those filters
namely 25 FG and FF 314 fiberglas. Those filters have to be changed at anywhere
from 3 to 6 month intervals depending upon the pressure drop. The maximum al-
lowable resistance for these filters in order to maintain the required air flow
is .7" WG. It is therefore economically advisable to start with as low an initial
resistance as possible consistant with the required efficiency for obtaining the
maximum life from the filters. With the above requirements in mind, AAF Co. has
recently developed a new media for this filter with an initial resistance of .2"
WG or less at an air flow of 250 cfm. The discoloration efficiency tests with
atmospheric dust for these filters ran 47 to 56%. It is understood that AAF Co.
is going to standardize on this media for this type of filter and discontinue
the two other types.

One of the special air cleaning problems which has been under development
at Argonne is that of removing perchloric acid fumes. This matter was referred
to Dr. Silverman who developed a scrubber for this purpose. The constructed
model which may be placed inside of a hood has been in operation at Argonne for
approximately 6 months. Recently the filter which was made especially for this
unit by Arthur D. Little, Inc. became clogged. The following slides show the
unit as well as the condition of the filter after failure: Slide Nos. 235-108,
109, 124 and 125. Apparently the aluminum separators disintegrated either from
the Na_2CO_3 or the acid fumes. Arthur D. Little, Inc. kindly made a replacement
filter, the separators of which are made of sheet steel instead of aluminum.
The Air Cleaning Studies Progress Report for February 1, 1951 to June 30, 1952
covers a description of the scrubber along with test data on the performance of
the scrubber with sulphuric acid. Further tests by Mr. O'Neil on this unit with
perchloric acid showed efficiencies ranging from 96 to 99.9%. Drawings are now
in progress for the construction of several of these units.

There are other ventilation problems at Argonne still in the process of
resolution. The one causing the most concern at present is the ventilation
treatment required for metallic fluorides. It is hoped that some information
in this connection may be obtained during this visit.

Nuclear Energy series, Div. VII, Vol, I, McGraw-Hill, N.Y. 1951 Page 198;

R. Landau and R. Rosen, Ind. Eng. Chem., 40,1389 (1948) and National

Nuclear Energy Series, Div. VII, Vol. 1, McGraw-Hill, New York, 1951,

Page 133 and E. M. Berly, M. W. First and L. Silverman in N.Y.O.-1585 1952.

The former two using NaOH as the scrubber liquid with low gas velocities

and a relatively long contact time of approximately one minute reported high

absorption of F_2 and HF. The latter, i.e., Silverman et al. using successive

stages of saran fibre wetted by a spray of water and followed by a dry cell

effected efficiencies of 99% with velocities of 200 L FM but with a pressure

drop of 4" H_2O.

.With these two methods available then, it was the objective to evaluate

each, i.e., for the limestone bed process to determine the efficiencies for

fluorides, chlorides, and bromides at room temperature and to determine the

minimum bed depth and gas velocities for minimum pressure drop and for adequate

efficiency with no recycling. And for the scrubber method to determine the

efficiency for elemental fluorine and interhalogens using a contact time on

the order of seconds rather than minutes in order to keep the size of the

tower reasonable.

The investigation of these two processes involved the use of two 5 inch

diameter pipes, one 4 feet long used as a spray tower in which a Shutte-Koerting

hollow cone 60° spray nozzle was centered and one 6 feet long in which the

various depths of limestone bed were packed. After the mixing of the halogen

and the air stream, the air-halogen stream entered a gas distribution section,

flowing either up through the bed in the limestone absorption tower or down

through the spray tower flowing concurrently with the aqueous potassium hydroxide

solution which was sprayed from the nozzle and which was used as the absorbing

solution.